The Economics of W.S. Jevons

Sandra Peart

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Truth is the iron hand within the velvety glove, and the one who has truth & good logic on his side will ultimately overcome millions who are led by confused and contradictory ideas.

(William Stanley Jevons, Miscellaneous Notes on J.S.Mill's Logical Method, JA6/5/43)

CONTENTS

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ABBREVIATIONS

ASF	*A Serious Fall in the Value of Gold Ascertained, and its Social Effects set forth* (1863)
BAAS	British Association for the Advancement of Science
CR	*Contemporary Review*
CW	*Collected Works of John Stuart Mill* (1962-)
HES	History of Economics Society
HOPE	*History of Political Economy*
ICF	*Investigations in Currency and Finance* (1884)
JA	Jevons Archives
JEL	*Journal of Economic Literature*
LPMJ	*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science*
Manchester School	*The Manchester School of Economic and Social Studies*
MME	*Money and the Mechanism of Exchange* (1875)
MSR	*Methods of Social Reform, and other Papers* (1883)
MT	'Brief Account of a General Mathematical Theory of Political Economy' (1862)
P&C	*Papers and Correspondence of William Stanley Jevons* (1972–81)
PE	*The Principles of Economics and Other Papers* (1905)
PPE	*Principles of Political Economy* by John Stuart Mill (1865)
PS	*The Principles of Science* (1874)
SRL	*The State in Relation to Labour* (1882)
TCQ	*The Coal Question: An Inquiry Concerning the Progress of the Nation and the Probable Exhaustion of our Coal Mines* (1865)
TPE	*The Theory of Political Economy* (1871)

1
INTRODUCTION
General themes

'William Stanley Jevons, Thinker'. Such is the title of a newsclipping that commemorates the fifty-year anniversary of Jevons's death (JA6/50/43). Reviews of his *Letters and Journal,* published posthumously in 1886, find that he was 'above all things, a mathematician', 'undoubtedly the foremost logician of his time', or, quite simply, 'A Great Statistician'.[1] Jevons was also, of course, a 'pioneer of modern economics'[2] and economists today most often come to know his work with marginal utility theory. But his interests encompassed policy issues as diverse as child care for working mothers and slum landlords, as well as the methodological procedures appropriate to the discipline. Jevons's research into the coal question and British manufacturing supremacy, and the effect of gold discoveries on the value of gold, was highly acclaimed during his lifetime; Léon Walras learned of Jevons's work on index numbers long before he became acquainted with the theory of exchange.[3]

From an early age, Jevons was driven by an intense desire to be, as he put it in an 1857 letter to his two sisters, Henrietta and Lucy, a '*powerful* good in the world'.[4] Early on, also, his talent for measurement became evident and was recognized by peers. Social science, 'the study of Man in society', attracted his efforts; and in social science he called for measurement, approximation, and quantification of hypotheses. He developed new techniques of data combination and manipulation, insisting that the scientist attack observations using 'wide averages'.[5] Jevons's contributions, both in terms of methodological recommendations contained primarily in *The Principles of Science* (Chapter 9), as well as the actual procedures he used in empirical studies (Chapter 10), proved fundamentally important to the subsequent development of empirical techniques in economics.[6]

William Stanley was born and raised in Liverpool, at the heart of industrial England.[7] The family was cultured, Unitarian, and, at least until 1848, well-to-do. His father, Thomas Jevons [1791–1855], worked in the iron trade and was an innovator in the use of iron for shipbuilding;[8] in 1834, Thomas published a work on reforming the criminal justice system, and in 1840, he published a piece on the Corn Laws.[9]

Jevons's mother, Mary Anne Roscoe [1795–1845], shared a cultured life with her father, William Roscoe [1753–1831], until her marriage to Thomas in 1821. She published two books of her own poetry, and introduced William Stanley to the subject of political economy when he was just eight years old, using Archbishop Whately's textbook, *Easy Lessons on Money Matters for the use of Young People*. Mary Anne died two years later, and a succession of tragic events beset the family: Jevons's older brother, Roscoe [1829–1869], who showed great intellectual promise at a young age, suffered a breakdown from which he never recovered. The family came to know the effects of economic fluctuations firsthand in 1848, when Jevons & Sons, the firm established by Jevons's paternal grandfather, suffered bankruptcy following the railway boom crisis. Jevons's youngest sister, Henrietta (Henny) [1839–1909], in whom he confided many of his innermost hopes, was institutionalized when she became mentally unbalanced soon after attending Roscoe's funeral, in 1869.

At the age of fifteen, Jevons entered the Junior School of University College, London, and he continued on to University College the following year. He studied chemistry, under Thomas Graham and A.W.Williamson, as well as mathematics and logic, under Augustus De Morgan.[10] He won the silver medal in chemistry in 1852, and the gold medal the following year. During these years in London a concern with the human condition began to manifest itself: Jevons spent many hours seeking out 'those wretched places I have heard so much of ' (31 October 1852; *P&C,* **i,** p. 68).

Jevons's talent for careful measurement, and the desire to quantify, became evident at an early age. When he was just seventeen, he was offered a position as assayer in Sydney, where a new mint was being established to coin the Australian gold discovered in 1851.[11] In part as a result of his father's financial difficulties, Jevons accepted the post. During the long sea voyage to Sydney in 1854, he began his study of weather and clouds that was to produce such articles as 'On Clouds; their various Forms, and producing causes, with experimental illustrations'; 'On the Cirrous Form of Clouds'; and 'On the Semidiurnal Oscillation of the Barometer' (see Appendix 1.2). In mid-January 1855, he began taking meteorological observations of temperature, moisture, rainfall, air pressure, cloud formation and wind conditions. He continued taking such measurements twice daily until mid-1858, when the Sydney Observatory began officially to record them.

During his years in Australia Jevons became interested in a public debate on policy regarding railways. The Inaugural Meeting of the Philosophical Society of New South Wales focused on railways; in 1856, Jevons's diary contains several references to railways, as well as a page headed 'Work to be done 1856', including 'Letter on railways' (P&C, **vii,** p. 116), with a tick beside it. The 7 February entry records 'Not doing much, except commencing a letter to "Empire" on the "Western Railwayline, & the general policy of government railway extension"' (pp. 116–17). He contributed two letters on land policy to the *Empire* in 1857, and his letter on the railway economy was published by the newspaper in December (see *P&C,* **ii,** pp. 282–87, and **vii,** pp. 1–11).

At about this time, and partly as a consequence of the railway discussion, Jevons undertook a serious study of political economy. He read Smith's *Wealth of Nations* early in 1856, and in 1857 he turned to Mill's *Principles of Political Economy* as well as Richard Whately's *Introductory Lectures on Political Economy;* by 13 September, Jevons had formulated his view of human nature: 'I regard man in reality as essentially selfish, that is as doing everything with a view to gain enjoyment or avoid pain' (*P&C,* **i,** p. 133). Early in 1857, he read Dionysius Lardner's *Railway Economy* [1850], which treated supply and demand using diagrams, as well as Adolphe Quetelet's *Treatise on Man,* which led him to the conclusion that 'man must be a creature of *cause & effect*', and that 'a perfect consideration of all these data, in fact of all the causes in operation must result in the determination of all effects' (to Henrietta Jevons, 30 January 1859; *P&C,* **ii,** pp. 361–2). Already, he was convinced that such treatment must proceed at a level that abstracted from detail: 'Of course', he continued, 'such is the infinite complexity of causes & of effect that we cannot treat them in detail' (p. 362). At this time also, Jevons undertook an extensive attempt at classification of social statistics—collecting information while on lengthy walks and using the Sydney Directories, classifying inhabitants by social class based on occupation, and then relating geographical location to social class. On 7 October, 1858, he published a portion of this research, entitled 'The Social Cesspools of Sydney. No. 1 The Rocks', in the *Sydney Morning Herald*.

As his interest developed in 'the scientific investigation of *Man*', Jevons became determined to give up his lucrative post at the Sydney Mint.[12] He returned to University College in October 1859, to complete his BA degree, studying mathematics, logic, philosophy, political economy, classics, and history. In June of 1860, he placed a joint first in mental philosophy, while in political economy he placed a disappointing third (see Chapter 2); in November, he won the Ricardo Scholarship (sixty pounds). Having obtained his BA in October 1860, Jevons continued his studies for the MA, winning, in 1862, the gold medal.

These were fruitful years. Sometime in 1860 (see Chapter 4), Jevons 'struck out' the seeds of his theory of exchange. His journal refers also to the conviction that would underpin all his later work: 'For a year perhaps I have entertained hopes of performing a general analysis of human knowledge, in which the fallacies of words would be as far as possible avoided—and *phil. would be shown to consist solely in pointing out the likeness of things*' (8 December 1861; *P&C,* **i**, p. 179; cf. 14 May 1866, entry,p. 205). He continued collecting and arranging statistics, formulating, sometime after October 1860, the idea 'to form a Statistical atlas of say 30 plates exhibiting all the chief materials of *historical stat*. For the last year this atlas has been my chief employment & I fear to look back upon the labour I have spent in searching all likely books for series of stat. then copying—calculating, arranging, & drawing the diagrams' (8 December

1861; *P&C,* **i,** p. 180).[13] Early in 1861, he contributed nine articles to the *Dictionary of Chemistry,* edited by Henry Watt, assistant professor of chemistry at University College; in September, he reported the meeting of the British Association for the Advancement of Science [BAAS], at Manchester for the *Manchester Examiner,* and he presented 'On the Deficiency of Rain in an Elevated Rain-gauge as caused by Wind' to the Mathematics and Physics section. In 1862, he published two statistical diagrams; two papers, 'Notice of a General Mathematical Theory of Political Economy', and 'On the Study of Periodic Commercial Fluctuations', were read to Section F, Economic Science and Statistics, of the BAAS.

Much has been made of Jevons's disappointment in the lack of attention his ideas received at this early stage of his career (see Chapter 2). In December 1862, Harry Roscoe, then Professor of Chemistry at Owens College, urged Jevons to accept a lowly post as tutor there.[14] Initially, Jevons resisted the suggestion, and hoped instead to continue his research and writing in London. But by early 1863 he began to reconsider his original intent of 'hack-writing', which, he concluded, 'unless to a person with a very ready and popular style, must be an occupation full of hardship and disappointment' (to Herbert Jevons, 19 February 1863; *P&C,* **iii,** p. 6). In April, he accepted the position at an annual salary of one hundred pounds; his duties commenced the following October. *A Serious Fall in the Value of Gold* was published the same year (see Chapter 9). *The Coal Question,* published in 1865, firmly established Jevons's reputation as an applied economist (see Chapter 2). By 1866, he became Professor of Logic, Mental and Moral Philosophy and Cobden Professor of Political Economy at Owens College. He now felt financially secure enough to marry, in 1867, the daughter of the proprietor of the *Manchester Guardian,* Harriet Ann Taylor. In 1872, he was elected a fellow to the Royal Society.

Recognition did not come cheaply. The strain eroded Jevons's health. He was forced to take a year's leave of absence from Owens College as a result of the toll taken by work on *The Principles of Science*. In 1876, he resigned from Owens College, and subsequently took up an appointment with a lighter teaching load at University College. Even this taxed his health, however, and in 1880 he resigned from University College in order to devote his waning energy to research. His health never recovered: on a family holiday in August 1882, Jevons drowned in the ice-cold coastal waters near Hastings.

*

Until recently, a largely unchallenged characterization of the development of economic thought during the last two centuries, juxtaposed the Classical emphasis on labour (or costs) as the determinant of value and a preoccupation with the growth and development of nations over time, to an early Neoclassical emphasis on (marginal) utility as the determinant of value and the study of allocative issues presuming fixed factors of supply.[15] At first glance, this juxtaposition aptly sums up the transition in Britain from the economics of John Stuart Mill, to the economics of Jevons. For Jevons was acutely conscious of his attempt to escape the 'noxious influence' of Mill's authority in British intellectual circles, and highly critical of the labour theory of value and the wage fund theory attributed to David Ricardo and his 'equally able but wrong-headed admirer', Mill (*Theory of Political Economy* [1871; *TPE*], p. 275, '1879 Preface', p. li). He offered his own, marginal utility based, theory of exchange which he contrasted to the 'mazy and preposterous' notions of the English Classical economists. He also excluded Malthusian population analysis from the *TPE,* which focused instead on static allocative issues.

In recent decades, however, a number of challenges have arisen to the interpretation of the development of economic thought entailing a 'Marginal Revolution'.[16] The novelty of the utility approach may have been substantially overstated by Jevons. The principle of diminishing marginal utility—which Jevons called the 'keystone' of his theory of exchange—was well established early in the nineteenth century as a necessary condition of exchange and a partial explanation of prices.[17] In addition, the analyses of Jevons, Léon Walras and Carl Menger were widely different (Blaug 1972; Jaffé 1976; Streissler 1972), so that it may not be accurate to refer to 'the economics' of early Neoclassicals, thereby masking potentially significant distinctions among these three.[18] Finally, Joseph Spengler (1972) has investigated the role and analysis of economic growth in Neoclassical economics.

Jevons's theoretical work, contained for the most part in the *Theory of Political Economy,* did constitute a departure from Classical theory. The theory of price-taking exchange, running in terms of a balance of 'feeling', provided a fertile research programme for Jevons's successors: into the nature, determinants, and measurability of utility. His formal treatment of exchange led very neatly to later generalizations of exchange theory by Francis Ysidro Edgeworth and Irving Fisher involving a general specification of the utility function, and began a long trek down the road to a formal investigation of the conditions of general equilibrium (Chapter 5).[19]

One additional way that the *TPE* altered the course of economics is Jevons's extensive use of mathematics in that work, his *apologia* for mathematics in economics (see Schabas 1990), and his calls there for subdivision within economics. The significance of the mathematical method for later developments of utility theory and Welfare Economics is explored briefly in Chapter 5 and then subsequently in Part III. His calls for subdivision (Chapter 4) served to broaden the scope of the discipline, and provided the requisite encouragement for the growth of the specialty, empirical economics, based on a method separate from that of theory.[20]

But on many questions of the day there *was* common ground between Jevons and the Classics. While he criticized a rigid formulation of the wage fund theory, Jevons allowed for the temporary application of a wage fund. He agreed with Ricardo and Mill on the theory of Rent and Capital, and he insisted that his utility based theory was consistent with a cost of production theory of long run value (Chapter 6). Jevons maintained that his newly formulated utility theory was fully in line with the 'ordinary' laws of supply and demand (Chapter 5). There were in fact few new implications of the theory and for this reason, in part, Marshall characterized Jevons's theoretical achievements as 'old friends in new dresses'. Additional theoretical continuities are highlighted in Chapters 2 and 3, where Jevons's allegiance to Classical growth theory, as well as his theory of economic fluctuations, are taken up.[21]

Jevons's exchange equations, which attempted to explain (equilibrium) exchange formally in terms of a balance of 'feeling', constituted the major departure from Classical theory, and this is the main subject of Chapters 4 and 5. For while utility played a key role in economic analysis from Jeremy Bentham through J.S.Mill, that analysis ran primarily in terms of necessary conditions for exchange, and the (non-numerical) estimation of 'happiness' associated with particular economic policies. Jevons, by contrast, placed the notion of the balance of 'happiness' squarely at the centre of his analysis of exchange; in place of the Classical notion (at least as he perceived it) of labour as the 'cause' of value, Jevons insisted on utility as the cause of value. When labour figured into value analysis, it, too, was reduced to disutility, so that Jevons felt he could claim that utility constitutes the 'only' cause of value, while he maintained at the same time that relative prices are proportionate to costs of production. Jevons did not reject a cost of production theory of value (Chapter 6), but he did his best to divert attention from the long run, and towards the explanation of market transactions instead.

Like J.S.Mill and many other political economists in the nineteenth century, Jevons was a utilitarian. He differed from Mill on the means of measuring utility, and insisted that pleasures differed only in their attributes, thereby eschewing the 'in kind—in amount' distinction made by Mill. Along with his insistence that economics become a quantitative science and his calls for approximation in economics, that position commenced a very influential tradition of cardinal measurement in Welfare Economics (see Chapters 7 and 8). For the purposes of actual policy recommendations, however, these differences were less important. Jevons, like Mill, favoured policies to improve the lot of the working poor. They shared a firm conviction that reform must encourage the acquisition of habits of self-reliance among the labouring classes (see Chapters 7 and 8). But a subtle shift in policy analysis did occur with the transition from Mill to Jevons: Jevons was somewhat less willing than Mill to endorse broad reform proposals and more cautious about the efficacy of education, of government, and of policy generally, to effect lasting economic improvement.

This account emphasizes an important tension in this regard throughout Jevons's economics. For while the *TPE* served to demonstrate that unregulated markets 'worked' in the sense that labourers receive their 'due' rewards, even in that theoretical work and more strongly elsewhere, his analysis reveals the desirability of intervention designed to alter behaviour (especially that of the labouring classes). In particular, while he allowed that (on average) consumers make correct decisions regarding the allocation of goods in the face of fixed prices and income constraints, he insisted that intertemporal decision-making skills, at least for the poor and uneducated, were much less well developed. Savings, for instance, were persistently 'too low' among lower and middle classes; the lower classes were unable, in addition, to make the family size choice correctly. We shall see that, as a consequence, there is a powerful role for institutions, which can influence, or 'improve', these decision-making habits: Jevons repeatedly called for education to ensure that appropriate savings and family size decisions were forthcoming.

In the methodology of economics, there was little continuity. Indeed, the method that Jevons consistently employed in his economics, and endorsed in his *Principles of Science,* had virtually nothing in common with that of his precursors. While the method of J.S.Mill—which held that specific experience be used as 'case studies' to evaluate theory, and insisted that the political economist account for the difference between observation and theory—prevailed, there was no room for the development or appropriation of empirical methods within economics. Jevons, by contrast, insisted that the social scientist abstract from such detail, and proceed by way of 'wide averages'; he called for the use of techniques to measure economic phenomena, and to approximate economic relationships.

APPENDIX 1.1 CHRONOLOGY OF JEVONS'S LIFE[22]

1 September 1835	Birth of William Stanley, at 14 Alfred Street, Liverpool.
1843	Receives his first lessons in political economy and botany from his mother, the former using Archbishop Whately's text, *Easy Lessons on Money Matters for the use of Young People*.
1845	Jevons's mother, Mrs Thomas (Mary Anne Roscoe) Jevons, passes away.
1848	Jevons & Sons firm suffers bankruptcy.
January 1846	Attends the Mechanics Institute High School in Liverpool; Headmaster, Dr William B.Hodgson (later Professor of Political Economy at Edinburgh).

Early 1847	Jevons's older brother, Roscoe Jevons [1829–69], suffers mental breakdown.
Autumn 1847	Attends Mr Beckwith's private school in Lodge Lane, Liverpool.
Autumn 1850	Attends University College School in London.
1851	Visits the Great Exhibition of the Works of Industry of All Nations.
October 1851	Enters University College, London.
October 1852	Wins silver medal for chemistry in College examinations.
July 1852	Wins botany prize.
February 1853	Plans for a business career in Liverpool.
May 1853	Wins gold medal for chemistry in College examinations.
July 1853	Offered and accepts assayership in new Sydney Mint. Leaves University without BA degree.
August 1853	Studies assaying in London under Professor Graham.
19 August 1853	Imperial Order in Council establishes the Sydney Mint as a branch of the Royal Mint.
February–March 1854	Studies assaying in Paris
29 June-6 October 1854	Voyage to Sydney, Australia; rents a two-roomed cottage at 8 Charlotte Place, Church Hill and shares with Charles Bolton; sets up laboratory and storageroom here also.
January 1855–1858	Collects meteorological observations twice daily at Church Hill; records air pressure, temperature, moisture, rainfall, cloud and wind conditions.
14 May 1855	Sydney Mint formally opens.
8 November 1855	Jevons's father passes away in Pisa.
March 1856	Takes a tour of gold diggings at Sofala.
May 1856	Excursion to River Hunter.
13 June 1856	Elected a member of the newly formed Philosophical Society of New South Wales.
September 1856	Becomes an unpaid Meteorological Observer for the *Empire* newspaper in Sydney; publishes weekly reports
Christmas 1856	Excursion to Richmond and Parramatta.
1857	Letters to *Empire* on railway and land policy.
April 1857	Trip to Wollongong.
June 1857–June 1858	Provides detailed monthly meteorological reports for the *Sydney Magazine of Science and Art*.

8 July 1857	Paper 'On a Sun-gauge or New Actimometer' read before New South Wales Philosophical Society.
September 1858	*Empire* files bankruptcy. Takes a photography expedition to Middle Harbour.
7 October 1858	Publishes part of a 'Social Survey of Sydney' in *Sydney Morning Herald,* entitled The Social Cesspools of Sydney. No. 1 The Rocks'.
December 1858	Offered and refuses a partnership in Melbourne.
January 1859	Leaves the Mint; takes a photography expedition to southern diggings in New South Wales.
March 1859	Leaves Sydney for Melbourne where he visits the goldfields.
March-September 1859	Travels to England via Peru, Panama, Havana, and the United States, where he visits older brother, Herbert Jevons.
September 1859	Returns to Liverpool; lives with his sisters, Lucy and Henrietta, and younger brother, Thomas Jevons (also a student at University College), at 8 Porteus Road, Paddington, London.
October 1859	Returns to University College to complete his BA degree. Undertakes coursework in logic, philosophy and political economy, mathematics, classics and history.
19 February 1860	Strikes out the 'true Theory of Economy'.
July 1860	Has a 'sad reverse' in College political economy examination.
October 1860	Receives his BA degree, in first division.
December 1860	Wins Ricardo Scholarship.
September 1861	Acts as a correspondent for *Manchester Examiner* at British Association meeting. 'On the Deficiency of Rain in an Elevated Rain-Gauge' read at BAAS meeting.
June 1862	Receives his MA degree with gold medal.
October 1862	'Notice of a General Mathematical Theory' and 'On the Study of Periodic Commercial Fluctuations' read at the British Association meeting, Cambridge.
April 1863	Takes a tutoring position at Owens College, Manchester. *A Serious Fall in the Value of Gold* published.
September 1863	*A Serious Fall* quoted in *The Times* and at BAAS meeting.
October 1863	First term at Owens College.
December 1863	*Pure Logic* published.
June-September 1864	Works on his book on coal in London.
July 1864	Elected Fellow of University College.

November 1864	Elected Fellow of the [Royal] Statistical Society (London Statistical Society).
April 1865	*The Coal Question* published.
May 1865	'The Variation of Prices' read before the Royal Statistical Society. Appointed to (part-time) Professorship of Logic, Moral Philosophy and Political Economy, at Queen's College, Liverpool.
October 1865	Acts as substitute lecturer in Logic and Philosophy at Owens College; appointed lecturer in Political Economy; resigns tutorship at Owens College.
November 1865	Herschel writes to praise *TCQ*.
16 March 1866	Gladstone writes Jevons to praise *The Coal Question*.
April 1866	Paper on 'Autumnal Pressure in the Money Market' read to the [Royal] Statistical Society.
17 April 1866	*TCQ* quoted by J.S.Mill in Commons debate.
May 1866	Appointed to the new Chair of Logic, Mental and Moral Philosophy, and Cobden Professorship of Political Economy at Owens College.
June 1866	'Mr. Gladstone's New Financial Policy', in *Macmillan's Magazine*.
October 1866	First lecture as Cobden Professor of Political Economy at Owens College.
January 1867	'Partnerships of Masters and Men', in *The Times*.
19 December 1867	Marries Harriet Ann Taylor, daughter of proprietor of the *Manchester Guardian;* couple moves to 36 (now 33) Parsonage Road, Manchester.
March 1868	Corresponds with Fleeming Jenkin concerning 'fluxion' theory of exchange.
April 1868	Provides evidence before Royal Commission on International Coinage.
June 1868	Paper on international currency read to the Manchester Statistical Society
October 1868	Two lectures on 'The Exhaustion of Coal' delivered to the Newcastle Literary and Philosophical Society.
17 November 1868	Paper 'On the Condition of the Metallic Currency' read to the [Royal] Statistical Society of London.
18 March 1869	Roscoe Jevons, William Stanley's elder brother, dies at the Liverpool Hospital, Ashton Street.
8 May 1869	'Depreciation of Gold', in *Economist*.

May 1869	Jevons's younger sister, Henrietta (Henny) [1839– 1909] suffers mental breakdown from which she never recovers.
June 1869	Figures on condition of gold coinage quoted in House of Commons.
November 1869	Inaugural Address as President of Manchester Statistical Society.
December 1869	Meeting with Chancellor of Exchequer, Robert Lowe.
September 1870	Becomes President of the Economics and Statistics Section (Section F), of the BAAS, Liverpool meeting.
October 1871	*Theory of Political Economy [TPE]* published.
November 1871	Review of *TPE* in *Saturday Review*.
January 1872	Review of *TPE* by J.E.Cairnes.
April 1872	Review of *TPE* by Alfred Marshall.
May 1872	Elected Fellow of Royal Society.
June 1873	Requests leave of absence from Owens College; offers to resign.
January–April 1874	Travels with wife on Continent; offers resignation again.
April 1874	*Principles of Science* published.
May 1874	Letter from Gladstone on *Principles of Science*.
November 1874	'The Progress of the Mathematical Theory of Political Economy' read to the Manchester Statistical Society.
December 1874	Examines for Cambridge Tripos in Political Economy.
June 1875	Proposes subject for discussion at Political Economy Club.
August 1875	Papers on sunspots and the Coal Question read to the BAAS at Bristol
November 1875	Examines for Ricardo Scholarship
December 1875	Accepts Professorship of Political Economy at University College, London. Examines for Cambridge Tripos. First son is born, Herbert Stanley.
February 1876	Finally resigns from Owens College, and becomes Professor of Political Economy at University College. Honorary LLD conferred by Edinburgh University.
October 1876	First lecture as Professor at University College, London. Moves to The Chestnuts, Branch Hill, Hampstead Heath.
August 1877	First daughter is born, Harriet Winefrid.
December 1877	Conversation with Gladstone at Political Economy Club.
March 1878	*Political Economy Primer* published.

August 1878	Paper on sunspots and periodic crises read at BAAS meeting, Dublin.
March 1879	Elected to Athenaeum Club (at Herbert Spencer's proposal).
June, 1879	Second edition of *TPE*.
October 1880	Decides to resign professorship at University College. Begins *Principles of Economics*.
December 1880	Second daughter is born, Lucy Cecilia.
May 1881	Resigns professorship at University College to devote time to literary work. 'Life' of Jevons appears in *Biograph*. Works on *State in Relation to Labour*.
November 1881	Examines for Ricardo Scholarship.
January 1882	Attempts to have Royal Commission formed, to examine treatment of children.
March 1882	Declines examinorships due to poor health.
13 August 1882	Drowns while bathing near Hastings, age 46.

APPENDIX 1.2
CHRONOLOGY OF JEVONS'S WORKS

1857	'On Clouds; their various Forms, and producing causes, with experimental illustrations' (read before Philosophical Society of New South Wales, published in *Sydney Magazine of Science and Art,* January 1858). 'On the Cirrous Form of Clouds' (*The London, Edinburgh and Dublin Philosophical Magazine and Journal of Science [LPMJ],* July). 'Railway Economy' (letter published in *Empire,* 29 December).
1858	'On the Forms of Clouds' (abbreviated version of 'On Clouds, their various Forms', *LPMJ,* April).
1859	'On the Semidiurnal Oscillation of the Barometer' (*LPMJ,* May).

1861	'On the Deficiency of Rain in an Elevated Rain-gauge as caused by the Wind' (read to the Mathematics and Physics Section of the British Association for the Advancement of Science [BAAS], Manchester, December).
1862	'Diagram, showing all the weekly accounts of the Bank of England, since the passing of the Bank Act of 1844, with the amount of Bank of England, Private and Joint Stock Bank Promissory Notes in circulation during each week and the Bank Monthly Rate of Discount' (published by Edward Stanford, Charing Cross). 'Diagram, showing the Price of the English Funds, the Price of Wheat, the Number of Bankruptcies and the Rate of Discount Monthly, since 1731, so far as the same have been ascertained' (Edward Stanford).
	'Notice of a General Mathematical Theory of Political Economy' (read before the BAAS in Cambridge; published in *[Royal] Statistical Society Journal* as 'Brief Account of…').
	'On the Study of Periodic Commercial Fluctuations, with five diagrams' (paper read before the BAAS at Cambridge; published in *ICF*).
1863	*A Serious Fall in the Value of Gold ascertained, and its Social Effects set forth. With Two Diagrams* (published by Edward Stanford; reprinted in *ICF*).
1865	*The Coal Question: An Inquiry concerning the progress of the Nation, and the Probable Exhaustion of our Coal Mines.*
	'The Variation of Prices and the Value of the Currency since 1782' (intended for the BAAS, read before the [Royal] Statistical Society, May; published in *ICF*).
1866	'Brief Account of a General Mathematical Theory of Political Economy' *([Royal] Statistical Society Journal).*
	'An Introductory Lecture on the Importance of Diffusing a Knowledge of Political Economy' (delivered at the opening of the session of evening classes at Owens College, 12 October; published in *P&C,* **vii**).
	'Ironmasters and Ironworkers' (letter to The Times, 17 December). 'Mr. Gladstone's New Financial Policy' (*Macmillan's Magazine,* June; reprinted in *P&C,* **vii**).
	'On the Frequent Autumnal Pressure in the Money Market, and the Action of the Bank of England' (read before the [Royal] Statistical Society of London, 17 April; published in *ICF*).
	Trade Outrages' (letter to *Manchester City News,* 3 November).
1867	'On Coal' (lecture given in the Carpenters' Hall, Manchester, 16 January; published in *P&C,* **vii**).

	'Partnerships of Masters and Men' (letter to The Times, 19 January).
1868	'The Exhaustion of Coal' (two lectures to the Newcastle Literary and Philosophical Society, 15 and 16 October).
	'On the Condition of the Gold Coinage of the United Kingdom, with reference to the Question of International Currency' (*Journal of the Royal Statistical Society,* December; reprinted in *ICF;* published version of 'On the Condition of the Metallic Currency of the United Kingdom, with reference to the Question of International Coinage', read before the [Royal] Statistical Society of London, 17 November).
	'On the International Monetary Convention, and the Introduction of an International Currency into this Kingdom' (read before the Manchester Statistical Society, 13 May; published in *P&C,* **vii**).
	'On the Probable Exhaustion of our Coal Mines' (read at the Royal Institution, 13 March; published in *P&C,* **vii**).
	'Trade Societies: Their Objects and Policy' (lecture delivered by request of the Trades Unionists' Political Association, Manchester, 31 March; published in *MSR*).
1869	'A Deduction from Darwin's Theory' (letter to *Nature,* 30 December).
	'The Depreciation of Gold' (letter to *Economist,* 8 May; reprinted in *ICF*).
	'Inaugural Address as President of the Manchester Statistical Society on The Work of the Society in Connection with the Questions of the Day' (10 November; published in *MSR*).
	'Two Lectures on Political Economy' (at Hyde, Cheshire; published in *P&C,* **vii**).
1870	'On Industrial Partnerships' (public lecture delivered under the auspices of the National Association for the Promotion of Social Science, 5 April; published in *MSR*).
	'On the Natural Laws of Muscular Exertion' (*Nature,* June).
	'On the So-Called Molecular Movements of Microscopic Particles' (read before the Manchester Literary and Philosophical Society).
	'Opening Address as President of Section F (Economics and Statistics) of the BAAS' (delivered at the 40th meeting, Liverpool, September; published in *Journal of the Royal Statistical Society,* September; reprinted in *MSR*).
1871	*The Match Tax: A Problem in Finance* (published by Edward Stanford, Charing Cross; reprinted in *PE*).
	The Theory of Political Economy (First Edition).

1874 *The Principles of Science: A Treatise on Logic and Scientific Method.*

'The Progress of the Mathematical Theory of Political Economy' (read before the Manchester Statistical Society, November; *Transactions of Manchester Statistical Society, 1874–75,* reprinted in *P&C,* **vii**).

'The Railways and the State' (*Essays and Addresses, by Professors and Lecturers of Owens College, Manchester;* reprinted in *MSR*).

1875 'Heredity' *(Nature).*

Money and the Mechanism of Exchange.

'The Post Office Telegraphs and their Financial Results' (*Fortnightly Review [FR],* December; reprinted in *MSR*).

'On the Progress of the Coal question' (read before Section F of the BAAS, Bristol, August; published in *P&C,* **vii**).

'The Solar Period and the Price of Corn' (read at the meeting of the BAAS at Bristol; published in *ICF*).

1876 'Cruelty to Animals—A Study in Sociology' (*FR,* May; reprinted in *MSR*).

The Future of Political Economy. Introductory Lecture at University College, London, 1876' (*FR;* reprinted in *PE*).

'On the United Kingdom Alliance and its Prospects of Success' (read to the Manchester Statistical Society, 8 March).

Primer of Logic, in Science Primers series.

1877 'Cram' (*Mind,* April; reprinted in *MSR*).

'The Silver Question' (read before the American Social Science Association at Saratoga, 5 September; published in *ICF*).

1878 'Amusements of the People' (*Contemporary Review [CR],* October; reprinted in *MSR*).

'Commercial Crises and Sun-Spots' (*Nature,* part i, 14 November; reprinted in *ICF*).

'On the Movement of Microscopic Particles in Liquid' (*Quarterly Journal of Science,* April).

'On The Periodicity of Commercial Crises and its Physical Explanation' (read before the BAAS, Dublin; published in the *Journal of the Statistical and Social Inquiry Society of Ireland,* 1878; reprinted in *ICF*).

Primer of Political Economy, in Science Primer series.

'Remarks on the Statistical Use of the Arithmometer' (read before the [Royal] Statistical Society; published in *P&C,* **vii**).

1879 'Commercial Crises and Sun-Spots' (Nature, part ii, 24 April; reprinted in *ICF*).

	'A fragment on Mill's logic', (*Owens College Magazine,* Vol. **xi**, no. 2, January 1879, pp. 81–87; JA6/5/9).
	'John Stuart Mill's Philosophy Tested' (four articles, *CR;* reprinted in *Pure Logic and other minor works*).
	'The Solar Influence on Commerce' (unfinished, intended for publication in the *Princeton Review;* published in *P&C,* **vii**).
	'A State Parcel Post' (CR, January; reprinted in *MSR*).
	'Sun spots and Commercial Crises' (letter to *The Times,* 17 January; reprinted in *P&C,* **v**).
	'Sun-spots and Commercial Crises' (letter to The Times, 19 April, reprinted in *P&C,* **v**).
	'Sun-Spots and the Plague' (*Nature,* 13 February).
	The Theory of Political Economy (Second Edition).
1880	'Experimental Legislation and the Drink Traffic' (*CR;* reprinted in *MSR*).
	'Postal Notes, Money Orders, and Bank Cheques' (*CR,* July; reprinted in *MSR*).
1881	'Bimetallism' (*CR,* May; reprinted in *ICF*).
	'The Rationale of Free Public Libraries' (*CR,* March; reprinted in *MSR*).
	'Richard Cantillon and the Nationality of Political Economy' (*CR;* reprinted in *PE*).
1882	'Married Women in Factories' (*CR,* January; reprinted in *MSR*).
	'The Solar-Commercial Cycle' (*Nature,* July; reprinted in *P&C,* **vii**).
	The State in Relation to Labour.
1883	*Methods of Social Reform, and other Papers,* edited and with Preface by Harriet Jevons.
	'The Use and Abuse of Museums' (intended for *CR,* published in *MSR*).
1884	*Investigations in Currency and Finance,* edited by H.S.Foxwell.
1905	*The Principles of Economics. A Fragment of a Treatise on the Industrial Mechanism of Society and Other Papers,* edited and with Preface by Henry Higgs.

Part I

MACROECONOMIC CONCERNS

Growth and stability

2
JEVONS'S THEORY OF ECONOMIC GROWTH

INTRODUCTION: THE EARLY YEARS[1]

As is well known, Jevons was disappointed with the early progress of his career in political economy. He confided to his brother, Herbert Jevons, in July 1860: 'In Political Economy I had a sad reverse, such indeed as I never had before, for in spite of having studied the subject independently and originally and having read some dozens of the best works in it, almost neglecting other classes for the purpose, I was placed 3rd or 4th when I felt confident of the first prize'.[2] In the same letter Jevons maintained that he would soon 'fully avenge' himself 'when I bring out my "Theory of Economy" and reestablish the Science on a sensible basis' (*P&C,* ii, pp. 416).[3] In June 1862, he published two diagrams, unsatisfactorily, at his own expense (£25):

> 1862: Diagram, showing all the weekly accounts of the Bank of England, since the passing of the Bank Act of 1844, with the amount of Bank of England, Private and Joint Stock Bank Promissory Notes in circulation during each week and the Bank Monthly Rate of Discount;

and

> 1862: Diagram, showing the Price of the English Funds, the Price of Wheat, the Number of Bankruptcies and the Rate of Discount Monthly, since 1731, so far as the same have been ascertained.[4]

A 6 September 1862, Journal entry laments the 'few' 'outward encouragements' received in his career (P&C, **i**, p. 182). Jevons submitted his two papers, 'Notice of a General Mathematical Theory of Political Economy' (published in the *[Royal] Statistical Society Journal* as 'Brief Account of a General Mathematical Theory of Political Economy' [1866; MT]), and 'On the Study of Periodic Commercial Fluctuations, with five diagrams', to be read at the British Association for the Advancement of Science (BAAS), Section F, in October

1862. He later wrote that the 'Mathematical Theory' was 'received without a word of interest or belief ' (31 December 1862; *P&C,* **i**, p. 188).[5] After publishing *A Serious Fall in the Value of Gold Ascertained, and its Social Effects set forth (ASF)* early the following year—again at his own expense (£43)[6]—Jevons concluded 'that it is useless to go on printing works which cost great labour much money [and] are scarcely noticed by any soul. I must begin life again & by another way, ingratiating myself where & when I can—only after long years of slow progress can ones *[sic]* notions be brought out with any chance of being even examined by those capable of judging them' (*P&C,* **i**, p. 191).[7] Soon after reaching this conclusion, Jevons began work on *The Coal Question: An Inquiry concerning the Progress of the Nation, and the Probable Exhaustion of our Coal Mines* [1865; *TCQ*], writing to J.E.Cairnes on 5 January 1865, that 'A matter which has been taking most of my attention lately is the possible exhaustion of our Coal Mines. I have lately completed an essay directed to clearing up the popular ideas on the subject, and showing that it is physically impossible for our industrial progress to be long continued (a few generations) at our present rate of geometrical increase. The consequences must be of a serious character' (*P&C,* **iii**, p. 65). In April 1865, *The Coal Question* was published.

With this publication, Jevons's fortunes clearly began to turn around; *TCQ* received widespread attention and acclaim. In November, Sir John Herschel wrote to Jevons that he had 'read every word of it (received yesterday) with the avidity with which one devours a new novel' (23 November 1865; *P&C,* **iii**, p. 77). Herschel praised the 'clear and luminous form of expression' in the work, 'supported by the most telling statistical documents' in order to 'dissipate *completely* the delusion which so large a majority of our own countrymen labour under, of the "inexhaustibility of our mineral resources"' (p. 77). Soon after this Jevons's publisher, Alexander Macmillan, sent him a letter from the Chancellor of the Exchequer, W.E.Gladstone,[8] in which Gladstone, having 'perused' the work with 'care' and 'extraordinary interest', wrote that it 'strengthens the convictions I have long entertained, but with an ever growing force, as to our duty with regard to the National Debt'.[9] Gladstone wrote to Jevons himself, in a letter dated 16 March 1866, reiterating the main point of *The Coal Question:* 'Nor is it an absolute exhaustion of coal which appears to me near, but it is such a shifting in the conditions of supply as under economical laws will formidably change our commercial position in relation to other countries' (*P&C,* **iii**, p. 87).[10] Then, on the 17 April 1866, J.S.Mill praised the work in the House of Commons:

> I hope there are many hon. Members in this House who are acquainted with a small volume written by Mr. Stanley Jevons, entitled *The Coal Question*. It appears to me, so far as one not practically conversant with the subject can presume to judge, that Mr.Jevons' treatment of the subject is almost exhaustive. He seems to have anticipated everything which can possibly be said against the conclusion at which he has arrived, and to have answered it.[11]

Three days later, Jevons thanked Mill for this praise: 'I cannot appreciate at first all that is contained in the fact that my work should so soon have received the complete approval of authorities such as yourself [,] the Chancellor of the Exchequer, and Sir John Herschel' (*P&C,* **iii**, p. 95).

This was by no means the end of public recognition accruing to Jevons as a result of *The Coal Question*. The *Pall Mall Gazette* noticed *TCQ* in an article on 4 January 1866, and then more substantially in a series of three articles entitled 'England's Prosperity—Permanent or Transient', where his work, as well as Mill's recognition of it, were discussed (see *P&C,* **iii**, p. 96, note 1). Attention was also given to *TCQ* in *The Times,* where Jevons published a number of related letters to the Editor during the spring of 1866 (see *P&C,* **iii**, pp. 98, 101). *Macmillan's Magazine* published Jevons's essay, 'Mr.Gladstone's New Financial Policy', in June.[12] Indeed, Jevons's fortunes had recovered enough that he confided on the 9 May to his older sister, Lucy (Mrs.John Hutton): '*The Coal Question* gets on apace. The papers are hammering away about it. A Member of Parliament is going to move for a Royal Commission to inquire into the whole subject, and there will be one or two debates upon the matter probably.'[13]

THE COAL QUESTION

Jevons's argument in *The Coal Question* entailed a straightforward application of Malthusian population growth and Ricardian diminishing returns, to the production of coal. While British producers in the 1860s enjoyed a competitive edge in manufacturing because of relatively cheap coal supplies, this advantage could not be sustained indefinitely. 'At a future time', he maintained, 'we shall have influences acting against us which are now acting strongly with us. We may even then retain no inconsiderable share of the world's trade, but it is impossible that we should go on expanding as we are now doing. Our motion must be reduced to rest, and it is to this change my attention is directed' (*TCQ,* p. xxxi). Since a nation, as Jevons put it, 'tends to develop itself by multiplication rather than addition—in a geometrical rather than an arithmetical series', the consumption of coal 'must similarly progress in a geometrical series' (p. 261). Thus, because population grows geometrically (the subject of pp. 24–29), Jevons presumed that the rate of growth of demand for coal was also geometrical. Based on annual figures for the amounts of coal produced ('raised from our coal mines') in Britain, from the Mining Records Office for the years 1854–1863,[14] he estimated the average rate of increase of coal consumption to be 3.7 per cent per annum, and then assumed, as a cautious estimate, an annual growth rate equal to 3.5 per cent (p. 269). This led him to the argument that *'Rather more than a century of our present progress would exhaust our mines to the depth of 4, 000 feet or 1,500 feet deeper than our present deepest mine'* (p. 274),[15] and to the conclusion that as a result of increased depth 'the cost of fuel must rise, perhaps within a lifetime, to a rate injurious to our commercial and manufacturing supremacy; and the conclusion is inevitable, that our present happy progressive condition is a thing of limited duration' (pp. 274–75).

Substitutes provided no solution to this dilemma, since all substitutes ultimately would face the same problem, of limited supplies. Electricity, for instance, constituted 'a marvelous mode of distributing power', but it was not 'a self-creating power' (*TCQ,* p. 161). To say otherwise would be to ignore the 'great advances which have been achieved in the mechanical theory of nature' that have 'greatly cleared up our notions of force and energy':

> It has been rendered apparent that the universe, from a material point of view, is one great manifestation of a *constant aggregate of energy*. The motion of falling bodies, the motions of magnetic or electric attractions, the unseen agitation of heat, the vibration of light, the molecular changes of chemical action, and even the mysterious lifemotions of plants and animals, all are but the several modes of greater or lesser motion.
>
> These views lead us at once to look upon all machines and processes of manufacture as but the more or less efficient modes of transmuting and using energy.
>
> (*TCQ,* p. 161)

The conclusion was, therefore, that only 'natural sources' might provide substitutes for coal: tides, solar rays, organic fuels, winds and falling waters (*TCQ,* p. 162). Jevons acknowledged that if coal were 'of high price, we might find wind, water, or tidal mills, a profitable substitute for coal' (p. 187). This, however, would still be a calamity for Britain, since the relative price of fuel would have increased, and 'It would not enable us to keep up our old efficiency, nor to compete with nations enjoying yet undiminished stores of fuel' (p. 187).

ON POPULATION GROWTH

The general message of *The Coal Question* is clear: Jevons insisted that the implications of population growth and the resultant increase in the consumption of coal were wide ranging, and—as a result of diminishing returns—entailed increased costs of coal production. He estimated a rate of growth of coal consumption, and based on the estimate, projected coal consumption for the next 110 years. He frequently referred to this estimate as a 'true law of coal consumption' and a 'natural law'. How was Jevons able to make the transition from what clearly constituted an empirical estimate, to a 'true' or 'natural' law? The elevated status of the rate of coal consumption increase derived from the 'natural' law status of the underlying population increase that prompted in turn the growth of coal consumption. We turn now to a detailed investigation of the population mechanism.

In Jevons's analysis, population growth is a positive function of income. Population responds to a change in the real wage via marriage, birth, and emigration rates. The 'laxness of the Poor-Laws, the impetus communicated by the rise of our manufacturing and trading system, [and] the demand for soldiers' had 'induced' early marriages during the early nineteenth century and thus caused a 'growing population' (*TCQ,* pp. 210–11). Poverty and 'superfluity of population' reduced the birth rate via delayed marriages and the emigration of persons of childbearing ages; this would 'tend to restrain marriage, and free emigration would then, at the most, allow the continuance of the usual rate of marriage' (p. 222). Cyclical fluctuations in marriage rates corresponding to cyclical variations in income were also noted: 'Every year of depressed trade and distress leaves its mark upon the returns of the Registrar-General, in the shape of diminished marriage; and every period of prosperity has a contrary effect' (p. 223).

In an 1875 Lecture delivered at Owens College, Jevons described the population response to a once-and-for-all increase in real wages as a result of tariff reforms, but suggested that labourers also spent their higher wages on 'the next want', purchasing a more varied wage basket:

> cheap corn allows of a large well fed (with corn) population and corn being cheap and they earning pretty good wages have a surplus which they will immediately proceed to expend in the next want…. As a matter of fact we know that all kinds of animal produce in this Kingdom are very remunerative to the farmers, all arising from the increase of population allowed by the free importation of corn.
>
> (*P&C,* **vi**, p. 15)

The exposition lacks precision in that Jevons refers first to the level of population and then to the increase of population which he infers must have occurred prior to the arrival at a 'large' population; and the analysis is not extended to situations where incomes are rising through time, inducing rising rates of population growth. Yet it is clear that a once-and-for-all rise in incomes was seen to induce a population response, as well as altered consumption patterns.[16]

In *The Coal Question* Jevons reiterated that as a result of a rise in incomes following the repeal of the Corn Laws, population responds; but consumers spend some of their new wealth on a more varied and expensive diet. Plentiful corn, 'creating population, creates also a demand for animal food, for dairy produce, for vegetables and fruit' (*TCQ,* p. 240). The once-and-for-all increase in income is used by labourers to pay for more expensive diets as well as more children; thus when real wages rise, they are not driven to former (or subsistence) levels by a maximum population growth response.[17] Jevons's analysis of the relationship between labour supply growth rates and real wages presumes here, then, that as incomes rise through time, the labour supply response to further increases in the real wage will decrease. Built into the relationship between population growth and the real wage is a notion that preferences over the mix of luxuries and children differ at different wage rates.

There is also a presumption that this taste pattern is culturally determined; in the 1875 Lecture Jevons contrasted the English custom of early marriage to the deferred marriage customs in France and Switzerland (*P&C,* **vi**, p. 58). (There is evidence in the *Theory of Political Economy,* also, that tastes are culturally determined; see pp. 119–21.)

On this issue Jevons suggested that Malthusian analysis was 'too gloomy'; the lecture on population described the 'general result' (attributed also to Ricardo):[18]

> there was no hope of the main body of the people being permanently elevated into a state of high civilization, because so soon as they acquired increased means of subsistence, they would be sure to marry and multiply. That would bring down the rate of wages, increase the demand for food, and the cost of food, and would prevent them from being any better than they were in former days.
>
> (*P&C,* **vi**, p. 59)

Jevons's objection here and in *The Coal Question* was to the prediction of a long-term subsistence wage because maximum sustainable population growth responses to short-term wage increases would always drive wages to a minimum.[19] The correct view, he argued, was that 'every enlargement of our resources only tends to land us in a larger…but a more straightened [sic] population' (p. 60).[20] Thus Jevons's argument, whereby (in the absence of innovation) there must be a tendency for the real wage to fall eventually as a result of resource scarcity, is contrasted here to the position attributed to Malthus and Ricardo whereby the wage rests at a minimum in a growing economy with short run increases that elicit labour supply responses.[21]

Apart from the historical questions surrounding Jevons's interpretation of Malthus, there is a theoretical problem with his own formulation of the issue.[22] For if a once-and-for-all increase in real wages occurs that is not accompanied by an increase in the rate of growth of output, any increase in the rate of growth of population would drive the real wage down. In order to sustain the higher wage rate, given a growth rate of output (and labour demand), the rate of growth of population must fall. Malthus, unlike Jevons, insisted that the higher standard of living would not 'necessarily' be permanent, unless 'moral checks' to population growth prevailed.

Jevons was also convinced that high infant mortality rates occurred when women entered the manufacturing labour force and neglected their children. The problem, which involved 'the whole of the lower-class population of the manufacturing districts', resulted because 'good wages in the mills' induced women to place their children in unhealthy settings. The existence of these arrangements formed 'the strongest possible incentive to improvident and wrongful marriages'; often 'dissolute men allure capable young women into marriage with the idea that the wives can earn wages, and enable their husbands to idle away their time' ('Married Women in Factories' [1882], *MSR,* pp. 157, 172; cf. *P&C,* **v,** p. 166).[23] Thus, in England at least, a buoyant labour market, coupled with 'the facility with which a young married woman can now set her children aside', apparently induced not only a birth rate response via early marriages, but also a rise in infant mortality rates (*P&C,* **v,** p. 166). In this analysis, Jevons did not suggest which influence might prevail.[24]

The law of social growth

Jevons adhered to the Classical labour supply mechanism whereby population responds positively to an increase in the real wage. But what of the relationship between rates of population growth and the real wage, and Jevons's so-called: 'Law of Social Growth' expressed thus in *The Coal Question:* 'the law that men, as well as all living creatures, tend to increase in an uniform geometrical ratio. An uniform rate of growth means an uniform ratio—an uniform percentage of increase—*uniform multiplication in equal periods*' (p. 193). Specifically, is there a functional relationship between the growth of population and the real wage? A first glance at the 'social law' suggests that Jevons posits a given (exogenous) rate of population growth. But while he insisted that population growth followed a geometric progression which enjoyed the status of a 'natural law', 'as true and necessary as a mathematical law', Jevons assumed that a specific growth rate of population corresponds to a rate of growth of output yielding constant real wages. Underlying the formulation is a concern that land scarcity will eventually cause falling per capita real wages and necessitate a reduction in population growth.

The 'Law of Social Growth' entailed on one level a logical proposition which —in the absence of disturbing causes—could not fail to hold true:

> If all things then go on the same, if no deterioration, no new obstacle presents itself, a family that rears a double progeny of children may expect a fourfold progeny of grandchildren, and an eightfold progeny of great-grandchildren. And though this could not be expected in a single family subject to every accident of life, it may be expected on the average of a great mass of cases.
>
> (*TCQ,* pp. 192–93)

The analysis thus predicts a geometric rate of population growth for a given level of real income: 'the statement *that living beings of the same nature and in the same circumstances multiply in the same geometric ratio* is self-evident when the meaning of the words is once properly understood' (p. 194).

The 1875 Owens College Lecture on population also stressed the geometric nature of population growth in the absence of interfering causes such as land scarcity:

> does population tend to increase in a geometrical ratio? Now, nobody asserts that in any part of the world are there any absolutely exact examples of this geometrical tendency, because so many causes interfere restraining the increase or disguising it. But I have no hesitation in saying that it is accurately true in a hypothetical point of view. There are two ways of proving it—a priori and posteriori.
>
> The *a priori* way consists in saying that from other reasons it is to be expected that it would increase in that way. Now, I don't see the slightest difficulty in showing that a priori it must be so.
>
> (*P&C,* **vi**, p. 56)[25]

A constant geometric rate of growth occurs because one generation 'naturally imitates' the other; this process of imitation is related to 'character', 'education', and 'career', which on average yield the same 'fortune', and via fortune the same population characteristics result from one generation to the next:

> Each generation naturally imitates the earlier one, from which both its hereditary character and its education are drawn. The son takes after his father—the same in body and mind, in passion and in judgment. Individual variations of character and career are of course innumerable; but, on the average, it is true that the son is as the father. He marries at the same time, strives at the same success in business, to gain the same fortune, to rear and educate the same family.
>
> (*TCQ,* p. 192)

Thus Jevons's argument, while presented as a logical proposition (the 'same' persons multiply at the 'same geometric ratio'), was based upon the assumption that each generation enjoyed the same fortunes, or income levels.[26]

In the outline of the *a priori* 'proof' of the geometric rate of growth, Jevons suggested that population might double within a thirty-five-year period; he stressed that having done so, the population would occupy 'twice the [land] area'. Then as long as the land quality did not deteriorate, if 'there is no alteration in their physical condition—…they have an equal amount of land to spread over, no mountains or sterile land, or anything different from before', this rate of doubling would continue (*P&C,* **vi**, pp. 56–57). While 'few countries' have increased so rapidly, Jevons argued that 'the same reasoning holds good of any other rate. We are about doubly as numerous as our grandfathers. If we are in other respects like them—equally vigorous and enterprising, and free from any new exterior obstacles—we may expect our grandchildren to be doubly as numerous as ourselves' (*TCQ,* p. 193).

Scarcity checks to growth

Underlying the notion of a constant geometric population growth rate is the assumption that land scarcity was not yet in evidence.[27] Yet the entire framework of analysis in *TCQ* and related works was designed to prove that scarcity checks would eventually manifest themselves. Jevons insisted that in contrast to population growth, output growth rates were, or at least eventually would be, arithmetic or certainly lower; while the arithmetic series for output might not be 'altogether true', it was valid as a 'rough' indication of diminishing returns:

> it is a mistake to suppose that [the arithmetic series] can be altogether true or that Malthus can really have meant it to be accurate. I take it to be merely a rough way of saying that food cannot be increased much without a great increase of difficulty; or, in other words, that the increase of food is not proportional to the increase of labour.
>
> (*P&C,* **vi**, p. 57)[28]

But the manifestation of diminishing returns was not confined to agricultural production; in manufacturing relying on 'natural materials', also, scarcity checks to growth must emerge: 'the growth of production cannot go on *ad infinitum;* natural limits will ultimately be reached on the side both of the agricultural and of the manufacturing country' (*TCQ,* p. 419).[29] Jevons concluded that 'a certain absolute and inexorable limit, uncertain and indefinable though that limit may be' must eventually be reached:

> the aggregate of our exterior circumstances, our *environment,* as Mr.Spencer expresses it, is usually changing. This is what Malthus argued. He said that, though our numbers tend to increase in uniform ratio, we cannot expect the same to take place with the supply of food. We cannot double the produce of the soil, time after time, *ad infinitum*. When we want to double the produce of a field we cannot get it by simply doubling the labourers. Any quantity of capital, and labour, and skill may fail to do it, though discoveries from time to time do allow of a considerable increase.
>
> (*TCQ,* pp. 194–95)

'Scarcity', in Jevons's view, would in all probability manifest itself in Britain through rising coal prices, combined with rising food prices. The development of world trade patterns which enabled Britain to obtain supplies of raw materials and agricultural products in return for manufactured goods, had only temporarily removed agricultural checks to population increases: 'in our most crowded towns, we have, in the development of our manufacturing and coal-consuming system, means of subsistence which for the present remove Malthusian checks to increase' (*TCQ,* p. 221). The long-term adjustment process entailed population growth and diminishing returns in American agriculture which would eventually lead to the development of a manufacturing base there; 'soon' agriculture in America would 'begin to lose its extremely easy and profitable character', when 'the choicest lands will have been taken up, and the second and third rate lands must be settled, or the old exhausted lands revived by more diligent culture' (p. 427). At the same time coal shortages would raise British manufactured goods prices, eventually diminishing and even terminating trade between these nations, and reducing Britain 'to a stationary condition' characterized by 'sufferings and dangers' (p. 232):[30]

> It is this decadence of agriculture joined to the rise of a manufacturing system, which most distinctly threatens our commercial position. Corn will be growing dearer in the States, while coal and iron are growing dearer here. The industrial conditions of England and the States will thus approximate to equilibrium, and the advantages of trade will diminish. We shall neither buy corn from them, nor sell iron articles to them.
>
> Then, if not before, the continuous multiplication of our home population and industry will receive a check, and a definitive choice of wholesale emigration or a change of habits will be presented to us.
>
> (*TCQ,* pp. 428–29; cf. p. 432)

Jevons's analysis in this context is distinctly pessimistic.[31] For his position was that land scarcity must 'soon' emerge in America, since migration west occurred 'rapidly' and settlers there were 'on the verge of deserts that never can be cultivated' (*TCQ,* p. 425). While land scarcity plays an important role in the Classical perspective, there is no suggestion there that limitations on the available supply of agricultural land would manifest themselves 'soon' in the colonies or for that matter in Britain.

In the absence of technological change, emigration, or increased prudence, Jevons feared an eventual outcome of falling real wages: 'In the increasing depth and difficulty of coal mining we shall meet that vague but inevitable limit which will stop our progress. We shall begin, as it were, to discover the further shore of our Black Indies. The wave of population will break upon that shore, and roll back upon itself '(*TCQ,* p. 200); 'The first check to our growing prosperity, however, must render our population excessive. Emigration may relieve it, and by exciting increased trade tend to keep up our progress; but after a time we must either sink down into poverty, adopting wholly new habits, or else witness a constant annual exodus of the youth of the country' (p. 11; cf. p. xxxii).[32]

Given these alternatives, Jevons conjectured that widespread emigration would follow (*TCQ,* pp. 422–23).[33] Yet this was only a temporary stopgap, since rapid population growth would lead to the development of American manufacturing industry, with devastating consequences: 'Then, if not before, the continuous multiplication of our home population and industry will receive a check, and a definitive choice of wholesale emigration or a change of habits will be presented to us' (pp. 428–29).

Causal mechanisms

Jevons never outlined a formal growth model. Yet the foregoing has revealed that he relied on a resource scarcity model entailing potential population pressure. As we have seen, the outcome is that, in the absence of technological change or reduced population growth, the real wage must fall over time.[34] One is led to inquire what causal mechanisms were perceived to move the economy through time. Two approaches have been outlined in the secondary literature: the 'dynamic equilibrium' model wherein labour supply and demand rates are envisaged to move in consort; and a 'disequilibrium' model whereby in a growing economy labour supply growth rates respond to disequilibrium wages that result from deviations in labour demand and supply growth rates.[35] It is therefore of interest to examine whether Jevons assumed that at each point in time in a growing economy wage rates equalize across sectors and countries given allowances for skill, experience and knowledge differentials, or whether he relied upon non-uniform factor returns as the force to drive the economy through time.

While there is a paucity of textual evidence on this matter, it appears that emigration (and to a lesser extent, birth) rates are perceived as responding to wage rate differentials both across sectors within Britain, and across countries, so that at any point in time the economic system is not in full equilibrium. Thus low agricultural relative to industrial wages are said to have 'drafted' English workers into towns:

> Now in England our agricultural population has received a check similar to that in the Scotch Highlands. No inconsiderable numbers have gone abroad, but in general the surplus country population has been drafted into the towns. Those nourished among sheeppastured hills, or richly tilled fields, in the quiet village, or the lonely hut, are attracted to the crowded, squalid alleys, the busy workshop, or the gloomy mine.
>
> (*TCQ,* p. 212)

The substantive Irish emigrations, also, are said to have been the result of relatively low productivity and wages (*TCQ,* p. 203). And overall observed emigration rates were viewed as the result of 'external allurements', the relatively high wages, independence and adventure offered by the colonies (p. 220).

A complex adjustment process was outlined whereby British growth stimulated colonial development via increased demands for foodstuffs, which in turn temporarily raised colonial wages, lured emigrants to the colonies, and provided a growing demand for British manufactured goods:

> The appearance of convergency which our population as a whole presented forty years ago was due to emigration. And this emigration was not a mere adventitious and disturbing circumstance. It was an integral part—the complement of our general development. The more we grow at home upon our mineral resources and manufacturing skill, the greater demands we make for food and raw materials. And it is to a great extent our demand which raises wages in our American, Australian, and African settlements to rates that attract our population abroad [*TCQ,* p. 219].… But the important result to us is the secondary effect of foreign British population in trading with the centres of manufacturing industry, and stimulating the growth of our wealth and numbers at home.
>
> (*TCQ,* p. 221)

It appears that Jevons had in mind a process whereby a wage differential induced migration and emigration which thereby narrowed the differential, so that at any point in time wage rate equality did not occur.[36]

THE EMPIRICAL ANALYSIS AND POLICY RECOMMENDATIONS[37]

Jevons did not believe that checks to population growth in the form of falling or subsistence wages were in evidence throughout the British economy when he published *The Coal Question* in 1865. In fact, diverging factor supply and demand growth rates are said to have created upward pressures on wages in industrial areas, and rising real incomes resulted: 'our increase of population was rather under than above the increasing means of subsistence' (*TCQ,* p. 222). (See Appendix 2.2 for Jevons's estimates of population growth, and a comparison with estimates in Mathias 1983.) Indeed, much of the analysis contained in *The Coal Question* is devoted to the demonstration of the rapidity of British population growth in response to ongoing rising incomes (cf. pp. 205–24). Thus technological improvements, (the steam engine, Arkwright's cotton machine, iron smelting using coal), are said to have caused increases in incomes, which induced increasing rates of population growth, a 'growing rate' of population growth (p. 233).[38] Yet the underlying message was that this observed rapidity would bring the nation 'soon' to limitations on further output growth, which would potentially threaten British 'popular institutions' (p. 422–23).[39]

Moreover, existing 'pauperism' caused by sectoral divergences in growth rates was perceived as a very real problem. Observing that growth rates of output and labour demand were uneven across sectors, Jevons in 1867 compared rates of population growth in high output growth areas (coal producing regions) to rates in agricultural areas, where labour demand growth was relatively low:

> All the coal producing counties are increasing very rapidly. Lancaster in the ten years from 1851 to 1861 increased in population 20 per cent,

> Staffordshire 23 per cent., West Riding 14 per cent, Durham 30 per cent, Glamorganshire 37 per cent…. Compare those numbers with the following for the agricultural counties: Bucks 3 per cent, Hereford 7, Dorset 2, Lincoln 1, Somerset no increase at all;… [and many are declining].
>
> (*P&C,* **vii**, p. 24)[40]

The secular decline in absolute agricultural labour requirements was attributed to changing consumption patterns, (a shift to the relatively non-labour intensive 'animal food', 'dairy produce' and 'vegetables and fruit' as a result of a once-and-for-all rise in income due in part to the removal of tariffs), and ongoing labour saving technological change: 'Labour saved is rendered superfluous. It is this that keeps agricultural wages so low; as steam-power is more and more used upon a farm, the number of labourers will continue to decrease' (*TCQ,* p. 243; cf. pp. 240–42).[41]

'Pauperism', which might partially be mitigated by emigration, prevailed in situations where labour demand growth was stagnating, as well as in the case of cyclical downswings in labour requirements. In agricultural areas, the 'rapid decline of the agricultural [population growth] rate shows how impossible it was for a growing population to find subsistence on the land' (*TCQ,* p. 209; cf. 'Opening Address as President of Section F (Economic Science and Statistics) of the BAAS' [1870], *MSR,* pp. 196–97). Here the extreme poverty, which had prevailed especially during the years 1811 to 1821 as a result of the 'laxness' of the poor laws, convinced Jevons that 'the increase of agricultural population which did occur was unsound and not warranted by any corresponding increase in the means of living' (*TCQ, p.* 209).[42]

Perhaps not surprisingly, given the Classical orientation of Jevons's analysis in *The Coal Question,* the policy recommendations to alleviate prospective and existing problems associated with decelerating growth, follow directly in the Classical tradition. Jevons suggested that while incomes were rising, the time was ripe for an effort to be made 'to raise the character of the people appreciably': 'The ignorance, improvidence, and brutish drunkenness of our lower working classes must be dispelled by a general system of education, which may effect for a future generation what is hopeless for the present generation. One preparatory and indispensable measure, however, is a far more general restriction on the employment of children in manufacture' (*TCQ,* pp. xlvii–viii).[43] The 'solution' to 'over-population' in these instances (to a subsistence wage or to 'the deep and almost hopeless poverty in the mass of people') lay in the cultivation of a desire 'to appreciate or accumulate the wealth which science brings' (*MSR,* pp. 196, 197). Increased 'appreciation' of wealth would alter consumption patterns and lower the population growth rate corresponding to any real wage, while accumulation by the poor would protect them from cyclical variations in labour demand.[44] That education would enable labourers to gain 'habits of providence and foresight' is spelled out also in Jevons's 1869 'Inaugural Address as President of the Manchester Statistical Society':

> Material well-being has comparatively little effect, for, however high the wages of an artizan may be, they may be spent intemperately, and on the slightest reverse of fortune his family or himself may come to the workhouse. It is distressing to find that a population such as that surrounding this city, which, on the whole, perhaps, has as great a command of good food and all the comforts of life as any in the world, has nothing to fall back upon, no accumulated savings of consequence, and that they are, therefore, ever ready upon the least breath of adversity to come upon the public funds. No people can be really well off unless to their material prosperity be joined habits of providence and foresight, which will lead them to fortify themselves in the position they have once attained.
>
> General education is, doubtless, the measure which most nearly approaches to a panacea for our present evils.
>
> (*MSR,* pp. 186–87; cf. *P&C,* **vii**, p. 28)[45]

An 1870 piece on industrial partnership reiterated that the labouring classes were myopic, improvident and ignorant; consequently overpopulation and poverty resulted (*MSR,* p. 146). Here Jevons pointed to a 'prospect of some change': partnership, and profit sharing arrangements, he predicted, would enable labourers to acquire habits of providence and foresight (see pp. 160–63).

While these recommendations refer to the general working population, Jevons sometimes framed his policy analysis with special reference to agricultural labourers, whose plight he believed was particularly pressing. In the 1870 'Opening Address' to the BAAS Liverpool meeting, and in an 1872 private correspondence with J.L.Shadwell, he referred to the 'ignorant', 'careless', 'improvident' and 'vicious' habits of the agricultural labouring classes (*MSR,* p. 196; cf. *P&C,* **iii**, p. 255). The argument here hinged upon cyclical and secular declines in the growth of agricultural labour demand which occurred because of the 'vicissitudes of the seasons', and because of productivity increases and changing consumption patterns. Again Jevons emphasized improvident habits that entailed less than optimal savings rates.[46]

Once the 'education question was put in a way of fair solution', Jevons enlarged his vision of reform to entail a remarkably broad programme of cultural activity, a programme designed to 'besiege' the 'citadel of vice and poverty' 'from below, from above, from within' in order to 'secure the ultimate victory of morality and culture' ('Amusements of The People' [1878], *MSR,* p. 2).[47] Since the 'vulgarity' of the working classes was due in part to the suppression of amusements 'by a dominant aristocracy', improvement of the 'low state of musical education' was a means to a 'higher civilisation' (pp. 6, 7, 11). Jevons recommended 'popular outdoor concerts' be established for the benefit of the labouring classes, as well as the establishment of playgrounds for their children (pp. 12, 16), a Free Public Library ('The Rationale of Free Public Libraries'

[1881], pp. 28f), and local collections of geological artifacts as educative tools ('The Use and Abuse of Museums' [1883], p. 62).

Not once in Jevons's analyses of population is there a suggestion that prudential behaviour includes birth control as a means to decreasing the birth rate; any decrease was to occur through delayed marriages. Moreover, while Jevons suggested that labourers must acquire an increased 'appreciation' of the means of subsistence, his exhortations pertained to the 'lower working classes', the 'deeply' impoverished, 'artizans' and agricultural labourers; there is no suggestion that labourers as a whole should delay marriages. This may be because, given high rates of emigration as a result of relatively high wages outside the United Kingdom, the urban rate of population growth was apparently in step with, or even below, the rate of growth of labour requirements. Thus existing population pressures were mainly a result of labour being released too quickly from agriculture and cyclical variations in employment; problems which could be resolved by migration to areas where labour demand was growing relatively quickly, and by inducing labourers to save for the 'vicissitudes of the seasons'. Yet the point remains, that Jevons was fully aware of the need for an overall reduction in population growth at some future date, in order to maintain labour supply growth rates in step with a falling growth rate of labour demand.

Jevons recommended, also, that the National Debt—a 'burden' on future generations in addition to diminishing returns—be reduced, a policy which entailed 'adding to the productive capital of the country'; 'slightly checking our present too rapid progress'; and 'lessening the future difficulties of the country' (*TCQ,* p. 448; cf. 'Mr.Gladstone's New Financial Policy' [1866], *P&C,* **vii**, p. 16). The debt reduction was to occur through a levy on inheritances, which constituted a portion of the capital stock and should not be consumed. Jevons based this recommendation squarely upon the work of J.S.Mill, who spoke in Parliament a year before the publication of *The Coal Question* concerning the need to reduce the national debt (cf. *TCQ,* p. xxxix). As noted on pp. 21–23, after the publication of *TCQ* Mill spoke again on the subject, and cited Jevons's work favourably.[48]

The striking feature of these recommendations is that they follow the Classical tradition, and J.S.Mill, so closely. Mill frequently urged the need for education, and 'improvement', of the labouring classes, and insisted that this improvement would occur only once labourers were educated to the necessary relationship between population growth and income levels.[49] He, also, as is well known, supported profit sharing and 'co-operative' arrangements, under which he believed reduced population growth rates would be forthcoming. We will return to this issue in Part III.

CONCLUSIONS

Perhaps the most widely held perception concerning late nineteenth-century economics, is that the emergence of Neoclassicism entailed the movement from an interest in and preoccupation with the issue of economic growth, to a static general equilibrium analysis of the efficient allocation of factors of production.[50] The authors of a popular textbook in the history of economic thought suggest that during the 1870s the analysis of Jevons, Walras and Menger 'focused attention on just that problem which would not have concerned the classics—the allocation of a set of parametric inputs—and regarded it as the central issue for economic analysis' (Walsh and Gram 1980, p. 123). For Mark Blaug, this preoccupation 'ruled out consideration of the effects of both increases in the quantity and quality of resources and the dynamic expansion of wants, effects that the Classical economists regarded as the *sine qua non* of improvements in economic welfare' (1962, p. 295).[51] Neoclassical economists, including Jevons, dismissed 'all questions about changes in the quantity and quality of productive resources through time' (p. 306); Jevons 'abandoned the deep-rooted Classical belief that economic welfare depends as much on capital accumulation and population growth as on efficiency in resource allocation' (p. 296).

The analysis above, however, reveals that Jevons adhered to a Classical mechanism whereby the growth of labour supply responds, via the marriage, birth, and emigration rates, to rising real incomes. Second, he was concerned with the Malthusian contrast between geometric population growth rates and limitations to output growth as a result of diminishing returns; indeed, he feared the emergence of land scarcity even in America. Moreover, the exhortatory tone of Jevons's writings on population, and his policy recommendations for the alleviation of eventual hardship, place him squarely within the Classical framework of analysis on this issue.

While based primarily upon *The Coal Question,* this argument has been elicited from a range of Jevons's work, including subsequent studies of the coal question, his 1875 Lectures, private correspondence, and *Methods of Social Reform*. Even the *Theory of Political Economy,* moreover, did not reject the analysis of growth in principle, but excluded the population theory from its limited range of concerns. The key to Jevons's position concerning the population mechanism, is the contention—in line with Alfred Marshall and the Classics—that population growth is a major determinant of economic welfare; the extent and severity of 'pauperism' being linked to population relative to labour demand growth rates.

The urgency of Jevons's warnings concerning future effects of diminishing returns, as well as his belief that education was the key means to alleviating poverty among labourers (via increased restraint and improved savings decisions) further reveal his kinship with the Classics on population. At the same time, however, Jevons deliberately distanced himself from Classical growth analysis, and for this reason, perhaps, his analysis of growth has been neglected. First, in the *TPE* he maintained that population 'forms no part of the direct problem of Economics'.[52] Yet one must regard this statement in the context of the analytical problem which Jevons was treating in the *TPE*. Once he set aside the issue of efficient resource allocation given factor supplies, Jevons clearly recognized that population growth had analytical implications for economic theory.

Jevons was not alone in this methodological treatment of population as a subject distinct from allocative economic theory. For J.S.Mill before him had argued that 'The political economist inquires, what are the actions which would be produced by this desire [for wealth], if, within the departments in question, it were unimpeded by any other', thus strictly speaking, excluding the population principle from the pure theory of economics. In Mill's evaluation, the population principle was granted a special status somewhere between a 'disturbing cause' and the core analysis of economics, it being a 'striking case' or 'correction', to be 'inter-polated into the expositions of Political Economy itself; the strictness of purely scientific arrangement being thereby somewhat departed from, for the sake of practical utility' ('On the Definition of Political Economy; and on the Method of Investigation Proper to It' [1836], *CW,* **iv**, p. 323).[53] J.E.Cairnes, also, excluded the treatment of population from his formal analysis of the effects of the gold discoveries: 'the impulse given to the movement of population, which has resulted in the rapid peopling and definitive settlement of districts' being a question distinct from 'the economical effects of the increased supplies of gold' (1873, p. 1).

There is, in addition, a general presumption in the secondary literature that Jevons's *The Coal Question* 'still appears as something set apart from the main body of his work in applied economics' (Black 1981, p. 17).[54] To the extent that Jevons's other major works do not treat growth issues in detail, this evaluation is correct. But while this may remind us that Jevons's overall preoccupations differed from those of Classical economists, it is notwithstanding clear that when he turned to the issue of growth, his analysis was pre-eminently Classical.

TCQ and Jevons's `sad reverse'

Did Jevons write *The Coal Question* in order to achieve recognition in the face of the disappointing reception of his early papers read to the BAAS in 1862? Much, indeed, has been made of Jevons's self-described 'sad reverse'—his failure to take a first at the University College of London political economy examination, noted at the outset of this discussion (pp. 21–22).[55] White has used evidence of Jevons's early dissatisfaction and impatience with the lack of recognition he achieved early on, in order to support his argument that Jevons 'followed the applied tack, although it was now to establish his reputation as an academic' (1991b, p. 232). He argues, further, that the analysis in *The Coal Question* was deliberately Millian, and, moreover, derivative of Sir William Armstrong's position in a Presidential Address to the BAAS in 1863.[56] Jevons is said to have endorsed analyses in *TCQ* that he had already rejected: *TCQ* 'required the use of a general framework and categories which were rejected in the marginalist theory' (p. 232); 'in the quest for public recognition which would establish a basis for him to publish his more original work, Jevons was prepared to utilize categories and a mode of analysis he had previously rejected and was later to criticize explicitly' (p. 233). At the same time, he did not reject the conclusions of *TCQ:* 'Nevertheless this does not mean Jevons did not believe *TCQ'*s predictions about coal prices and the threat to manufacturing'.

There is certainly textual evidence (outlined on pp. 21–22) that Jevons was disappointed with the reception of his earlier work, and that he perceived Mill's influence on British political economy to be excessive. Moreover, as White has argued, by choosing to write *The Coal Question* Jevons did arrive at a topic that was currently being debated in British intellectual circles. His early disappointment, as well as his resolve to achieve success, might indeed explain why he chose to write a book about the role of coal in the British economy. Nonetheless, it is important to bear in mind that Jevons used Malthusian-style analysis and recommended Classical remedies because he genuinely believed those were appropriate. He chose to publish a work on what would assuredly be a popular topic: the prospects for British growth late in the nineteenth century. Having chosen that subject matter, he found Classical growth theory most appropriate for his analysis. Evidence in support of this interpretation, consists of Jevons's repeated and continued praise of Malthusian principles both in works published during his career and also in his private journal and correspondence, when there was no need to praise Malthus, except that the praise was genuine.

Jevons's early writings reveal a profound interest in population levels, density and growth, and in Malthus's analysis of population growth. The 9 June 1857 Diary entry remarks 'Finished I Vol of Malthus which is certainly a great & useful work if it was really the first exposition of so important a principle of human nature as that of over population' (*P&C,* **vii**, p. 119).[57] The same month he published a letter in *The Empire* containing population and per capita crop estimates for countries possessing widely different land endowments (24 June 1857; **vii**, p. 4). In 1860, correspondence with his brother focused on American population growth.[58] An 1861 reply refers to the Statistical Atlas which Jevons hoped to com-pile, recording in the first table 'Population and its changes', and including information regarding birth, death, marriage and emigration rates (7 April; *P&C,* **ii**, pp. 425–26; cf. p. 425, Note 2). In correspondence with his sister, Mrs Lucy Hutton, Jevons referred to his 'strong opinions in favour of the *Coal Question*', and to his confidence 'that nearly all parts of the book at all events will bear examination, [so] that I am not afraid' (9 May 1866; *P&C,* **iii**, p. 101).

As noted above, one of the twenty-three lectures delivered at Owens College in 1875–76 focused specifically on population; its study being 'quite essential' to the investigation of 'the general problem which we ultimately come to of the progress of nations—the cause of poverty or prosperity' (*P&C,* **vi**, p. 54). Thus the population issue was integral to the study of 'progress', or growth, and economic welfare in a growing economy.

'The Future of Political Economy' [1876], which called for specialization within economics, insisted that 'pauperism' (which, as the quotation above reveals, is intimately related to population levels and growth) should not only be analysed by economists, but also merited study as one of the separate specialties, or fields of economics (*PE,* p. 200; cf. pp. 203–204). As late as 1882, in *The State in Relation to Labour,* Jevons remarked that geometric population growth could be demonstrated 'scientifically', although the policy implications of this result were by no means clear: 'It is one thing to demonstrate scientifically the tendency of population to progress in a geometric ratio; it is quite another thing to infer that marriage should therefore be discouraged, still more that it should be discouraged by some particular measure, which might involve consequences of the most varied character' (p. 9).

In the light of Jevons's continued interest in the subject, as well as his apparent conviction that *TCQ*'s analysis was correct, it seems unnecessarily harsh to suggest that he chose his theoretical allegiances with his reputation in mind. In setting out to write *The Coal Question,* Jevons intended to write a work about a subject matter that was *au courant,* and having chosen his subject matter with an eye on its predicted reception, he used the Classical perspective to analyse the questions posed there, because that perspective seemed eminently reasonable for his analysis.

TCQ and energist physics

Does *TCQ* constitute evidence of Jevons's adherence to energist physics?[59] He occasionally did refer to the conservation of energy in this context. Towards the end of *The Coal Question,* he contended that *'we are drawing more and more upon a capital which yields no annual interest, but once turned into light and heat and motive power, is gone for ever into space'* (p. 412).[60] Yet these remarks concern the physical properties of energy sources that were understood well before the 1860s. Here and in the discussion of substitutes for coal Jevons reiterates the physicists' argument that the energy used in, for instance, production processes was but transformed from other forms of energy.[61] Evidence that he understood that physical principle in broad terms cannot constitute proof that Jevons adapted the conservationist framework to the analysis of economic problems.

In order to contend that *The Coal Question* is energist physics 'extrapolated' to economics, one must provide evidence that Jevons transferred the mathematical framework developed by conservationist physicists to economic analysis. Given that he did not solve a mathematical constrained optimization problem, acceptable evidence must at least reveal that he approached the problem informally, with the theoretical framework of conservation in mind. A striking feature of the coal analysis, however, is that Jevons never once focused upon an optimal extraction rate schedule, given a fixed resource stock and a set of preferences over consumption goods. Yet this is the natural way to proceed with the microeconomic problem of an exhaustible resource, given a fixed initial stock of the resource. And this would be the procedure if in fact Jevons viewed the coal 'problem' as an 'extrapolation' of energetics, analogous to a constrained optimization problem. The procedure would yield a time independent equilibrium path of resource prices.

Jevons's concern in the coal analysis was not the optimal extraction schedule given a stock of resources—since, at any rate, he did not perceive the stock to be fixed—but the potential problems created by rising extraction costs for British trade and for the labouring classes. His analysis implies that institutional variables (legislation concerning trade, for instance), technological achievements which affect production in a complex fashion, and the tastes of, especially, the labouring classes, all affect that process of growth. And the exhortatory tone of the entire work reveals Jevons's firm conviction that policy-makers must alter the growth path by manipulating the behaviour of the labouring classes through policies designed to render their choices more 'responsible'.[62] Thus, while Jevons occasionally used the language of the new physics in *TCQ,* that framework apparently played a limited role in influencing his analysis of growth.

APPENDIX 2.1
COAL CONSUMPTION

Jevons's procedures for calculation of the average rate of increase of coal consumption (per cent) (*TCQ,* pp. 268±69)

1 Jevons noted that the consumption of coal depends upon the activity of trade and, therefore, varies throughout the business cycle.
2 Using the data of the Mining Record Office below, Jevons observed 1854 and 1861 as cyclical maxima.

Year	*Tons*
1854	64,661,401
1855	61,453,079
1856	66,645,450
1857	65,394,707
1858	65,008,649
1859	71,979,765
1860	80,042,698
1861	83,635,214
1862	81,638,338
1863	86,292,215

3 Comparing 1854 and 1861, Jevons found the average annual rate of increase over the interval to be 3.7 per cent. (The comparison of 1854 and 1864 yields a similar figure.)
4 As a cautious estimate, Jevons then rounded to obtain a 3.5 per cent average rate of increase per annum for his remaining discussion.

Jevons's predictions regarding the future consumption of coal (*TCQ,* pp. 272±75)

1 Using the 3.5 per cent per annum growth rate, Jevons calculated future consumption:

Year	*Consumption (millions of tons)*
1861	83.6
1871	117.9
1881	166.3
1891	234.7
1901	331.0
1911	466.9
1921	658.6
1931	929.0
1941	1,310.5
1951	1,848.6
1961	2,607.5[63]

2 Adding the results, the total consumption would be 102,704 million tons over the 110-year period, 1861–1970. Allowing for the possibility that 1861 was a maximum, Jevons estimated total coal consumption to be 98,281 million tons. He then rounded to an approximation of 100,000 million tons.
3 Comparing this estimate to Edward Hull's estimate of 83,000 million tons of remaining coal in Britain within a depth of 4,000 ft, Jevons predicted that a

century at the growth rate of 3.5 per cent would deplete the mines to a 4,000 ft depth.

4 Jevons concluded that the price of fuel must rise 'to a rate injurious to our commercial and manufacturing supremacy' (*TCQ,* p. 274).

APPENDIX 2.2 POPULATION DATA

Jevons's population figures, England and Wales (1570± 1861)

Year	*Population*	*Numerical increase*	*Rate of increase**
1570	4,160,321		
1600	4,811,718	217,132	5
1630	5,600,517	262,933	5
1670	5,773,646	43,282	1
1700	6,045,008	90,454	2
1701	6,121,525		
1711	6,252,105	130,580	2
1721	6,252,750	645	0
1731	6,182,972	−69,778	−1
1741	6,153,227	−29,745	0
1751	6,335,840	182,613	3
1761	6,720,547	384,707	6
1771	7,153,494	432,947	6
1781	7,573,787	420,293	6
1791	8,255,617	681,830	9
1801	8,892,536	636,919	11
1811	10,164,256	1,271,720	14
1821	12,000,236	1,835,980	18
1831	13,896,797	1,896,561	16
1841	15,914,148	2,007,351	14
1851	17,927,609	2,007,461	13
1861	20,066,224	2,138,615	12

Source: The Coal Question, p. 205
* Decade rate of increase; per cent.

Mathias's figures, Great Britain

Year	*Population*	*Rate of increase**
1801	10,690,000	
1811	12,150,000	13.7
1821	14,210,000	17.0
1831	16,370,000	15.2
1841	18,550,000	13.3
1851	20,880,000	12.6
1861	23,190,000	11.1

Source: Mathias, Peter (1983). *The First Industrial Nation,* 2nd Edition, London: Methuen, p. 415.
* Decade rate of increase; per cent.

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SUNSPOTS AND EXPECTATIONS
Jevons's theory of economic fluctuations

INTRODUCTION

Business cycle theorists have recognized that there is a long history to contemporary procedures whereby expectations figure prominently in the analysis of economic fluctuations. Thus, for instance, Robert Lucas has remarked that 'a commonplace in the verbal tradition of business cycle theory at least since Mitchell' has been that 'speculative elements play a key role in business cycles, [and] that these events seem to involve agents reacting to imperfect signals in a way which, after the fact, appears inappropriate' (1981, p. 286). Recent research (Cass and Shell 1983) resurrects Keynes's phrase, 'animal spirits', to describe expectations, and even more recent work has focused on 'sunspots' involving purely extrinsic uncertainty that influences expectations (Woodford 1990).

In fact, the 'inappropriate actions' argument originates with the recognition of periodic economic fluctuations early in the nineteenth century, and achieves prominence in Jevons's analysis of fluctuations. This chapter focuses first briefly on the work and influence of John Mills (1821–1896), a Manchester banker who succeeded Jevons as President of the Manchester Statistical Society in 1871, and whose work formed a basis for Jevons's theory of fluctuations. Mills's emphasis on expectations was applauded by Jevons. But while he fully accepted Mills's characterization of fluctuations as well as the common cause explanation for the cycle, Jevons—unlike Mills—was unwilling to endorse the theory that moods varied cyclically for no apparent reason. Mills was content to compare the cyclical variation of moods to the inevitable course of a disease, but Jevons insisted that the analyst seek out a cause for mental fluctuations within the 'industrial environment'. While he used Mills's descriptive phrases for the cycle freely and he relied on Mills's characterization of the common features of fluctuations, Jevons therefore distanced himself from Mills's medical metaphors when analysing the role of 'moods' in the cycle.[1]

Throughout the nineteenth century, as today, the discussion of economic fluctuations was framed in the context of policy implications: if fluctuations were due to 'natural' or, as Hyde Clarke put it, 'organic' causes, then policy would be, by assumption, ineffective at mitigating their effects; if banking and currency regulations were to blame, then there might be a role for policy. Among the early writers on cyclical behaviour, the consensus was that currency and banking regulations were sound, and that there was little that monetary policy might do to end or dampen the effects of cyclical fluctuations. There was, notwithstanding, an important role for policy. For Mills and Jevons allowed that education of the investing and mercantile classes might reduce the amount of unwarranted speculation and dishonest trading throughout the cycle, thereby, as Mills argued, 'proportionately limit[ing] the sphere and powers of designing knaves'. This argument raises an issue which still resonates in contemporary economic analysis: how, if at all, did analysts reconcile theories of fluctuations, based on 'mistakes', with microeconomic analysis that presumed individuals make correct decisions?[2] It transpires that for Mills and Jevons correct intertemporal decision-making is to some extent an acquired habit, which might be indoctrinated, or learned, through the 'proper' education.[3]

Much of the groundwork for Jevons's explanation of economic fluctuations had been prepared by 1867, and reflected an important Manchester component. The notion of regular (decennial) cycles was established in 1857 by William Langton,[4] a member of the Manchester Statistical Society. By 1867 another prominent member of the Manchester Statistical Society, John Mills,[5] insisted that the regularity of the cycle implied a single causal explanation and emphasized that the cycle was characterized by alterations in commercial 'moods'. As an active member of the Manchester Statistical Society himself, Jevons was familiar with the research conducted there, and in particular with the work of Langton and Mills.

Jevons's thought on fluctuations evolved considerably from 1862 until 1882. Early on, his research focused on seasonal fluctuations and nominal price variations, and touched on the business cycle only peripherally; he accepted apparently without modification Mills's characterization of the 'credit cycle'. Even then, however, he seems to have been uneasy with Mills's analysis as a full-fledged explanation of the fluctuation—lacking as it did the initiating cause for 'commercial moods' to alter. Eventually (by 1875) he explicitly acknowledged that the explanation was lacking, and provided what he believed to be the missing piece of the puzzle. What Jevons added to the understanding of economic fluctuations, was the argument that it was solar-generated agricultural fluctuations that periodically altered 'moods'. This mood alteration and the subsequent alterations in investment decisions multiplied the effect of the harvest fluctuation, and caused the full-fledged business cycle.

In its final formulation, Jevons's theory of economic fluctuations was neither wholly exogenous, nor wholly endogenous. But there is more endogeneity than Jevons has been given credit for, and the transmission mechanism (from the sunspot to the economic cycle) is more sophisticated than has generally been recognized (see pp. 64–66). Like Mills, Jevons emphasized the role of expectations or 'moods' in the cycle, moods which he believed to be unstable

—'ever ready to break into a ripple'.[6] What he added to Mills after 1875 was the argument that moods alter cyclically as a result of changing price signals, thereby multiplying the direct effect of the harvest variation. Jevons appreciated that agents' reactions to price signals might create self-fulfilling expectations concerning the development of an economy through time, an argument now widely accepted by analysts of fluctuations.[7]

EARLY RECOGNITIONS OF THE ROLE OF EXPECTATIONS

In 1837, Lord Overstone published 'Reflections Suggested by a Perusal of Mr.J.Horsley Palmer's Pamphlet on the Causes and Consequences of the Pressure on the Money Market', in which he observed in what appears to be one of the earliest recognitions of the role of commercial moods in the cycle, that the 'history of what we are in the habit of calling the "state of trade"' is subject to periodic conditions characterized by successions of commercial moods. 'First we find in it a state of quiescence', he argued, and 'next improvement,—growing confidence,—prosperity,—excitement,—overtrading,—convulsion,—pressure, —stagnation,—distress,—ending again in quiescence' (Overstone 1837, p. 31).[8] Overstone's primary concern in this pamphlet was the regulation of British bankers, whom, he argued, were under pressure to act 'in concert' with the moods of their customers:

> When confidence is increasing, the spirit of enterprise beginning to expand itself, when hope in all its forms is coming into active operation, when prices are rising, profits increasing, and every merchant or tradesman, with a view of benefiting by these circumstances, is desirous of extending his operations,—the Banker is looked to by his customers to act in concert with them, to facilitate their operations, and to distribute amongst them all the aid which the extent of his resources enables him to command.
>
> (Overstone 1837, p. 32)

An expansion of bank loans through the creation of notes (beyond what he termed 'real capital' limits) would, Overstone argued, exacerbate cyclical pressures within the economy by facilitating 'overtrading' and speculation.[9] Overstone thus favoured the strict convertibility conditions eventually embodied in the 1844 Bank Act.[10]

Recognition of the role of expectations in the cycle figures also in J.S.Mill's *Principles of Political Economy* [1848; *PPE*], where Mill argued that crisis periods characterized by excess commodity supply and capacity (compared to 'normal' or quiescent levels) were driven by altering expectations. Here we find a description of 'Some accident which excites expectations of rising prices, such as the opening of a new foreign market, or simultaneous indications of a short supply of several great articles of commerce', which 'sets speculation at work in several leading departments at once' (Mill *CW,* **iii**, p. 542).

While credit extension and contraction are characteristic of the cycle, they are not, Mill argued, the cause of fluctuations; the crisis of 1847 is explained, for example, in terms of increased 'foreign payments', caused by a high cotton price and 'an unprecedented importation of food', which along with railway speculation, created some contraction in the loan market (*CW,* **iii**, p. 543). Mistaken speculation is said to have occurred during periods of 'over-trading'; Mill stressed also that capital is sunk in railways and 'other works of uncertain profit' (p. 741). Further, the 'willingness to lend' is said to vary throughout the cycle, being 'greater than usual at the commencement of a period of speculation, and much less than usual during the revulsion which follows'—falling to a minimum during the 'panic' or trough (pp. 650–51). The rate of interest, correspondingly, varied cyclically.[11]

There is little appreciation of the periodicity of cycles in mainstream economics early in the nineteenth century (see Henderson 1992). Yet that concern gradually found expression in research published by the British statistical societies, as well as the *Railway Register*. Specifically, research focused on dating cycles and the apparently decennial nature of fluctuations. Hyde Clarke,[12] who came to economic matters as an engineer and journalist interested in the growth of British railways (Black 1992, p. 42),[13] maintained in a paper published by the *Railway Register* in 1847 that the key question concerning business cycles was whether these fluctuations were caused by 'isolated accidental events' or some common cause—'organic laws'. The question, Clarke argued, entailed an important policy implication: 'If the mania for speculations be a periodical consequence of a regular series of events, it must be utterly futile to pass laws for its suppression, and interference inconsistent with such a fact can only have the effect of doing mischief '(in Henderson 1992, p. 3).[14]

William Langton also appreciated the regularity of economic fluctuations, which he demonstrated in an 1857 presentation to the Manchester Statistical Society. Langton linked fluctuations to 'moral causes', referring to a 'wave, which appears to have a decennial period, and in the generation of which moral causes have no doubt an important share' (1857, p. 11). During these fluctuations 'an amount of trade' occurred 'inconsistent with prudence, and often, in consequence of its excess, unremunerative, if not destructive of much of the material wealth of the country' (p. 11). Langton placed the blame for these 'convulsive movements'[15] on 'the inordinate use of Credit' (p. 12).

It was another Manchester banker, John Mills, who most coherently put together the 'moral causes' arguments from Overstone and Langton, and the increased emphasis on credit evident in Langton, with the decennial periodicity and common cause arguments of Clarke.[16] Like Overstone, Mills paid tribute to the role of 'over-trading' or speculation in the panic. But Mills insisted that since over-trading 'is not an ultimate fact', cyclical over-trading required explanation, and he turned his attention to this explanation.

In Mills's estimation, 'conditions of trade and currency' during the early nineteenth century exhibited 'no uniformity whatever' (1867, pp. 14–15). The 'so-called causes of Panics' also occurred with 'bewildering diversity' (p. 15).[17] Thus neither currency nor trade conditions could be held responsible for the decennial fluctuation;[18] Mills maintained that one must strike instead 'far below the level of [the fluctuation's] physical particulars' to enter into the investigation of the 'sciences of the mind' for the ultimate cause. This argument constituted a key departure from Overstone who, while recognizing that cyclical swings in expectations characterized economic fluctuations, did not make a causal connection between moods and the cycle.

Central to Mills's characterization of fluctuations and to the 'ultimate cause' on which his investigation focused, is his insistence that 'Credit is a thing of moral essence' (1867, p. 17). Since credit is linked to belief, when beliefs alter, so does forthcoming credit. Mills next argued that there is a 'natural predisposition' for moods to alter periodically, so that credit also passes 'through normal and predictable phases'. Thus expectations, or moods, constituted the 'ultimate cause' of fluctuations, and fluctuations followed specific stages driven by periodic alterations in 'moods' (ibid., p. 29; cf. p. 17). Mills consequently characterized 'the malady of commercial crisis' as a malady of the *'mind'* instead of the *'purse'*.

For the alteration in 'mood' Mills provided no detailed causal analysis, although he speculated that 'Possibly also the season of gloom and decadence may have a certain predisposing tendency. Men's *credos* are scarcely so vigorous in the proverbial month of suicides as they are in the youth of the year' (1867, p. 29). For the most part, however, he asserts mood alterations to be an ultimate cause, a 'normal tendency of the human mind' (pp. 16–17). On more than one occasion Mills maintained that this 'normal tendency', was particularly strong in England. This, he argued in 1867, followed from the 'existing conditions of an island nation, with vast accumulated wealth, of energetic temperament and a low average of economical training' (p. 17). He seems to have believed that British institutions, notably its education system and strong trading tendencies, fostered speculative 'manias'. At the same time, however, he maintained that the English commercial classes were by nature particularly susceptible to over-trading, because of their 'irrepressible energy' (1866, p. 4). It is Mills's insistence that the tendency for faulty credit to grow operated within and was influenced by distinct institutional features, that provides the keys to understanding his policy recommendations for the mitigation of fluctuations (see pp. 61–63).

Thus, for Mills, the cycle was characterized by 'mental moods', which affected credit decisions of the lending and borrowing classes. Like Overstone, he distinguished between 'ordinary credit', and credit 'beyond these limits', 'faulty' or 'diseased' credit (1867, p. 19). In the former case, beliefs matched reality; while in the latter, beliefs were incorrect. Among these latter engagements, Mills argued, credit 'partak[es] somewhat of the nature of faith in things unseen'; and 'experiences the decennial changes'.[19]

As the 'faith in things unseen' varied cyclically, the fluctuation unfolded. During the 'post-Panic' stage a plethora of credit is produced; this stage featured unused capital, dormant enterprises, and low profits and prices.[20] A 'remainder of distrust' concerning investment prospects makes lenders cautious. At the same time, borrowers reduce their demands for loans, since they, too, must face increased risk (1867, pp. 20–21). Mills did not elaborate on this issue, but it appears that the collapse of 'beliefs' affected beliefs concerning all credit.

In short, the 'normal'[21] characteristics of the post-panic period included 'the great accumulation of unused Capital and the ruling of an excessively low rate of interest; and a concurrent identity of mental mood in the revulsion from habitual beliefs' (1867, p. 22). Time alone might heal this revulsion: 'The old race of traders have still a vivid remembrance of a "black Friday" or some other day of equally sombre hue. Time alone can steady the shattered nerves, and form a healthy cicatrice over wounds so deep' (pp. 23–24).

But healing did occur (though it is, perhaps, a weakness of Mills's treatment that no analysis is provided here for why optimism should return). The revival period begins, and the number of new companies increases, and existing companies expand. Credit now draws upon previously unengaged capital (1867, pp. 21–25). Since the 'tendency of the human mind' is to 'take from present conditions the hues of a forecasted future', and since 'the unfortunate fact [is] that the existing system of culture amongst our commercial classes is but little adapted to correct the want of personal experience' (another reference to the lack of general education among British commercial traders), 'a healthy growth gradually merges into a dangerous inflation' (p. 25). Eventually, given institutional arrangements in England, the speculative phase commences, when credit grows 'out of proportion' to capital reserves, prices rise, and 'unproductive investment' and 'excessive commitments' occur.[22] Capital now becomes 'diverted' from 'channels of regular trade, temporarily closed, into others of a speculative, but highly promising character' (1866, p. 4); and the nation 'runs up' 'an enormous score of credit, far outstripping the current savings of the nation' (p. 6). 'Bold speculators' are now able to make 'enormous gains'.

As profits rise investors become convinced (through 'habit') that high profits are to be earned in new avenues, and they are consequently increasingly willing to take on risky investments (1867, p. 25). In this context Mills refers again to 'the absence of adequate foresight and self-control', to which he assigns the blame for speculation attaining 'most rapid growth exactly when its growth is most dangerous; that is, when Credit has become inflated out of proportion to the reserves of loanable Capital' (p. 26).[23]

Driving this new condition of speculative trading is 'a further change in the mental mood of traders'. Mills's choice of adjectives concerning investors' beliefs ('morbid excess', 'hypertrophy', 'too facile faith') indicates his position that investors now are all too willing to take risks; that is, that investors are mistaken about the distribution of the expected returns to investments. Further, these mistaken expectations, entailing higher expected returns than are available through traditional investments, induce 'non-traders' to enter the market, further exacerbating the upswing (1867, p. 27).[24]

Inevitably, it appears, 'unhealthy' credit once accumulated in large masses, must collapse: whereupon mistaken beliefs become strikingly corrected. Accumulations of credit in large masses, 'once tainted by suspicion' now become 'mere magazines of Panic' (1866, p. 7). Some event, however stimulated, 'startles' the public into a mood 'of doubt', and credit does indeed become tainted. Creditors call in loans, and the collapse occurs (1866, p. 7; cf 1867, pp. 27–28). Consequently, the 'Panic' consisted of 'the destruction, in the mind, of a bundle of beliefs' (1867, p. 19).[25] That destruction of belief affected confidence concerning not only 'diseased' but also healthier forms of credit; all 'mere instruments of credit' are temporarily discredited 'in the supreme moment of fear' (1866, p. 7).[26]

Mills's contribution

While Mills's analysis of fluctuations leaves room for improvement, he added much to the observations of Overstone and Langton concerning the role of 'moral causes' in the cycle. First, his recognition that currency arrangements had varied widely across cycles, and his corresponding argument that this implied that currency could not be the ultimate cause of cycles lent credibility to the defence of the 1844 Bank Act. Jevons would take up this argument. Second, Mills's emphasis on the common features of the cycle, and his insistence on a single causal explanation was widely appreciated by subsequent analysts of fluctuations such as Jevons. A major weakness of Mill's analysis, however, is that there is little recognition of how the transitions take place, or of the need for any explanation of transitions. It is this weakness which would trouble and preoccupy Jevons.

JEVONS'S EARLY ANALYSIS OF FLUCTUATIONS

Jevons followed Mills's characterization of the cycle, as well as his focus on the importance of commercial moods. As early as 1863, he remarked on the volatility of commercial moods: 'The current of human business is ever ready to break into a ripple. A good or bad season marks it with a crest or a trough, and the fluctuation multiplies and continues itself (*A Serious Fall in the Value of Gold Ascertained, and its Social Effects set forth, [ASF], ICF,* p. 48). In Jevons's early writings concerning economic fluctuations,[27] however, several differences emerge between Mills and Jevons. First, Jevons was more struck than Mills by *harvest* fluctuations; in 1862 he remarked that 'Every branch of industry and commerce must be affected more or less by the revolution of the seasons' ('On the Study of Periodic Commercial Fluctuations', *ICF,* p. 2). Second, even at this early date Jevons recognized the fact that he later stressed, that a theory of economic fluctuations required an explanation for fluctuations in investors' moods.[28] While Mills had linked expectations or moods to prices, there was no cyclical reason for prices to vary. Thus, unsatisfactorily in Jevons's mind, mood alterations were simply unexplained.

Jevons's earliest thinking concerning fluctuations is reflected in the notes accompanying his 1862 statistical diagram ('A Diagram showing the Price of the English Funds, the Price of Wheat, the Number of Bankruptcies, and the Rate of Discount Monthly, Since 1731'),[29] *ASF,* and an 1865 letter to J.E.Cairnes.[30]

Perhaps because the cycle was not his main concern in these studies, his reasoning here is not always clear; most importantly, he failed to specify the causes of 'over-investment'. Jevons referred to corn as 'capital', and maintained that abundant harvests were linked to high real accumulation rates; but he did not adequately explain this link. The implication seems to be that bumper crops assure plentiful availability of the major wages good and thus money funds for accumulation (although the process is by no means always spelled out in detail).[31]

In the notes accompanying his 1862 diagram, Jevons maintained (without elaboration) that wheat, 'being the principal article of food', constituted 'the most important part of the capital of the country' (*ICF,* p. xiv). Crop failures 'naturally' were 'followed by the indications of a scarcity of capital', a rise in the rate of interest. Thus harvest fluctuations caused variations not only in corn prices but also in the rate of interest, and capital 'undertakings':

> A low price of corn, low rate of interest, with few bankruptcies, and a high price of the funds, lead to the employment of capital in vast undertakings at home and abroad. Capital gradually becomes less abundant compared with the demand, and in the revolution of the seasons, the scarcity is suddenly increased by a failure of the harvest, and a rise in the price of corn. The rapid ascent of the rate of interest is necessarily followed by a sudden flood of bankruptcy, and a general revulsion of credit, which brings incalculable loss and disappointment upon all classes.[32]

Apparently relying upon the observations made during the course of work on the statistical diagram, Jevons became convinced that harvest alterations were causally related to economic cycles. His argument in *ASF* was that these harvest fluctuations 'hasten or retard' various cyclical forces at play emanating from the non-agricultural side: 'The bountiful or scarce supplies of food with which Providence favours us in the several seasons strongly contribute to hasten or retard the several periods of abundant capital and investment, and again those of scarcity and revulsion' (*ICF,* p. 48). He was already convinced that economic fluctuations were the norm, that their initial cause was 'multiplied' throughout the cycle, and that the cycle followed natural laws: 'The current of human business is ever ready to break into a ripple. A good or bad season marks it with a crest or a trough, and the fluctuation multiplies and continues itself. Yet, according to a known principle, it insensibly tends to fall into place with the fluctuations of nature, which it may obey but cannot rule.'

Jevons conceded in this context that the 'remote cause' of ongoing fluctuations—the force generating observed regular cycles—remained unknown (*ICF,* p. 27); but he opined that it 'seems to lie in the *varying proportion which the capital devoted to permanent and remote investment bears to that which is but temporarily invested soon to reproduce itself*' (p. 28).[33] He described how 'permanent investments in houses, ships, improvements of land, manufactories, mines, railways, foreign loans or undertakings' are 'multiplied at certain periods' and consequently 'temporarily' 'absorb the means of subsistence of the community'. Successful investment schemes are said to cause rising prices, since the growth of demand for intermediate goods outstrips the growth of supply (Their production being incapable of any but slow extension, their prices rise'), and rising prices result in 'a mania for speculative investment' (p. 29). A 'revulsion' follows, 'due no doubt to the previous great permanent investment', resulting in a 'dearth of capital, or loanable money', an occasion 'accelerated by the failure of the harvest, or some event which cuts off a large part of the anticipated gains of the country'.[34] Again the role of agriculture appears as a disturbance, which multiplies already existing cyclical forces at play. 'Panic' and 'the collapse of credit' result (p. 31).

In correspondence early in 1865 Jevons reiterated his view that there is a 'tendency to a periodic recurrence of fixed investment' which plays a key role in economic fluctuations; again an agricultural shock is said to play a reinforcing role should it 'coincide with' 'prolonged activity of trade & *fixed investment*' (or a dampening role, should 'natural events' reverse the cycle):

> I must confess my expectation judging from the present prolonged activity of trade & *fixed investment* that a collapse will occur of serious magnitude not far from ten years after 1857…a fall in the price of cotton if it should coincide by chance with a rise in the price of corn which may be anticipated, & renewed & intensified pressure in the money market must occasion a reverse. But, though there is I believe *some tendency to a periodic recurrence of excessive fixed investment* & consequent scarcity of capital, all matters of trade are of course constantly liable to disturbance & reversal by political or natural events.
>
> (to J.E.Cairnes, 5 January; **iii**, pp. 64–65)

Already therefore, Jevons was convinced that during a cyclical expansion some apparently quantitatively strategic industries increase 'fixed investment' and produce more than their 'normal' levels of output, and that an expansion of credit occurs. He did not specify here the cause of the 'reverse' of this expansion.[35]

Ten years elapsed before Jevons returned to the topic of economic fluctuations. In 1875–76, he delivered a series of lectures at Owens College, and three of these focused on economic fluctuations. In the second, 'Commercial Fluctuations Since 1836', Jevons's perspective altered slightly compared to that above; he now argued that the *'effect'* of low corn prices is an increase in 'floating capital'—a remark which suggests that corn is not itself capital.[36] While he still maintained that variations in corn crops were related to accumulation rates, his main argument here was that low corn prices (reflecting bumper crops in the face of low demand elasticity) ensure increased surplus income to spend on manufactures. The justification for this reasoning is formally outlined in the *Theory of Political Economy,* where Jevons cited Adam Smith's argument that satiety occurs faster with food than luxuries (p. 149; cf. pp. 151, 157).[37] In this Lecture however, Jevons never explicitly addressed how harvest-generated expenditure changes were related to alterations in investment. Bumper crop years are said to cause low corn prices that create a (monetary) surplus which in turn provides a source for accumulation, and 'manufactures increase rapidly'. Because of a low elasticity of demand for corn, consumers then 'spend freely in other directions':

> The effect of the low price of corn is to increase the floating capital of the country. It is the floating capital itself, or the principal item enabling people to live readily and spend freely in other directions. The low [corn] prices caused less land to be sold, so that when there came an unfavourable season in 1836, prices rose to 60/-, afterwards in 1838 to 80/-. Now while the price of corn was low—1833–1–5, there was general prosperity of manufactures. It was a period when all mechanical manufactures increased rapidly; and then joined to it was a great speculation in foreign loans.
>
> (*P&C,* **vi**, p. 121)

Speculative elements played a key role in the cycle; in the years of 1844–46 'the extraordinary railway mania [took place], when everybody who had money put it into railway shares, and the amt. of companies started and the engagements made are extraordinary' (p. 123). Following crop failures in 1846, 'there was a great speculation in the corn trade'; good harvests in 1847 led to 'a series of great failures in the corn trade'.[38]

In the third Lecture on fluctuations, 'Bank of England and Money Market Generally', Jevons summarized the features of the trade cycle, which was said to be characterized by pro-cyclical variations in prices, railway expenditures, workers' savings, bullion, banking reserves, note circulation, coin issues, and bills created, and by counter-cyclical variations in pauperism, bankruptcy and the rate of discount (pp. 130–31).[39] Thus, for Jevons as well as J.S.Mill (p. 48), fluctuations occur in prices and credit, as well as output and employment.

JEVONS'S SUNSPOT THEORY[40]

While John Mills had emphasized the cyclical nature of moods, he left the explanation for altering moods unspecified. Sometime around 1875, this explanation began to preoccupy and trouble Jevons, who, while fully accepting Mills's characterization of the cycle, eventually went beyond Mills in suggesting, first, that mood alterations required explanation, and, second, that harvest fluctuations were the initiating cause of ongoing fluctuations in the commercial mood. It is in 'The Solar Period and the Price of Corn' [1875] that for the first time we encounter sunspots. In the series of papers written between 1875 and 1882 Jevons outlined more fully a theory of economic fluctuations which continued to rely upon the notion of a corn-generated surplus. Here he explicitly attributed the cycle to a common initiating cause (allowance being made always for disturbing causes which alter the course of the cycle)—namely, fluctuations in the corn harvest due to weather variations. He moved to a fuller treatment of the repercussions of harvest alterations—arguing that merchants, bankers and investors base their credit and investment decisions on observed data concerning the harvest. The notion of a real investment cycle *with no underlying cyclical cause* disappeared from Jevons's analysis, and the crop cycle no longer impinged upon already existing cyclical investment forces, but instead took precedence in the analysis.

An important feature of the sunspot papers is that Jevons now focused on the cyclical variation in commercial moods, and sought an economic explanation for these variations. Understandably, since he was indeed seeking for this explanation, there is a piecemeal quality to these papers. I examine each major sunspot paper briefly first, and then draw together the implications of that investigation.

In 'The Solar Period', Jevons concurred with John Mills's argument that 'public moods' were 'the principal part' of cyclical fluctuations, but suggested that alterations in moods were caused by 'outward' or 'external events' which 'excite hopefulness at any one time or disappointment and despondency at another'. Further, he argued, 'it seems…very probable that these moods of the commercial mind, while constituting the principal part of the phenomena, may be controlled by outward events, especially the condition of the harvests' (*ICF,* pp. 203–204). It is by way of harvest cycles, caused by solar activity, that price signals are created that produce 'variations of despondency, hopefulness, excitement, disappointment and panic':

> Assuming that variations of commercial credit and enterprise are essentially mental in their nature, must there not be external events to excite hopefulness at one time or disappointment and despondency at another? It may be that the commercial classes of the English nation, as at present constituted, form a body, suited by mental and other conditions, to go through a complete oscillation in a period nearly corresponding to that

> of the sun-spots.[41] In such conditions a comparatively slight variation of the prices of food, repeated in a similar manner, at corresponding points of the oscillation, would suffice to produce violent effects.

Jevons thus attempted to demonstrate that 'the harvest and the price of grain… depend more or less upon the solar period, and will go through periodic fluctuations in periods of time equal to those of the sun-spots' (pp. 194–95). Having shown 'that there is an average variation in the price of corn to the extent of some 16 or 20 per cent. recurring at these intervals', he suggested that these price 'variations form the impulses, as I apprehend, which produce the rolling of the commercial ship' (p. 204).[42]

But serious difficulties remained. Most important was the fact, recognized by Jevons, that 'the same data would give other periods of variation equally well' (to John Mills, 3 January, *P&C,* 1877; **iv,** pp. 188–89). Jevons consequently withdrew the paper from publication. In the summer of 1877, he wrote 'Credit Cycles', Chapter xiv of the *Primer of Political Economy* (a work intended for a non-specialist audience), where he remarked upon a decennial 'tide' in business, the cause of which 'is not well understood', though he reiterated that 'commercial crises are connected with a variation in weather' (p. 120).[43]

Jevons continued working on the connection between commercial crises and sunspots, and until late 1878 he relied upon the causal mechanisms sketched above, maintaining that fluctuations were generated by alterations in commercial 'moods' caused by harvest cycles, which created price fluctuations observed and interpreted by investors and speculators. In August 1878, he presented 'On the Periodicity of Commercial Crises' to the British Association for the Advancement of Science, where, following Mills, he argued that 'No accidental cause' such as wars, tariff reforms, or foreign competition, 'is sufficient to explain so widespread and recurrent a state of trade' since these real causes did not recur periodically (*ICF,* p. 206).[44] Instead, only a periodic cause—'some great and widespread meteorological influence recurring at like periods'—could explain the 'recurrence' of economic fluctuations (pp. 206, 207).

Here Jevons reiterated Mills's suggestion that cycles were caused by the 'periodic variations' of 'mental action', a 'commercial panic' being 'the destruction of belief and hope in the minds of merchants and bankers' (1878a, *ICF,* p. 215).[45] Again he stressed that the regularity of commercial panics suggested that they were provoked by a common 'external cause', a change in what he now termed the 'industrial environment'. Again also, it is evident that Jevons was implicitly critical of Mills's failure to explain the alteration in mood, and sought an explanation of observed regular variations in commercial moods:

> I can see no reason why the human mind, in its own spontaneous action, should select a period of just 10.44 years to vary in. Surely we must go beyond the mind to its industrial environment…. When we know that there is a cause, the variation of the solar activity, which is just of the nature to

> affect the produce of agriculture, and which does vary in the same period, it becomes almost certain that the two series of phenomena, credit cycles and solar variations, are connected as effect and cause.
>
> (*ICF,* pp. 215–16)

By way of causality, Jevons stressed, first, that 'Merchants and bankers are continually influenced in their dealings by accounts of the success of harvests, the comparative abundance or scarcity of goods' (*ICF,* pp. 215–16), and second, that since 'By far the largest part of the population have but a small margin of income remaining when their necessary expenditure on food has been provided for…it is now well known to manufacturers that an active demand for their produce is to be expected only when food is cheap' (p. 217). Alterations in the Indian harvest also played a role, since abundant 'harvests in certain parts of the earth' yielded 'brisk trade' with British manufacturers (p. 219):

> It might seem that Tenterden Church steeple and the Goodwin Sands are not more remotely connected than the cotton-mills of Lancashire, the paddy-fields of India, and the spots on the sun; yet the connection is obvious when we carefully trace it out. The depressed trade of Lancashire at the present time is generally attributed to the slackness of the export trade to India, which is due to the scarcity of food in many parts of that country, this scarcity absorbing the whole earnings of the poorer classes.
>
> (*ICF,* pp. 217–18)[46]

In late 1878, Jevons asserted that 'the principal fluctuations in European commerce' were caused by fluctuations in trade 'with India, China, and probably other parts of the tropical and semi-tropical regions'. Moreover, the severity of fluctuations was linked to credit institutions: those nations 'which trade most largely to those parts of the world, *and which give long credits to their customers*' 'suffer most from these crises' (1878b, *ICF,* pp. 232, 233).[47]

In a letter to *The Times* dated 17 January 1879, 'Sun spots and Commercial Crises', Jevons outlined particularly carefully how the weather shock worked its way through the economic system. Here he argued that expectations of economic performance based upon observed trade patterns lagged behind actual economic potential; agents consequently incorrectly forecast profit-maximizing investment rates. A series of good crops in 'India, China, and other tropical or semi-tropical countries' was expected to lead to an 'unusual' demand for British manufactures, and induced manufacturers to expand capacity in anticipation of sustained increased demand: 'good trade in Lancashire and Yorkshire leads the manufacturers to push their existing means of production to the utmost and then to begin building new mills and factories' (*P&C,* **v,** p. 10). But when 'a mania of active industry is thus set going in Western Europe', Jevons argued, 'the solar radiation is waning', and high crop prices in England, China and India reduce the demand for manufactures, so that the increased capacity which manufacturers have planned for is no longer required: ‘when our manufacturers are prepared to turn out a greatly increased supply of goods famines in India and China suddenly cut off the demand’ (pp. 10– 11). A temporary excess capacity is said to result: ‘Our practical men… just manage to make demand and supply not meet. Their arrangements are made about five years too late; just when they are in the depths of despondency they ought to be actively preparing for the coming favourable change in the Indian trade, and when they are all hopeful and excited the real opportunity has already slipped by’ (p. 11).

On several occasions Jevons specified that the size of the harvest fluctuations was not as important as its periodicity. Thus in 1875 he argued that ‘a comparatively slight variation in the prices of food repeated in like manner’ might create the cycle (p. 56). ‘On the Periodicity of Commercial Crises’ suggested that what merchants and bankers responded to was not the actual size, or variation, of the harvests, but ‘accounts’ of their ‘success’ (p. 57). The Indian famines are likened in ‘Commercial Crises and SunSpots’ to a ‘match which fires the inflammable spirits of the speculative classes’ (1878b, *ICF,* p. 243). Underlying this analysis, is a firm belief that swings in ‘commercial mood’ occur when investors react to non-stationary price signals; Jevons insisted in each of the sunspot papers that ‘moods’ were the stimulating cause of the economic cycle —his point being simply that the ‘mood’ alterations were linked to harvest cycles via observed changes in agricultural prices and trade patterns.[48] And merchants, bankers and producers are myopic, since they are not able to foresee and plan for the course of the agricultural cycle. In fact throughout the cycle investors’ expectations are persistently incorrect. Thus, not only do the labouring classes have difficulty with intertemporal decision-making (Chapter 2), but also merchants and investors make persistent mistakes throughout the course of the cycle.[49]

In his unpublished paper, ‘The Solar Influence on Commerce’ [1879b], Jevons reiterated that the intensity of the sun’s rays affected the growth rates and prices of crops (and then animals), and consequently altered trade patterns. Again the cycle is said to entail complex ‘transactions of currency, credit & speculation’:

> Now the solar influence, assuming it to be periodic in amount, will undoubtedly produce variations in industry, which variations will be periodic, but the several effects will follow in a chain at successively greater intervals after the occurrence of the cause. The greater intensity of the sun’s rays will alter the condition of the atmosphere; this will affect the growth of crops, the price of vegetable food, subsequently the price of animal food; the currents of trade will then be varied in amount & direction, and the influence, if sufficiently great, will more or less manifest itself in the most complicated transactions of currency, credit & speculation.
>
> (*P&C,* **vii**, p. 93)

Jevons here insisted, however, that 'many of the remote effects of solar variation will be beyond the power of our insight' because of 'great disturbing causes, such as wars, social disturbances, changes in currency and other social institutions, mutations of fashion & habit, etc, etc' which might cause fluctuations, and counter or reinforce the effects of weather. In fact, early in 1879 he argued that the American crisis of 1873 was 'an exceptional event, due to the breakdown of inflated paper currency prices', and 'not one of the decennial series at all' (to *The Times,* 17 January; *P&C,* **v,** p. 11).[50]

By the end of March 1879, Jevons referred to the 'required keystone to my commercial crisis theory', the 'wonderful periodicity' of Indian corn prices (to T.E.Jevons, 31 March; *P&C,* **v,** p. 36). The 'missing link required to complete the first outline of the evidence' was expounded in a letter to *The Times* dated 19 April 1879, where he argued that periodic famines in India, revealed by wheat prices at Delhi between 1763 and 1838, influenced her ability to purchase British manufactured goods (*P&C,* **v,** pp. 45, 46–47).[51]While this was now cited as the 'stimulating cause' of the cycle, Jevons again insisted that 'the extent of the commercial mania or crisis' was not directly related to the fall in demand for manufactured goods; instead the cycle was driven by changes in 'the inflammable spirits of the speculative classes':

> The impulse from abroad is like the match which fires the inflammable spirits of the speculative classes. The history of many bubbles shows that there is no proportion between the stimulating cause and the height of folly to which the inflation of credit and prices may be carried.… I feel sure the explanation [of the change in commercial 'mood'] will be found in the cessation of demand from India and China occasioned by the failure of harvests there, ultimately due to changes of solar activity.
>
> (*P&C,* **v,** p. 48)

In sum, the downward portion of the cycle was said to involve solargenerated alterations in what Jevons called the 'industrial environment' which, working through increased agricultural prices and altered international spending patterns, impinged upon expectations concerning profitability in British manufacturing. Trading and investment behaviour altered, investment projects being delayed and reduced in size. Recovery, on the other hand, involved buoyant demand as a result of a succession of good harvests which stimulated confident expectations, an expansion of investment, new companies formed, and credit. An inflation of prices resulted from unwarranted credit expansions, and the banking system's loan to reserve ratio fell. The height of this 'bubble' did not depend directly upon the depth of the trough, or the empirical magnitude of previous bumper crops, being instead determined by expectations concerning overall economic performance and financial conditions. The crisis, an 'explosion of commercial folly followed by the natural collapse' (*P&C,* **v,** p. 48), involved also some erroneous expectations, 'bad trading and speculation' that produced inflated values which ultimately collapsed (*P&C,* **vi,** p. 117). And shortages of capital remained key ingredients to the crisis: 'I do not think there is any ground for a crisis just yet. It will take a year or two for the investment in their companies to tell upon the abundant free capital of the country' (to Thomas Jevons, 18 April, 1881; *P&C,* **v,** p. 134).[52]

From 1875 until 1882, Jevons maintained that sunspot activity caused alterations in 'moods' which led to this 'bad trading and speculation' (cf. *P&C,* **v,** p. 171). While he allowed that many causes alter 'moods', the only regularly recurrent (i.e. decennial) cause which he found that altered moods, was the harvest cycle.[53]

General gluts

It is generally accepted that Jevons adhered to 'the Say-Mill rigmarole about "the impossibility of general gluts"' (Hutchison 1988, p. 5; also Peach 1987, p. 1018).[54] Jevons's strictures against the 'over-production' theory are well known; in the *Theory of Political Economy,* he suggested that the 'doctrine [of over-production] is evidently absurd and self-contradictory' (p. 202). How might we reconcile this position with the theory of economic fluctuations outlined above? Jevons allowed in the *TPE* that 'supplies must be *suitable*—that is, they must be in proportion to the needs of the population. Over-production is not possible in all branches of industry at once, but it is possible, in some as compared with others' (p. 203). He thus maintained that while secular over-production was logically impossible, some industries could over-produce temporarily. But in fact Jevons proceeded farther. For as we have seen (pp. 58), he insisted that temporary over-production occurred cyclically as a result of investors misreading the state of the market. While he stood by Say's Law as a proposition concerning the secular course of output, then, Jevons clearly acknowledged that over-production, financed by credit, occurred throughout the cycle.

ECONOMIC POLICY AND FLUCTUATIONS

The scope for monetary policy was remarkably limited in Jevons's analysis, being restricted to the speculative upswing and crisis periods (Mints 1945, pp. 178f); there is no discussion of active monetary policy in the context of the cyclical downturn.[55] Perhaps because his first concern was improving the stability of the banking system, cyclical unemployment did not figure in Jevons's analysis of fluctuations. While the harvest variation could not be prevented by policy-makers, however, sound monetary policy might mitigate and shorten the resultant banking crisis. Jevons believed that convertibility was one means to this end, since it prevented unwarranted increases in lending during the speculative upturn.[56] He championed the 1844 Bank Act, arguing that it restricted 'only the illegitimate expansion of the note currency' ('On the Frequent Autumnal Pressure in the Money Market, and the Action of the Bank of England', 1866, *ICF,* pp. 179–80). Foreign drains on bullion were not to be accommodated by the banking system (cf. *Money and the Mechanism of Exchange* [1875; *MME*], pp. 340–42). But internal drains were divided into 'purely temporary' fluctuations, which should be accommodated, and irregular alterations, which should not be accommodated, since these were not attributable to currency regulations.

In his 1866 study of the money market, Jevons concluded that a 'concurrence of causes' created autumnal drains on currency (*ICF,* pp. 170– 72). Expediency thus required that the Bank increase its reserves before October and then allow them to fall below the 'normal' level, 'knowing that the excess of currency issued will in the natural course of events return' (p. 180). While such 'normal', 'temporary', or 'regular' currency drains should be accommodated, unusual demands for money were to be handled by market forces, bankers raising the 'terms of advance', and 'restricting their amount'. Jevons believed the Bank Act allowed this policy.

Remarkably (since his research on the cycle suggested otherwise), Jevons never allowed in this context that decennial economic fluctuations might be considered 'regular', or 'normal' variations, and thus require accommodation. Instead, he included 'deficient harvests' in 'abnormal changes' in 1866, and in 1878 correspondence with Mills he reiterated that 'a judicious raising of the bank rate in good time would do much to mitigate [cyclical] panics' (20 February; *P&C,* **iv,** pp. 231–32). The suspension of the 1844 Bank Act during the severe credit shortage of 1847 is said on one occasion to have restored 'confidence'; yet Jevons refrained from lending this measure unqualified support, and never went so far as to suggest a general rule for suspension (see *P&C,* **vi,** pp. 129, 123). In this regard, both J.S.Mill and John Mills went beyond Jevons by arguing that an 'authorized departure from the letter of the Act in times of crisis' would do much to mitigate the panic, and 'in reality' constituted 'a more effectual carrying out of [the Bank Act] spirit'.[57]

On balance, Jevons argued that 'sudden collapses' in money markets, were caused by 'bad banking' as opposed to 'bad currency [laws]', and to prevent these he recommended that bankers follow responsible lending policies, raising interest rates and restricting loans during speculative periods, and that cash reserves held by banks be increased (cf. *MME,* pp. 322–24; and the letter to J.Mills, 23 November 1866; *P&C,* **iii**, p. 140).

But there was room for mitigation of cyclical fluctuations. Although Mills allowed that monetary policy could play a limited role throughout the cycle, nonetheless apparently he remained hopeful that 'the cycles of Credit can be indefinitely lengthened, and the evils which mark their close greatly mitigated' (1867, p. 38). He maintained that there were several, not necessarily mutually exclusive, classes of commercial traders—the educated, the moral, the uneducated and the immoral.[58] Blame for the severity of the cycle was placed squarely on the shoulders of the uneducated and immoral traders who were largely responsible for the creation of 'diseased' credit. Consequently, he recommended education to mitigate cyclical pressures: 'the special Education of our trading classes in those scientific truths, bearing on the creation and distribution of wealth, the ultimate lesson of which is embodied in many a shrewd old aphorism which we are equally apt to quote in words and to neglect in practice' (1867, p. 39). Education, Mills asserted, would 'strengthen the mind' of the trading classes against the instinct for hasty gain, thereby reducing the number of incorrect investment decisions driven by speculative desires for gain.

While he was never altogether clear on this matter, Mills apparently believed that education would mitigate, but not entirely eliminate, cyclical pressures. The problem was, he maintained, that once ignorance and consequently some immorality (insofar as immorality resulted from ignorance) were removed as causes of cyclical fluctuations, immorality would always remain: 'Educate, indeed, as we may, Credit will always fulfil its own law of growth; and as you cannot endow all men with caution and conscience, the growth will still tend, at intervals to degenerate into a critical rankness' (1867, p. 39). Mills maintained, however, that:

> to the extent in which you increase the average intelligence, and elevate the average moral tone, you co-operate with the conservative action of economic law on the equilibrium of Credit and Capital. It is the liability to an *ignorant* speculative excitement, and a willingness to take *immoral* risks, which ultimately put the growth of Credit beyond the control of the price of loan Capital. Diminish those, and the cycle may then expand beyond its customary decade.
>
> (Mills 1867, p. 39)

In support of his calls for education, Mills referred to widely accepted policy recommendations for the labouring poor (a broad system of education) put forward by J.S.Mill as well as by Jevons.[59] In fact, Mills referred in this context to Jevons's position at Owens College, where, as part of his regular duties, he provided public lectures in order to educate the working classes; Mills suggested that the Cobden chair, 'at present so ably filled, might become a centre from which should radiate the remedial influences which I venture to suggest' (1867, p. 40).

Jevons shared Mills's belief that intertemporal decision-making is in some way harder to 'get right' than decisions at a point in time. As we have seen above, Jevons's analysis presumed that investors mistakenly forecast profits throughout the cycle, increasing capacity when famines reduce demand, thereby 'just manag[ing] to make demand and supply not meet' (p. 58). We have also seen that he presumed that the labouring classes were unable to make correct savings and family size choices without the proper course of education (see Chapter 2). Thus, in his many discussions of population pressures, as well as co-operation and trade unions, he recommended a broad system of education to correct the 'one great defect' of the working classes, their 'want of thrift and providence'. The resulting increased savings would improve the lot of labourers not only secularly, but also throughout the cycle. We return to Jevons's analysis of savings behaviour in Chapter 5, and then in Part II below.

CRITICAL EVALUATIONS OF JEVONS'S SUNSPOT THEORY

Jevons's sunspot papers have encountered widespread and severe criticism. An 1879 study purported to show that sunspots explain the periodicity of wins in boat races (*P&C,* **v,** p. 51). While praising his ability to manipulate data and extract information from them, Stephen Stigler argues that Jevons's work on the business cycle is an 'anomaly' (1982, p. 362; cf. pp. 364, 354). Barbara MacLennan contends that the studies of fluctuations neglect theory, the theoretical analysis of the cycle being 'very slight as compared to the detailed treatment of the data' (1972, p. 64). Mark Blaug's textbook summarizes Jevons's treatment of fluctuations in three sentences, concluding that he 'failed to show theoretically how this [sunspot] or any other exogenous disturbance is capable of generating endogenous fluctuations' (1962, p. 316).

Jevons's theory of fluctuations relies upon an ongoing series of exogenous shocks to the economic system; consequently commentators such as Schumpeter have been critical of the analysis (1954, p. 1133). But once we appreciate the fact that the business cycle was, for Jevons, largely a matter of alterations in 'commercial mood' which in turn play upon investment decisions, his procedure appears more reasonable. He felt obliged to seek out the stimulus for altering expectations; his argument is that to posit unexplained alterations in expectations —as John Mills had done—was an inadequate explanation of regular cyclical activity; to posit unexplained alterations in investment and credit markets (as Jevons had in 1863 and 1865) would likewise have been to beg the question. Thus, while agreeing with Mills that 'these periodic collapses are really mental in their nature', Jevons insisted that the cause of these mental 'oscillations' be found. And while the solar variation was exogenous to the economy, mood alterations were said to be generated by the periodic fluctuations of *economic* variables that the sunspot cycle affected.

In 'The Solar Period' Jevons encountered some difficulty fitting observed price variations to variations in sunspot activity, and posited unexplained changes in 'mood'. He wrote later that he 'went so far as to form the rather fanciful hypothesis that the commercial world might be a body so mentally constituted, as Mr.John Mills must hold, as to be capable of vibrating in a period of ten years, so that it would every now and then be thrown into oscillation by physical causes having a period of eleven years' (1878b, *ICF,* p. 226; cf. 1875, *ICF,* pp. 204–205). Yet this was unacceptable, amounting to the admission that 'moods' vary for no apparent economic reason. Jevons declined to publish the paper or future research on this topic until he could provide empirical evidence to support his economic explanation for why these moods, and through them investment behaviour, altered cyclically. But he stood by the harvest explanation; while he allowed for many causes which could all have real effects on the economic system, Jevons found no reason for these to generate the 'remarkable appearance of regularity and periodicity' that he observed to 'characterise these events' (1878b, *ICF,* p. 222). While many causes influenced expectations, none fit the critical requirement of periodicity (*P&C,* **vii**, p. 91).

One might speculate, as Professor Black has, that Jevons was drawn to *sunspots* as the ultimate cause of mood alterations because he came to economics via a scientific training and interest in meteorology (1981, p. 21; see Chapter 1).[60] Indeed, Jevons embarked on the sunspot research soon after the publication of his *Principles of Science,* which contains an analysis of the periodicity of sunspot data, as well as the claim, based firmly upon the scientific reputation of the astronomer, Sir John Herschel, that periodic causes generate periodic effects.[61] But the fact remains that while the sunspot cycle was the explanation offered for the decennial trade cycle—an explanation which emerged from an observed correlation of the length of these two cycles—the correlation *was* explained with the aid of economic theory. Specifically, the sunspot cycle was linked to trade cycles via alterations in expectations which followed changes in observed prices. Jevons always insisted that expectations are affected by a myriad of economic and political causes that might dampen, amplify, or reverse the effects of harvest fluctuations, or cause fluctuations of another length (p. 59). And he maintained that an observed correlation which is accompanied by 'explanation' is much more compelling than the correlation alone. Thus in 1879 he wrote that

> this *prima facie* probability [of a causal relationship] is immensely strengthened if we can give other reasons for believing that a cause of the nature supposed, apart from the question of its period, is likely to have effects of the kind we are attributing to it. In short, mere equality of period is a perfectly valid ground of inductive reasoning; but our results gain much in probability if we can analyse and explain the precise relation of cause and effect…it lends much strength to such an inference if we can show that a variation of the nature in question, namely sunspot variation, would be likely to produce variations in commerce which might constitute a commercial crisis.
>
> (*P&C,* **vii**, p. 94)

The sunspot papers are mainly devoted to establishing the correlation between sunspots and harvests, relatively little attention being paid to outlining how the harvest alteration impinges upon the wider economy. That Jevons's attention was so focused is unfortunate. Yet it is entirely understandable. For he believed that much of the work which had been accomplished on the economic cycle before 1875—the characterization of cyclical behaviour by J.S.Mill and then John Mills—was sound. And Jevons's explanation for the alteration in moods following harvest fluctuations relied upon well-established economic principles that he attributed to Smith (p. 54). This left only the need to establish the link between harvest and sunspot variation.[62]

But I would go a step farther. Jevons's procedures do not in fact imply that his analysis of fluctuations is devoid of economic theorizing. Most importantly, denigrations of the sunspot explanation of the cycle neglect an important feature of Jevons's position, namely that it encompasses more than an analysis of how agricultural output alters with direct consequences for aggregate demand. If this had been Jevons's main concern, he would have concentrated on the measurement of crop variations and could never have argued that the depth of the cycle is not determined by the extent of the famine. Instead, the thrust of his argument is that agricultural fluctuations impinge upon expectations, which in turn affect investment and speculative behaviour, and multiply the effect of the initial shock. This is Jevons's major contribution to the understanding of economic fluctuations, one which added a dimension to the psychological theory of John Mills.

In addition, Jevons's argument that abnormal or unusual events—such as wars —did not cause fluctuations which were characterized by regular features and which recurred at regular intervals was an important application of the 'common cause' argument, and one which business cycle investigators have recently invoked.[63] Thus the notion that business cycles are alike is said to be 'attractive and challenging, for it suggests the possibility of a unified explanation of business cycles, grounded in the *general* laws governing market economies, rather than in political or institutional characteristics specific to particular countries or periods' (Lucas 1983, p. 218).

Jevons's emphasis on the role of expectations in creating fluctuations via changes in investment and credit decisions, as well as the argument that cyclical weather patterns constituted a plausible explanation for mood alterations, were taken up later by an important contributor to cycle theory. In *Unemployment* [1913], A.C.Pigou explicitly referred to Jevons, and maintained that

> variations in real income come about naturally enough as the result of variations in the bounty of nature, and variations in business confidence come about as the result of variations in the mood of business men. At first sight it might seem that these two sets of variations are independent and are likely to start separate trains of causation. As a matter of fact, however, they are often associated together, the changes in mood being themselves caused by changes in the bounty of nature.
>
> (Pigou 1913, p. 114)[64]

Like Jevons also, Pigou concluded that the alteration in expectations itself affects aggregate output: 'the aggregate wage-fund is subject *at the same time* to both the two causes of expansion…namely, increased real income *and* increased willingness to employ income in investment instead of holding it in store' (1913, p. 115; emphasis in the original). In short, he insisted that as long as the case can be made for periodic harvest variation, 'Jevons's suggestion that the ultimate reason for cyclical movements is to be found in sunspots may, perhaps, contain a larger element of truth than critics have been willing to believe' (p. 116).

CONCLUSIONS

Paradoxically, given the normal identification of sunspots with agriculture, the development of Jevons's thought on trade cycles suggests a growing appreciation of the diminishing importance of corn (or 'nature') in the British economy. For while his theory of fluctuations placed much emphasis on the special role of 'corn', and supported Classical speculations concerning the nature of the demand for necessities, Jevons came to regard Britain as, primarily, a manufacturing nation. By 1878 his analysis of the cycle reflected this position, for the impetus for the cycle was now said to emerge from altered trade patterns affecting manufacturers generated by cyclical harvest conditions in agricultural nations.

Like *The Coal Question,* Jevons's theory of economic fluctuations relies in a general sense upon the principles of energist physics.[65] In the following passage from the unpublished 'Solar Influence on Commerce', Jevons maintained:

> it requires a very moderate acquaintance with physical science to know that almost all the motions and changes going on upon the earth's surface are ultimately referable to the energy of the sun's rays. We must except the tides, volcanic, and a few other inconsiderable phenomena; the winds & ocean currents are in some degree referable to the earth's own energy of rotation.
>
> (*P&C,* **vii**, 1879b, p. 97)

He continued to argue that 'vegetable life' and 'through that animal life is wholly dependent on solar radiation'. Thus, 'in a physical point of view' the sun 'is simply the soul, the fount, the mainspring of life & energy of the planetary system. To our part of the material universe it is what the spring is to the watch, the weight to the clock, the water to the mill, the fuel to the engine.' The next sentence is a key to this passage: 'What then is there absurd or fanciful in the supposition that if the sun varies in power of radiation, those variations will in virtue of the principle of forced vibrations, manifest themselves in the course of industry and trade'.

Taken as a whole, however, these remarks are designed to persuade the reader that a causal relationship exists between the sunspot and trade cycles. If the sun is the 'mainspring of life & energy' and varies in 'power and radiation', the sunspot theory of the business cycle gains credibility, Jevons thus called for 'direct experiments upon the heating power of the sun's rays' which might 'prove the fact of variation' and thereby lend support to his theory (cf. 1878b, *ICF,* pp. 213–14).

No nineteenth-century economist would have disputed that vegetable and animal life are dependent upon solar energy; none would have denied that the sun provides the energy for plants and animals to grow or, for that matter, that a variation in harvests might have wide-reaching implications for the economy. Thus, Cairnes remarked to Jevons in 1864 that the 1832–34 general rise of prices 'w^{d} find its explanation in the—as well as I recollect at present—remarkable succession of unfavourable seasons which occurred in that interval' (28 April; *P&C,* **iii**, p. 55). Malthus maintained that the Post-Napoleonic depression was caused by harvest conditions and inelastic corn demand (1836, p. 417). And the role of harvests also figures into J.S.Mill's exposition of 'commercial crises' (cf. *CW,* **iii**, p. 540).[66]

Most significantly, Jevons's analysis of fluctuations constitutes a striking reminder that the assumptions of perfect information and foresight, as well as the very strong claims concerning the outcome of unregulated market transactions underlying works such as the *Theory of Political Economy,* were relaxed in other contexts.[67] We have, first, Jevons's conviction that 'moods' of investors and bankers were unstable, 'ever ready to break into a ripple'. Following a long tradition of analysts, he devoted much energy to the explanation for why these expectations varied cyclically, causing 'ripples', or panics, that occurred with apparent regularity. Second, fundamental to Jevons's understanding of fluctuations and very much in line with Mills's argument, is the notion of mistaken responses by investors and creditors to price fluctuations; these mistaken responses then 'multiply' the direct effect of altered demand for British manufactured goods and cause the full-fledged fluctuation. And finally, there is the underlying conviction that in the context of intertemporal decision-making, education was required in order to ensure that self-interested agents make correct economic decisions.

Thus, just as our investigation in Chapter 2 revealed Jevons's conviction that the labouring classes systematically undersave and 'overpopulate', a conclusion of the foregoing examination is that, without education, investors fail to perceive the nature of the cycle and cannot correctly forecast prices or profits throughout the course of the cycle. But this conclusion raises an additional issue: how, if at all, did analysts reconcile theories of fluctuations, based on 'mistakes', with microeconomic analysis that presumed individuals make correct decisions? It transpires that for Jevons correct intertemporal decision-making is to some extent an acquired habit, which might be indoctrinated, or learned, through the proper education. This policy matter is taken up in detail in Chapter 8. In the meantime, we turn to the analysis of microeconomic decisions in Jevons's economics.

Part II

MICROECONOMIC THEORY

4
JEVONS'S *THEORY OF POLITICAL ECONOMY*
Origins, scope and purpose

> The conclusion to which I am ever more clearly coming is that the only hope of attaining a true system of Economics is to fling aside, once and for ever, the mazy and preposterous assumptions of the Ricardian School. Our English Economists have been living in a fool's paradise.
>
> (*TPE,* pp. xliv–xlv)

INTRODUCTION

As is well known, Jevons was self-consciously revolutionary in his *Theory of Political Economy,* urging, in the first edition, that 'our conception of Value' be reconsidered, along with other 'purely delusive' doctrines (p. vi). Our first task in this chapter is to examine his criticisms of Classical political economy, as well as those to whom credit is granted for having correct economic notions. He allowed that Classical economists had no trouble recognizing and interpreting economic facts, such as those underlying the laws of supply and demand, but he insisted that their explanations of economic phenomena (specifically, of value) were incorrect. In contrast to a Classical preoccupation with value derived from labour, Jevons's theory is said to be derived from Benthamite considerations of pleasure and pain. In addition, value could be conceptualized only in relative terms, or in terms of the ratio of quantities exchanged; Classical economists erred, Jevons maintained, when they neglected this important point.

While Jevons was highly critical of the 'Ricardo-Mill' school of economics, credit is given in the second edition of the *TPE* to a number of precursors, including Bentham, Dupuit, Cournot, and Gossen. Dupuit is singled out for having discovered the law of diminishing marginal utility, and Jevons recognized striking parallels with Gossen's theory; in fact, he felt it necessary to assert that he had not encountered the German economist's work until after the publication of the first edition.

We examine below (pp. 78–81) Jevons's Mathematical Theory [MT], read before the British Association in Cambridge in 1862, and published in 1866 in the *Journal of the Royal Statistical Society*. Here it will become clear that all the key ingredients of Jevons's theory of exchange, developed more extensively by 1871, were present in this early work. The Law of One Price and the corresponding decision to deal with equilibrium exchanges, as well as the notion of maximizing behaviour and the 'most important law' of diminishing marginal utility, proved sufficient for Jevons to characterize the conditions under which trade ceases, i.e. to characterize the price taking individual's equilibrium. His discussion of the laws of utility and exchange in 1871 served to elaborate upon, but not to alter fundamentally, the 1862 analysis.

Jevons's purpose in *TPE* was twofold, and this is our main concern in pp. 81–88. First, he attempted to place utility, the laws of utility, and the act of exchange, at the centre of economic analysis, diverting attention from a labour theory of value, and from production (which, at any rate, might also be reduced to utilitarian notions). Thus his intent was to 'trace out carefully the natural laws of the variation of utility' in order to provide a theory of exchange based on incremental utility equivalents. Second, he insisted that the theory, being mathematical in nature because it dealt with relations among varying quantities, must be presented mathematically.

But Jevons carefully circumscribed his purpose in *TPE*. He insisted, as in MT, that his mathematical treatment of pleasure and pain pertained only to equilibrium situations. The rationale for this treatment was pragmatic: Jevons acknowledged that, in the absence of circumscribing his task to equilibrium exchanges, he would be forced to use differential equations, while in the 'statical view of the question', he could use ratios of infinitesimals and avoid integrating the utility functions (*TPE,* p. 94).

In addition, Jevons maintained that neither evaluations of total pleasure nor interpersonal comparisons of feelings were required for the theory of exchange. He circumscribed his purpose also by treating only 'the lowest rank of feelings' in the *TPE*—those feelings aimed at supplying 'the ordinary wants of man at the least cost of labour'. Here again his approach was pragmatic; while recognizing higher forms of motivation than private self-interest, he tackled the simpler problem of analysing choices driven only by the lower feelings. He omitted from *TPE* consideration of a 'higher calculus of moral right and wrong' which might reveal how the individual 'may best employ that wealth for the good of others as well as himself ' (*TPE,* p. 27).

Jevons insisted that theoretical economics, treating relations of quantities, must reason mathematically, but he allowed that other methods were appropriate for non-theoretical economics. He insisted that several non-theoretical types of economics be pursued: 'empirical, historical, or practical'. While his exposition of value theory relied on introspective data (the 'condition of a mind') economics in practice treats 'an aggregate of individuals' (*TPE,* pp. 14–15). Gathering and interpreting economic statistics thus constituted an important, neglected, and legitimate form of economic research. Jevons's call for subdivision constituted a break with the Classical political economist who synthesized considerations of theory, policy, applications, and institutional arrangements. The Jevonian economist was encouraged, by contrast, to specialize in a subset of the discipline. Thus, the *TPE* had two concomitant effects: by insisting that the exchange decision be analysed in mathematical terms, Jevons narrowed the scope of economic theory. His recommendation that the economist might specialize along the lines of subject matter or method, served potentially to narrow the requisite breadth of any researcher's expertise. At the same time, his calls for specialization and for the collection and analysis of data to complement economic theory, served to broaden the potential scope of topics to be treated by late nineteenth-century economists as a whole.

JEVONS'S INTELLECTUAL HERITAGE: THE `PREFACES' OF 1871 AND 1879

Jevons is explicit in his 'Preface' to the first edition about exactly how he differs from the Classical economists, and also when he agrees with them. He points to the 'unquestionable truth', for instance, of 'the Laws of Supply and Demand',[1] founded as these were 'upon facts' (p. vi), as well as the 'truth' of Malthusian population doctrine, alluded to in Chapter 2. In addition, his theory of rent is said to have been 'accepted by English writers for nearly a century' (p. 210), while his views on capital are said to be at one with Ricardo (p. 222).

Yet Jevons insisted that 'our conception of Value' be reconsidered, along with other 'purely delusive' doctrines—'especially the so-called Wage Fund Theory', the latter a 'mere truism' since it 'pretends to give a solution of the main problem of the science [of economics]—to determine the wages of labour; yet, on close examination, its conclusion is found to be a mere truism, namely, that the average rate of wages is found by dividing the whole amount appropriated to the payment of wages by the number of those between whom it is divided' (p. vi).[2] In the second edition Jevons was more generous in offering credit for his varied intellectual debts; yet he spoke there even more strongly against the 'mazy and preposterous assumptions of the Ricardian School' and the 'old erroneous doctrines' of the English economists living in a 'fool's paradise' (pp. xliv– xlv), and he urged the need to establish 'a true system of Economics' by shunting aside the theory of 'that able but wrong-headed man, David Ricardo' and 'his equally able and wrong-headed admirer, John Stuart Mill' (p. li).

In opposition to a Classical preoccupation with value derived from labour, Jevons's theory is said to be derived from Benthamite considerations, and to treat 'Economy as a Calculus of Pleasure and Pain' (p. vi).[3] This emphasis on exchange and utility, Jevons argued, was to be contrasted with the Classical preoccupation with labour: 'Repeated reflection and inquiry have led me to the somewhat novel opinion, that *value depends entirely upon utility*. Prevailing opinions make labour rather than utility the origin of value; and there are even those who distinctly assert that labour is the *cause* of value' (p. 1).[4] He objected also to the 'thoroughly ambiguous and unscientific' use of the term 'value' in

Smith's *Wealth of Nations* [1776] and in Mill's *Principles of Political Economy* [1848; *PPE*].[5]

Consequently, the first step towards establishing 'a correct idea of the science of Economics', Jevons insisted, is to obtain 'a perfect comprehension of the Theory of Exchange' founded upon a clear notion of the term 'value' (*TPE,* pp. 75–76). In opposition to the 'value in use'—'value in exchange' juxtaposition of Smith, and in opposition to Mill's claim that The value of a thing means the quantity of some other thing, or of things in general, which it exchanges for', Jevons maintained that value 'merely expresses *the circumstance of* [a substance] *exchanging in a certain ratio for some other substance*' (p. 77). Value, then, could be conceptualized only in relative terms, or in terms of the ratio of quantities exchanged; Classical economists erred when they neglected this important point. Absolute value, or value as 'a concrete thing', for Jevons, is a 'scientifically incorrect' conception (p. 78).[6] In order to distinguish his own terminology from an absolute value concept, he 'discontinue[d] the use of the word value altogether', using in its place *'Ratio of Exchange'* (p. 81).[7]

In the 'Preface' to the second edition, Jevons acknowledged that his doctrine of wages 'adopted in 1871, under the impression that it was somewhat novel', was original only 'to those whose view is bounded by the maze of the Ricardian Economics' (p. xliv).[8] The 'true doctrine', he maintained, was to be found by contrast with the French school of J.B.Say.[9] Further, he reiterated his rejection of the wage fund theory, and now also criticized the 'Cost of Production doctrine of Value',[10] and the 'Natural Rate of Wages' (pp. xlv–xlvi), insisting that the English school 'must [instead] regard labour, land, knowledge, and capital as conjoint conditions of the whole produce, not as causes each of a certain portion of the produce' (p. xlvi).[11]

While Jevons was highly critical of the 'Ricardo-Mill' school of economics, credit is given in the second edition of the *TPE* to a number of precursors, including, as we have seen, Bentham, as well as A.J.Etienne-Juvenel Dupuit, Antoine Augustin Cournot, and Hermann Heinrich Gossen. Thus he maintained that 'It is the French engineer Dupuit who must probably be credited with the earliest perfect comprehension of the theory of utility' (p. xxviii). Indeed, Dupuit is singled out for having discovered the law of diminishing marginal utility, establishing 'a theory of the *gradation of utility,* beautifully and perfectly expounded by means of geometrical diagrams', a theory, in fact, that is said to be 'undoubtedly coincident in essence with that contained in this book' (p. xxix).

Cournot also comes in for high praise, being credited with 'an important anticipation of discussions concerning the proper method of treating prices, including an anticipation of my logarithmic method of ascertaining variations in the value of gold' (*TPE,* p. xxx). The 'most important part of the book', Jevons asserted, 'contains a wonderful analysis of the laws of supply and demand, and of the relations of prices, production, consumption, expenses and profits' (p. xxx). Cournot's procedure is said to entail the 'assumption' that débit, or demand, is functionally related to price, $D=F(p)$, and then, 'after laying down empirically a few conditions' of the demand function, the derivation of 'the consequences that follow from those conditions' (p. xxxi).[12] Despite the obvious fact that 'Cournot does not recede to any theory of utility', but instead 'commences with the phenomenal laws of supply and demand' and, thus, that 'his investigation has little relation to the contents of this work *[TPE]*'—which, by contrast, takes utility and exchange as the starting-point for economic analysis, and proceeds to the 'laws' of supply and demand only secondarily, as empirical propositions—Jevons recognized the 'high economic importance' of Cournot's work and predicted that 'when the treatment of demand [proceeds]', 'when the parts of political economy to which the theory relates come to be adequately treated', that treatment 'must be based on the analysis of Cournot' (p. xxxi).

Turning to Gossen, Jevons recognized parallels with his theory so striking that he felt it necessary to assert that he had not read or 'heard any history of Gossen's work until after the publication of the first edition.[13] For Gossen had anticipated Jevons in terms of the mathematical method, as well as the basis and nature of economics: 'He then at once insists that mathematical treatment, being the only sound one, must be applied throughout' (*TPE,* p. xxxiii). In Gossen, the theory of pleasure is acknowledged as the proper central concept of economics, and a clear statement of the famous law of diminishing marginal utility ensues:

> The treatise then opens with the consideration of Economics as the theory of pleasure and pain, that is as theory of the procedure by which the individual and the aggregate of individuals constituting society, may realise the maximum of pleasure with the minimum of painful effort. The natural law of pleasure is then clearly stated, somewhat as follows: Increase of the same kind of consumption yields pleasure continuously diminishing up to the point of satiety.
>
> (*TPE,* pp. xxxiii–xxxiv)

Consequently, Jevons concluded that Gossen 'completely anticipated me as regards the general principles and method of the theory of Economics' (p. xxxv).[14]

While Jevons maintained that he had arrived independently at his Theory of Exchange, then (and there is no reason to doubt the truth of this claim) he clearly acknowledged the similar earlier treatment by Gossen and Dupuit, as well as the direct influence of Bentham. Coupled with the contemporaneous treatment by Léon Walras,[15] the Gossen-Dupuit discussions served to confirm Jevons's belief that the new approach constituted the 'true' economic theory: 'The fact that some four or more independent writers such as Dupuit, Gossen, Walras, and myself should in such different ways have reached substantially the same views of the fundamental ideas of economic science, cannot but lend great probability, not to say approximate certainty, to those views' (*TPE,* pp. xxxix–xl).

Timing the discovery

Precisely when did Jevons arrive at his theory of exchange? It has been argued convincingly (LaNauze 1953, pp. 356–58) that we can date the 'discovery' of utility theory on 19 February 1860. This argument relies on records in Jevons's Diary (now published in Volume **vii** of the *Papers and Correspondence*). One entry there refers to research along the lines of a labour theory of value, and a subsequent entry refers to the earlier 'blunder' concerning value, as well as a 'true comprehension' of value theory. In February 1860, Jevons wrote: '3rd–5th including Sat. and Sun.—was almost entirely engaged in commencing a work on Pol. Econ. to be established on a demonstrative basis, in the form of connected and distinct propositions. Value to be established on the basis of labour and the problems of rent wages interest etc. to be solved as mathematical functions' (*P&C,* **vii**, p. 120). Less than two weeks later, he repudiated this attempt, and seems to have discovered a new approach: 'At home all day & working chiefly at Economy, arriving as I suppose at a true comprehension of *Value* regarding which I have lately very much blundered' (p. 120). Within a few months, he wrote to his brother, Herbert Jevons, announcing the discovery of 'what I have no doubt is *the true Theory of Economy,* so thorough-going and consistent that I cannot now read other books on the subject without indignation' (letter dated 1 June 1860; **ii**, p. 410).

JEVONS'S *BRIEF ACCOUNT OF A MA THEMA TICAL THEORY*

In the letter to Herbert Jevons cited above, Jevons maintained 'I have no idea of letting these things lie by till somebody else has the advantage of them—and shall therefore try to publish them next Spring' (*P&C,* **ii**, p. 411). In fact, it was in 1862 that Jevons presented a paper to the famous Section F of the British Association for the Advancement of Science (BAAS), in which many of the ideas later developed more fully in the *Theory of Political Economy,* were presented publicly for the first time. The 'Brief Account of a General Mathematical Theory of Political Economy' [MT] appeared in the *Journal of the Royal Statistical Society* in 1866.

The MT commences with a call for the reduction of the 'main problem' of Economy to a 'mathematical form', a reduction which would not, however, serve to render the laws of economy any more or less exact. Instead, while its 'mathematical principles may become formal and certain', its 'individual data [will] remain as inexact as ever' (MT, p. 282).[16] Immediately, Jevons recognized the incomplete nature of this study, which considered individuals motivated only by pleasures and pain[17] ('the great springs of human action') and which abstracted from many human motives that cannot be reduced to pleasure and pain: 'There are motives nearly always present with us, arising from conscience, compassion, or from some moral or religious source, which economy cannot and does not pretend to treat. These will remain to us as outstanding and disturbing forces; they must be treated, if at all, by other appropriate branches of knowledge' (p. 282).[18] Jevons never clarified, however, why conscience and compassion cannot be reduced to pleasure and pain.

Feelings of pleasure and pain, Jevons argued, vary, are 'capable of *more or less*', and as such, they initiate actions: 'Our choice of one course out of two or more proves that, in our estimation, this course promises the greatest balance of pleasure' (MT, p. 282). His focus was on those 'critical points of the theory' when, he argued, individuals estimate that 'the opposing motives' are 'nearly equal'. Pleasure is conceptualized as a quantity in two dimensions, intensity and duration (time), with intensity varying continuously as a function of time. Thus, if duration is represented by the abscissa, and intensity by the ordinate of a curve, the area under the curve is 'the quantity of feeling' (MT, p. 283). In *TPE,* however, Jevons left no doubt that the area is not what he wants to measure (see pp. 85–88).

Economy deals with the principles of pleasure and pain only as they relate to *'useful objects'* that produce pleasure and pain. Useful objects either create pleasurable feelings instantaneously, or excite expectations of future pleasure (which, if the future is uncertain, must be reduced somewhat compared to the same pleasure instantly created). Any reduction associated with the future nature of pleasure is due to the fact that such pleasure may be imperfectly anticipated, or the fact that the future is uncertain. For these to be separate rationales, uncertainty in and of itself must be painful, or utility reducing. Abstention, delaying pleasure consumption now, does not enter into the argument and in fact, as we shall see (Chapters 5 and 8), Jevons argued that it was irrational to discount perfectly anticipated future pleasures. Abstention does, however, underlie the argument in *TPE* that negative utility is associated with capitalization (see Chapter 6).

Jevons called the amount of pleasure, *'amount of utility'*. He then asserted that 'Every appetite or sense is more or less rapidly satiated' (MT, p. 283). No evidence is provided to support this assertion, which is apparently based on introspection. The additional utility resulting from increments of commodity 'usually decreases in some proportion, or as some function of the whole quantity received'. This variation exists 'even in the smallest quantities', in which case 'we must recede to infinitesimals, and what we shall call the *coefficient of utility*', that is, the 'ratio between the last increment or infinitely small supply of the object, and the increment of pleasure which it occasions', the limit of (u/ x). Jevons thus arrives at the 'most important' law of the whole theory: 'The coefficient of utility is, then, some generally diminishing function of the whole quantity of the object consumed' (p. 283).

The particular functional form for the coefficient of utility depends directly on the good involved, and also 'more or less' on the individual. Jevons envisioned a Smithian hierarchy of goods whereby the coefficient of utility declined more rapidly for necessities than for luxuries: 'Thus, the appetite for dry bread is much more rapidly satisfied than that for wine, for clothes, for handsome furniture, for works of art, or, finally, for money' (MT, p. 283).[19] Variations in tastes were acknowledged, although Jevons did not make it clear whether this would imply that some consumers violated the 'typical' hierarchy of goods, or whether, within that hierarchy, variations in the coefficient of utility existed: 'And every one has his own peculiar tastes in which he is nearly insatiable' (p. 283). Because of the 'more or less' qualification concerning individual tastes, however, one might speculate that he had the latter situation in mind.

The theory of exchange is deduced from these laws of utility. Individuals will exchange goods, he reasoned first, as long as the action of exchange leaves them no worse off. Each individual has veto power over the action of exchange and therefore will not consent, as a rule, to utility reducing transactions: 'If a person has any useful object, but an object belonging to another person would have greater utility, he will be glad to give the one in return for the other. But it is a necessary condition that the other person will likewise gain, or at least not lose by the exchange' (MT, p. 284). Then, if we consider individuals exchanging 'more or less' of goods, 'even down to infinitely small quantities', an individual will exchange at a given exchange rate, until 'if he gave an infinitely small quantity, either more or less, but at the same rate, he would not gain in utility by it' (p. 284).

At this point in his argument, and without elaboration Jevons invokes the Law of One Price, 'that all quantities of the same commodity, being uniform in kind, must be exchanged at the same rate' (MT, p. 284). Thus, the last increments exchanged must 'be exchanged, in the ratio of the whole quantities exchanged' (p. 284). While he finds it 'almost impossible' to explain how the adjustment to equilibrium occurs and thus how relative prices are established at any point in time, Jevons clearly possessed a firm conception of the characteristics of the equilibrium: 'The known quantities are those of the commodities previously possessed. We have also the functions of utility of the commodities with respect to the persons. An equation may thus be established on either side between the utility gained and sacrificed at the ratio of exchange of the whole commodities, upon the last increments exchanged' (p. 285).[20] The 'balance' occurred, Jevons insisted, in the 'gain of utility' and not the total utility: 'Let it be remarked, that though the exchanges be regulated by equations, there cannot be equality in the whole utilities gained and lost, which are found by integrating the functions of utility of the respective commodities before and after exchange. The balance is the gain of utility, and from the nature of exchange there must be a gain on one side at least' (p. 285).

In sum, as early as 1862 Jevons's theory of exchange relied on the Law of One Price, and the corresponding decision to deal with equilibrium exchanges, as well as the 'most important law' of diminishing marginal utility. These proved sufficient for Jevons to characterize the conditions under which trade ceases, i.e. to characterize the price taking individual's equilibrium. It would be almost another decade before Jevons elaborated upon the laws of utility and exchange outlined in the MT.

SCOPE AND PURPOSE OF THE *THEORY OF POLITICAL ECONOMY*

An undated note by Jevons sheds some light on why he published the *TPE* in 1871, attributing the decision 'in part' to correspondence with the engineer Fleeming Jenkin[21] who published a paper in 1870 containing a graphical analysis of supply and demand:

> In regard to this and certain other essays of Professor Fleeming Jenkin, it seems desirable that I should make the following explanation, to prevent misapprehension. My theory was originally read at the British Assoc. in 1862 & printed in the Stat. Journal in 1867. In March 1868 Prof.Jenkin wrote an article for the Br.Quarterly Review in wh. he stated (?) at pp 13–14 the law of supply and demand in math, language. He courteously sent a copy to me & requested my opinion thereon: in replying I sent a copy of the paper mentioned above, & a correspondence ensued concerning the correctness of the theory in the course of wh.curves were used in illustration by both parties.
>
> In 1870 appeared Prof.Jenkins 'Graphic Illustrations…' in which no reference is made to my previous.
>
> Partly in consequence of this I was led to write and publish the Theory in 1871.
>
> (*P&C,* **iii,** p. 166)

Since, as we know (from the discussion in Chapter 2 as well as pp. 75–78) Jevons fervently desired recognition and was much concerned with the notion of priority, it seems likely that the Jenkin-Jevons exchange did indeed influence the timing of the publication of *TPE*.

Jevons's purpose in *TPE* was twofold: first, as noted above, and as in the MT, he attempted to 'trace out carefully the natural laws of the variation of utility' in order to provide a theory of exchange based on incremental utility equivalents.[22] Second, Jevons insisted that the theory, being mathematical in nature because it dealt with relations among varying quantities, must be presented mathematically.

But Jevons also carefully circumscribed his purpose:

> this book was never put forward as containing a systematic view of economics. It treats only of the theory, and is but an elementary sketch of elementary principles. The working out of a complete system based on these lines must be a matter of time and labour, and I know not when, if ever, I shall be able to attempt it.
>
> (*TPE,* p. xliv)[23]

At the outset, Jevons insisted here, as in MT, that his treatment of pleasure and pain pertained only to equilibrium values: 'The nature of Wealth and Value is explained by the consideration of indefinitely small amounts of pleasure and pain, just as the Theory of Statics is made to rest upon the equality of indefinitely small amounts of energy' (p. vii).[24] Again, the rationale for this treatment was pragmatic: just as 'It is much more easy to determine the point at which a pendulum will come to rest than to calculate the velocity at which it will move when displaced from that point of rest', it is also 'a far more easy task to lay down the conditions under which trade is completed and interchange ceases, than to attempt to ascertain at what rate trade will go on when equilibrium is not attained' (p. 94). In the absence of circumscribing his task to equilibrium exchanges, Jevons would be forced to use differential equations. In the 'statical view of the question', however, considering equilibrium trades, he could use ratios of infinitesimals and thereby avoid integrating utility functions (p. 94).[25] We return to this matter in Chapter 5.

Throughout, Jevons's second intent then, is to present his new theory mathematically. In the first edition of the *TPE,* he maintained that 'I have long thought that as [Economics] deals throughout with quantities, it must be a mathematical science in matter if not in language' (p. vii). His task was to render economics mathematical in language as well as subject matter: Utility, Labour, Capital, and 'especially that most puzzling of notions *Value*' were all capable of 'mathematical analysis and expression' (p. vii).[26] The 'Preface' to the second edition put the case more strongly: 'I contend that all economic writers must be mathematical so far as they are scientific at all, because they treat of economic quantities, and the relations of such quantities and all quantities and relations of quantities come within the scope of the mathematics' (p. xxi).[27] Because, however, economists have 'long been mathematicians without being aware of the fact', they 'generally' were 'bad mathematicians' (p. xxiii) and, in Jevons's mind, 'an almost necessary condition of any real improvement of the theory' therefore consisted of 'explicit recognition of the mathematical character of the science' (p. xxiii).[28] If economics 'is to be a science at all', Jevons concluded, it 'must be a mathematical science' (p. 3).[29]

Further, in the light of the fact that 'the quantities with which we deal must be subject to continuous variation', Jevons insisted on the use of calculus: 'the theory consists in applying the differential calculus to the familiar notions of wealth, utility, value, demand, supply, capital, interest, labour, and all other quantitative notions belonging to the daily operations of industry' (p. 3).[30] As we will see below, while he insisted on use of calculus, his theory—treating of equilibrium trades—relied on ratios of infinitesimals (marginal utilities), rather than any full-blown constrained optimization.

While Jevons insisted that theoretical economics, treating relations of quantities, must reason mathematically, he allowed that other methods were appropriate for non-theoretical economics. And he insisted that there were several non-theoretical types of economics to be pursued: 'empirical, historical, or practical'. Gathering and interpreting economic statistics, for instance, constituted an important, neglected, and legitimate form of economic research. Jevons thus made a prescient call for subdivision and cross-subdivision in economics, along the lines of subject matter as well as methodology:

> Subdivision is the remedy. We must distinguish the empirical element from the abstract theory, from the applied theory, and from the more detailed art of finance and administration. Thus will arise various sciences, such as commercial statistics, the mathematical theory of economics, systematic and descriptive economics, economic sociology, and fiscal science. There may even be a kind of cross subdivision of the sciences; that is to say, there will be division into branches as regards the subject, and division according to the manner of treating the branch of the subject. The manner may be theoretical, empirical, historical, or practical; the subject may be capital and labour, currency, banking, taxation, land tenure, etc.—not to speak of the more fundamental division of the science as it treats of consumption, production, exchange, and distribution of wealth.
>
> (*TPE,* p. xvii)[31]

Instead of encouraging the political economist to master economic theory and also, the 'art' of policy evaluation, as J.S.Mill did,[32] Jevons's recommendation was that the profession be separated into those who specialized in matters of taxation, or in gathering and analysing statistics. By contrast with the Classical synthetical approach to Political Economy, the Jevonian economist was encouraged legitimately to specialize in a subset of the discipline. As a consequence, at the same time that Jevons's *TPE* generated new research questions and methods for subsequent political economists, the scope of any individual economist's research programme was appreciably narrowed.

But all branches of the science, Jevons held, have as their basis 'certain general principles'—just as 'all the physical sciences[33] have their basis more or less obviously in the general principles of mechanics'. It was to the 'limited' goal of explicating these general principles, to 'tracing out of the mechanics of self-interest and utility' that the *TPE* was devoted (*TPE,* pp. xvii–xviii), a goal that constituted a 'necessary preliminary to any definite drafting of the superstructure of the aggregate science' (p. xviii).[34]

Jevons left no doubt as to the universality of these general principles. The laws treating of 'the relations between human wants and the available natural objects and human labour by which they may be satisfied', he argued, 'are so simple in their foundation that they would apply, more or less completely, to all human beings of whom we have any knowledge' ('The Future of Political Economy' [1876], *PE,* p. 196).[35] Indeed, Jevons speculated—partly tongue in cheek—that the relationships between wants and labour might apply to some of the 'more intelligent classes of animals':

> I should not despair of tracing the action of the postulates of political economy among some of the more intelligent classes of animals. Dogs certainly have strong though perhaps limited ideas of property, as you will soon discover if you interfere between a dog and his bone.
>
> I come to the conclusion, then, that the first principles of political economy are so widely true and applicable that they may be considered universally true as regards human nature.
>
> (*PE,* p. 197)[36]

Thus, while the scope of economic theory was narrowed by Jevons's insistence on subdivision within the discipline, the applicability of its principles was by no means limited, but was instead granted universal status.

Measurement issues

The task of tracing out the universally applicable laws of utility was made particularly difficult by the fact that no means existed to 'weigh' or 'gauge' or 'test' 'the feelings of the mind' (*TPE,* p. 7), a problem which was to some extent, however, faced in every science. For while Jevons acknowledged that feelings were difficult to gauge, he insisted that this was no conceptual problem, but instead simply constituted a problem of measurement: 'But it is chiefly a want of method and completeness in this vast mass of information which prevents our employing it in the scientific investigation of the natural laws of Economics' (p. 11). Direct measurement of pleasure was a pipe-dream: 'I hesitate to say that men will ever have the means of measuring directly the feelings of the human heart' (p. 11). Since feelings can be inferred indirectly from the effects of feelings, (actions), however, all that was wanting to make Economics an exact science was 'a perfect system of Statistics' (pp. 11–12): 'But we only employ units of measurement in other things to facilitate the comparison of quantities; and if we can compare the quantities directly, we do not need the units. Now the mind of an individual is the balance which makes its own comparisons, and is the final judge of quantities of feeling' (p. 12). Just as we know gravity by its effects, Jevons argued, we can also know the human mind via observed effects:

> We can no more know nor measure gravity in its own nature than we can measure a feeling; but, just as we measure gravity by its effects in the motion of a pendulum, so we may estimate the equality or inequality of feelings by the decisions of the human mind. The will is our pendulum, and its oscillations are minutely registered in the price lists of the markets.
>
> (*TPE,* pp. 11–12)

From the outset, Jevons maintained that neither evaluations of total pleasure nor interpersonal comparisons of feelings were required for his theory:

> We can seldom or never affirm that one pleasure is an exact multiple of another; but the reader who carefully criticises the following theory will find that it seldom involves the comparison of quantities of feeling differing much in amount. The theory turns upon those critical points where pleasures are nearly, if not quite, equal. I never attempt to estimate the whole pleasure gained by purchasing a commodity.
>
> (*TPE,* p. 13)[37]

Instead, the theory presumed that consumers evaluate and compare the alteration of utility associated with consuming a little more, or less, of two goods. Jevons refrained from specifying why it would be less restrictive to require that consumers can estimate utility changes but not total utility.[38] And interpersonal comparisons of utility were categorically ruled out: 'there is never, in any single instance, an attempt made to compare the amount of feeling in one mind with that of another. I see no means by which such comparison can be accomplished' (p. 14).[39]

While his theoretical exposition relied on introspective data (the 'condition of a mind'), however, economics in practice treats 'an aggregate of individuals' (*TPE,* pp. 14–15):

> The general forms of the laws of Economics are the same in the case of individuals and nations; and, in reality, it is a law operating in the case of multitudes of individuals which gives rise to the aggregate represented in the transactions of a nation. Practically, however, it is quite impossible to detect the operation of general laws of this kind in the actions of one or a few individuals. The motives and conditions are so numerous and complicated, that the resulting actions have the appearance of caprice, and are beyond the analytic powers of science.
>
> (*TPE,* p. 15)[40]

Jevons maintained that individuals sometimes make mistaken evaluations of the benefits accruing from a particular choice: 'It is true that the mind often hesitates and is perplexed in making a choice of great importance: this indicates either varying estimates of the motives, or a feeling of incapacity to grasp the quantities concerned. I should not think of claiming for the mind any accurate power of measuring and adding and subtracting feelings so as to get an exact balance' (*TPE,* p. 13). On average, however, he argued that aggregate laws are correct since such mistaken evaluations, and omitted causes such as imperfect information or capricious motives will tend to 'neutralize' each other: The use of an average, or, what is the same, an aggregate result, depends upon the high probability that accidental and disturbing causes will operate, in the long run, as often in one direction as the other, so as to neutralize each other' (p. 16). Aggregate laws are not generally the same as individual laws, 'unless all those individuals were of the same character and position as regards wealth and habits' (p. 15). Elsewhere Jevons reiterated this point:

> It should be remarked, however, that the economic laws representing the conduct of large aggregates of individuals will never represent exactly the conduct of any one individual. If we could imagine that there were a thousand individuals all exactly alike in regard to their demand for commodities, and their capabilities of supplying them, then the average laws of supply and demand deduced from the conduct of such individuals would agree with the conduct of only one individual. But a community is composed of persons differing widely in their powers, wants, habits, and possessions. In such circumstances the average laws applying to them will come under what I have elsewhere [*PS,* p. 363] called the 'Fictitious Mean', that is to say, they are numerical results which do not pretend to represent the character of any existing thing. But average laws would not on this account be less useful, if we could obtain them; for the movements of trade and industry depend upon averages and aggregates, not upon the whims of individuals.
>
> (*TPE,* p. 90)[41]

The `lowest rank' of feelings

Jevons circumscribed his purpose, finally, by treating only 'the lowest rank of feelings' in the *TPE*. Specialization—abstracting from 'extraneous' or 'capricious' motives while recognizing their existence—was a means by which to overcome the conceptual difficulties associated with the investigation of the very complex conditions of the mind. Thus, he omitted consideration of a 'higher calculus of moral right and wrong' which might reveal how the individual 'may best employ that wealth for the good of others as well as himself '(*TPE,* p. 27).[42] Higher orders of 'feelings' are acknowledged, but ruled out as the subject matter for the treatment of exchange:

> [A person] is capable also of mental and moral feelings of several degrees of elevation. A higher motive may rightly overbalance all considerations belonging even to the next lower range of feelings; but so long as the higher motive does not intervene, it is surely both desirable and right that the lower motives should be balanced against each other. Starting with the lowest stage—it is a man's duty, as it is his natural inclination, to earn sufficient food and whatever else may best satisfy his proper and moderate desires. If the claims of a family or of friends fall upon him, it may become desirable that he should deny his own desires and even his physical needs their full customary gratification. But the claims of a family are only a step to a higher grade of duties.

> The safety of a nation, the welfare of great populations, may happen to depend upon his exertions, if he be a soldier or a statesman: claims of a very strong kind may now be overbalanced by claims of a still stronger kind. Nor should I venture to say that, at any point, we have reached the highest rank—the supreme motives which should guide the mind. The statesman may discover a conflict between motives; a measure may promise, as it would seem the greatest good to great numbers, and yet there may be motives of uprightness and honour that may hinder his promoting the measure. How such difficult questions may be rightly determined it is not my purpose to inquire here.
>
> (*TPE,* pp. 25–26)[43]

But although Jevons attempted to remain neutral concerning individual choices, even in his treatment of lower pleasures, we can perceive his own judgements about what types of consumption should prevail. For, at the lowest stage of pleasures, a man ought to satisfy only his 'proper and moderate' desires. Then, if 'the claims of a family or of friends fall upon' the consumer, 'it may become desirable that he should deny his own desires and even his physical needs their full customary gratification'. For the purposes of his limited investigation in *TPE,* however, Jevons insisted that 'the will or inclination of the person immediately concerned' should be regarded as 'the sole criterion, for the time, of what is or is not useful' (*TPE,* p. 39).

CONCLUSIONS

Jevons's *TPE* was highly critical of any understanding of value as an absolute, and of labour as the cause of value. In the place of such 'mazy and preposterous' notions, he attempted to generate new research questions and methods. Thus, he placed utility at the heart of economic analysis, opening up the investigation of the nature of as well as the measurability of utility, the individual's marginal, (and total), utility functions, and the nature of Social Utility, or Welfare, as potential research questions for the generations of economists who followed Jevons.

It is not surprising, then, that two of Jevons's followers, F.Y.Edgeworth[44] and Irving Fisher, took up the challenge of generalizing his utility theory. In 1881, Edgeworth generalized Jevons's utility function to the case of many goods, and developed the famous equation for the contract curve.[45] Fisher, who claimed that Jevons's *TPE* was one of 'two books which have influenced me most',[46] argued that his equations were an 'appropriate extension of Jevons' determination of exchange of *two* commodities between *two* trading bodies to the exchange of *any number* of commodities between *any number* of traders' (1892, pp. 3–4). Like Edgeworth's, Fisher's work proceeded by way of a generalized utility function (pp. 64f). In addition, as we will see in Chapter 8, both Edgeworth and Fisher were very much concerned with the nature and measurability of Social Welfare.

Instead of encouraging the political economist to master both economic theory and also to practise the 'art' of policy evaluation, as J.S.Mill did, Jevons urged social scientists to specialize in a subset of the discipline. The scope of an economist's legitimate research programme (legitimate in the sense that it carried the stamp of approval by a leading political economist of the time) was thereby potentially appreciably narrowed. Jevons's calls for specialization also, importantly, opened the way for empirical research as a specialization within economics. For while the theory of exchange was said to rest on immeasurable utility principles and require no interpersonal comparisons of utility, in practice Jevons recognized that some types of welfare measures might prove useful to the assessment of tax incidence, or indeed to assessments of the effects of any policy measures. Coupled with his calls for the appropriation of empirical methods in economics (Chapter 9) his calls for the collection of economic statistics led directly to the rise of statistical thinking as a specialization within the discipline. Yet, as we have seen, Jevons left no doubt as to the universality of the general principles underlying economic theory.

That universal status, however, did not imply that economic agents possessed either perfect foresight, or perfect decision making skills in practice. Jevons insisted that individuals make mistakes, when, because of capricious motives or imperfect information, they are unable to evaluate 'the quantities concerned' (*TPE,* p. 13). He sometimes presumed that such mistakes would balance across individuals, since omitted causes would tend to 'neutralize' each other (p. 16). In such cases, he argued, an aggregate observation of behaviour is appropriate. We will see in Chapter 5, however, that when it comes to intertemporal decisions, Jevons maintained that many consumers make persistent mistakes; here his inclinations about what constitutes 'desirable' behaviour are very pronounced.

5
JEVONS'S THEORY OF EXCHANGE

> The ordinary laws of supply and demand, when properly stated, are the practical manifestation of the theory.
>
> (*TPE,* p. 108)

INTRODUCTION

Jevons's *Theory of Political Economy* placed utility at the centre of economic analysis, presenting his own (alternative) theory of exchange, which ran in terms of a balance of 'feeling'.[1] While utility had figured into Classical value theory, it was, until 1862 and then more formally in 1871, inconceivable that exchange should be explained by utility considerations only, that the primary phenomenon to be explained by economics consisted of the very act of exchange by two parties (abstracting from who those parties are) or that the laws of utility could be represented formally.[2] By placing utility at the heart of economic analysis, Jevons opened up a series of new research problems for subsequent economists:

1 The investigation of the nature of utility and the utility function.
2 The formal representation of utility maximization.
3 The measurement of utility or social welfare.

The exchange equations, which attempted to explain (equilibrium) exchange in terms of a balance of 'feeling',[3] are the main subject of what follows. Jevons placed the Benthamite notion of 'happiness' squarely at the centre of his analysis of exchange; in place of the Classical notion (at least as he perceived it) of labour as the 'cause' of value, Jevons insisted on utility as the cause of value. While he did not reject a cost of production theory of (long run) value (see below, Chapter 6), he did his best to divert attention away from the long run, and towards the explanation of market transactions instead.[4]

For Jevons, the key economic phenomenon requiring explanation was the act of exchange. Given prices, exchange between any two or more economic actors ('trading bodies') occurred as long as a preponderance of utility gain resulted;

exchange ceased when the (given) ratio of exchange equalled the inverted ratio of the final degrees of utility. The treatment of exchange was predominantly concerned with the interaction among or between individuals—with general equilibrium market phenomena, the phenomena of what John Creedy has called a 'catallactic community' (1992, p. 174). Jevons proceeded with clarity in this treatment. He recognized the difficulties inherent in solving a simple two-equation system, when the equations are generally non-linear and may yield multiple solutions, or none at all. His discussions of cases of exchange more complex than the simple two-person analysis demonstrate a firm understanding of the mathematical reasoning involved.

While he insisted on the novelty of his analysis in *TPE,* Jevons maintained that it carried with it no new implications for economics, but was, instead, fully consistent with the 'ordinary laws of supply and demand' (*TPE,* p. 108). These implications are the subject of pp. 107–11. Jevons maintained that his theory implied that unregulated trade serves to maximize individual utility. At the same time, however, he held that individuals persistently discount future pleasures, behaviour which, in Jevons's mind, is non-maximizing. As a consequence, savings rates were 'too low' among, especially, the uneducated labouring classes. This implication, which parallels the arguments outlined in Chapters 2 and 3, confirms the existence of a tension in Jevons's analysis of decision-making involving consumption at a point in time compared to those decisions involving the allocation of consumption across time.

THE LAWS OF UTILITY

Insisting that since labour occurs 'with the sole object of consuming', Jevons turned to 'a full and accurate' investigation of the laws of utility (*TPE,* p. 39).[5] Utility, like value, is not intrinsic, but constitutes instead 'a *circumstance of things* arising out of their relation to man's requirements' (p. 43).[6] Consequently, one can never claim 'absolutely' that goods possess utility. And goods not presently being used (or possessing anticipated usefulness) possess none: 'The ore lying in the mine, the diamond escaping the eye of the searcher, the wheat lying unreaped, the fruit ungathered for want of customers, have no utility at all. The most wholesome and necessary kinds of food are useless unless there are hands to collect and mouths to eat them sooner or later' (pp. 43–44).[7] Thus, there is no allowance here for situations where a good presently not in use possesses utility that is outweighed by the disutility associated with rendering it usable (e.g. with picking a fruit crop). This also presumes that goods such as wheat fields and fruit trees are not enjoyed for any aesthetic characteristics they might possess in addition to the food they could provide were they harvested.

As is well known, Jevons carefully distinguished between *'total utility'* and the 'utility attaching to any particular portion' of a commodity.[8] Citing a 'physiological law', whereby the human response to a stimulus is such that 'the degree of each sensation which is produced, is by no means commensurate with the quantity of the commodity applied to the senses',[9] he worked through the idea of diminishing marginal utility for the case of water, and then bread. In the case of water, 'the most useful of all substances', 'a certain quantity' is indispensable, but beyond this the utility associated with additional increments sinks to zero and then 'may even become negative' if it becomes 'inconvenient' or 'hurtful' to deal with additional quantities:

> A quart of water per day has the high utility of saving a person from dying in a most distressing manner. Several gallons a day may possess much utility for such purposes as cooking and washing; but after an adequate supply is secured for these uses, any additional quantity is a matter of comparative indifference. All that we can say, then, is, that water, up to a certain quantity, is indispensable; that further quantities will have various degrees of utility; but that beyond a certain quantity the utility sinks gradually to zero; it may even become negative, that is to say, further supplies of the same substance may become inconvenient and hurtful.
>
> (*TPE,* p. 44)[10]

Thus, utility is 'not proportional to commodity' but instead varies 'according as we already possess more or less of the same article' (p. 44), increasing substantially initially, and then increasing relatively slowly and, possibly, decreasing. That reasoning generalizes 'to other things' (p. 44). Consequently, 'the total utility of the food we eat consists in maintaining life, and may be considered as infinitely great; but if we were to subtract a tenth part from what we eat daily, our loss would be but slight. We should certainly not lose a tenth part of the whole utility of food to us' (p. 45).

Continuing with the example of food, Jevons imagines 'the whole quantity of food which a person consumes on average during twenty-four hours to be divided into ten equal parts' (*TPE,* p. 45): 'If his food be reduced by the last part, he will suffer but little, if a second tenth part be deficient, he will feel the want distinctly; the subtraction of the third tenth part will be decidedly injurious; with every subsequent subtraction of a tenth part his sufferings will be more and more serious, until at length he will be upon the verge of starvation' (pp. 45–46). Calling each of the tenth parts 'an increment', Jevons speculated that 'each increment of food is less necessary, or possesses less utility, than the previous one' (p. 46). Then, letting *ox* represent the quantity of food, divided into ten equal parts, he constructs a rectangle to represent the utility associated with each increment of food.

The 'most important' feature of this diagram (Figure 5.1), Jevons asserts, is the 'comparative utility of the several portions' (*TPE,* p. 47): 'As we approach towards *o,* each increment bears a larger rectangle' (pp. 46–47). In fact, he deliberately left the two rectangles closest to the origin open, in order to show the indispensability of these portions of food: 'the utility of the next increment, II, is undefined, as also is that of I, since these portions of food would be

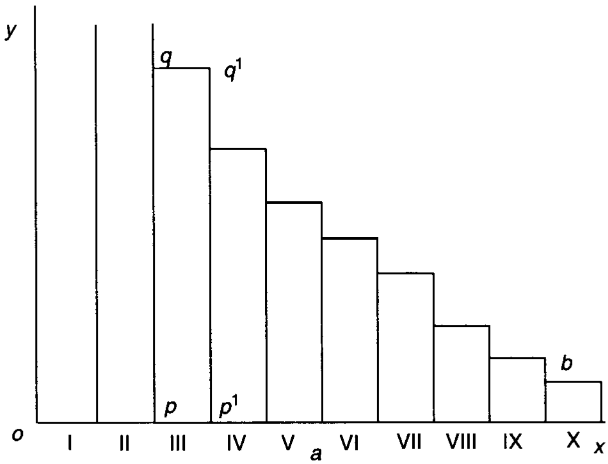

Figure 5.1 Utility of ten increments of food

indispensable to life, and their utility, therefore, infinitely great’ (p. 47). We can, he argued, conceptualize the ‘utility of the whole food’ simply by ‘add[ing] together the proper rectangles’ (p. 47). But since two rectangles are open-ended, total utility of the whole food is ‘infinitely great’ (p. 47).

Jevons now proceeds to argue that the increments of food might, theoretically, if not practically,[11] be made ‘infinitely small’, in which case the ‘law of the variation of the degree of utility of food may thus be represented by a continuous curve *pbq,* and the perpendicular height of each point of the curve above the line *ox,* represents the degree of utility of the commodity when a certain amount has been consumed’ (*TPE,* p. 48). To justify this assumption he argued that ‘when we consider the consumption of a nation as a whole, the consumption may well be conceived to increase or diminish by quantities which are, practically speaking, infinitely small compared with the whole consumption’ (p. 48). The fact, however, that individual consumption is very small relative to aggregate consumption has no bearing on whether it is realistic to presume that the individual utility function is continuous.

Jevons next argued that *‘total utility’* may be represented by an area, while ‘*the degree of utility* of the commodity at any point’ is represented by a line (*TPE,* p. 49). Total utility is a function of the (single) commodity consumed, *x:* ‘that is, it will vary in some continuous and regular, but probably unknown, manner, when *x* is made to vary’ (p. 50).[12] Since the utility of a commodity varies ‘with perfect continuity’, ‘we commit a small error in assuming it to be uniform over the whole increment x’ (p. 51). To obtain ‘a correct expression for *ab,* the degree of utility at the point *a*’, ‘we must imagine x to be reduced to an infinitely small size, *u* decreasing with it’ (p. 51). Then, the limit of the ratio *u*/ *x*, *du/dx,* is the degree of utility corresponding to the quantity of *x*. That degree of utility, as Jevons recognizes, is itself a function of x. The 'degree of utility of the last addition, or the next possible addition of a very small, or infinitely small, quantity to the existing stock', Jevons writes, shall be called 'the *final degree of utility*' (p. 51)[13]. Under 'ordinary circumstances', the final degree of utility 'will not be great compared with what it might be' (p. 51).[14] While the entire utility curve might well be unknown, it is the final degree of utility that is of interest to Jevons: 'To be able to estimate the total enjoyment of a person would be an interesting thing, but it would not be really so important as to be able to estimate the additions and subtractions to his enjoyment, which circumstances occasion' (p. 52). Here he engaged in some rhetorical bluff, suggesting that the problem of measuring total and marginal utility was analogous to the complexity of measuring total wealth and changes thereof: 'In the same way that a very wealthy person may be quite unable to form any accurate statement of his aggregate wealth; but he may nevertheless have exact accounts of income and expenditure, that is, of additions and subtractions' (p. 52).

It is the 'final degree of utility' function—as opposed to 'the total utility function'—'upon which the Theory of Economics will be found to turn' (*TPE,* p. 52).[15] In making this distinction, Jevons returned to the diamond-water paradox, providing the now familiar reason why water has a zero price: it is so abundant that 'its final degree of utility is reduced nearly to zero' (p. 52). Because 'No commodity can be named which we continue to desire with the same force, whatever be the quantity already in possession', Jevons now generalized the law of diminishing marginal utility, expressing the 'all-important point in economic problems' thus: 'We may state as a general law, that *the degree of utility varies with the quantity of commodity, and ultimately decreases as the quantity increases*' (p. 53).[16]

Thus, Jevons maintained that 'All our appetites are capable of *satisfaction* or *satiety* sooner or later', although this by no means implied that the final degree of utility would 'always sink to zero', as in the case of water. A hierarchy of goods was envisaged: while the final degree of utility might fall to zero eventually for necessities—'simple animal requirements' —such as 'food, water, air', Jevons held that 'more refined and intellectual' needs were less 'capable of satiety' (*TPE,* p. 53).[17]

Jevons allowed also that goods might be 'bads', or in other words, be associated with negative utility throughout the consumption range. Consumption of these goods produces pain, which Jevons also called 'inconvenience', 'disadvantage' and 'harm' (*TPE,* pp. 57–58). These goods, which constitute '*anything which we desire to get rid of,* like ashes or sewage' are referred to as *'discommodities'* (p. 58; cf. pp. 127–33).[18]

Having established the all-important law of diminishing marginal utility, Jevons ponders its usefulness in 'considering the mode in which we distribute a commodity when it is capable of several uses' (*TPE,* p. 59). The analysis pertained, for instance, to commodities such as barley, used to make beer, spirits, bread, or to feed cattle; to sugar, used to eat or to produce alcohol; to timber, used in construction or as fuel; or to iron and other metals that have several functions (p. 59). The logic behind Jevons's analysis here was brilliantly simple. Imagining, first, that 'an isolated family' or individual (one, presumably, who has no means to exchange goods in a market) possesses a fixed stock of barley, Jevons queried, how will he decide how much of the stock to allot to each of several uses? Since 'it is the inevitable tendency of human nature to choose that course which appears to offer the greatest advantage at the moment', the equilibrium distribution can be characterized: 'when the person remains satisfied with the distribution he has made, it follows that no alteration would yield him more pleasure', reasoning which implies that an increment of commodity would yield exactly as much additional utility in one use as in another (p. 59). If the stock of barley is s and x_1 and y_1 are allotted to each of two uses (with the restriction that $x_1+y_1=s$), it should be the case that, in equilibrium, the final degrees of utility in each use (x and y) equalize, or that $du_1/dx=du_2/dy$. The 'general result' of this reasoning, Jevons asserts, is 'that commodity, if consumed by a perfectly wise being, must be consumed with a maximum product of utility' (p. 60).[19] The phrase 'if consumed by a perfectly wise being' emphasizes that Jevons presumed theoretical perfection while recognizing that, in practice, individuals may make mistakes or lack full information (see pp. 85–87; 98–99).

Jevons quickly recognized, however, that many goods are consumed for only one use. That circumstance is 'theoretically represented by saying, that the final degree of utility in this employment always exceeds that in any other employment', in which case the equations 'fail' (i.e. $du_1/dx>du_2/dy$ when s is allotted entirely to use x): 'Even when x is equal to 99/100 of the stock, its degree of utility might still exceed the utility attaching to the remaining 1/100 part in either of the other uses. This would mean that it was preferable to give the whole commodity to the first use' (*TPE,* p. 60). Such a circumstance 'might' in fact not be 'the exception but the rule' (p. 60).

Alterations in the distribution of uses occur in response to supply alterations. Here Jevons described a situation where agricultural shortages occurred that raise the utility of barley in food use, in which case barley might be taken out of alcohol use and distributed entirely to food (*TPE,* p. 61). From the passage, it is not clear whether he had in mind only a reduction in s, the stock of barley, or what seems more likely (in the light of his phrase 'In a time of scarcity', p. 61), a reduction in all types of agricultural products, including barley.[20]

Consumption, Jevons argued, as well as supply, is properly considered as a flow. In this context he insisted again that the notion of absolute consumption is meaningless: 'Consumption of commodity must have the same dimensions [as the rate of supply, MT^{-1}]. For goods must be consumed in time… To say that a town consumes fifty million gallons of water is unmeaning *per se*. Before we can form any judgment about the statement, we must know whether it is considered in a day, or a week, or a month' (*TPE,* pp. 64–65). Indeed, since 'time enters into all economic questions', since 'we live in time, and think and act in time; we are in fact altogether the creatures of time' it is, consequently, the 'rate of supply, rate of production, rate of consumption, per unit of time' that economists must treat (p. 65).

Utility, however, is (indirectly) independent of the element of time, 'a long perplexing' fact for Jevons (*TPE,* pp. 66–67). This is because the degree of utility, 'intensity', must be represented by *'so much commodity producing a certain amount of pleasurable effect per unit of time'*—MUT^{-1} (p. 66). But total utility is, then, intensity times duration, or $MUTT^{-1}$; thus 'time eliminates itself' (p. 67) and he arrives at the expression for *quantity of utility* being MU (p. 66). Jevons provided no reason to suppose that marginal and total utility should be measured in different units with respect to time.[21]

Jevons distinguished, finally, between actual, prospective, and potential utility (*TPE,* pp. 69–70). The treatment of potential utility was very much in line with his discussion of wheat fields (p. 91). 'Potential utility'—such as might be associated with iron ore that will never be extracted from 'the bowels of the earth'—'does not really enter into the science of Economics' since there is no probability that the object will be needed.[22] However, since prospective utility entails goods that exist today and may be consumed over time (the 'large part of commodities'),[23] the issue arises of how the consumption of a good is to be distributed over time.

In this situation, 'If we reckon all future pleasures and pains as if they were present', Jevons argued, the utility maximizing solution was formally identical to the case of a good distributed across different uses (*TPE,* p. 71). If a good were used over n days, and v_i is the marginal utility associated with each day's use, the distribution made by a 'being of perfect good sense and foresight' (p. 72)[24] will be such that $v_1=v_2=v_3=\cdots=v_n$ (p. 71). If the commodity is perishable, and the 'being of perfect good sense and foresight' can estimate 'more or less exactly the probability of its remaining good' for the various uses, 'p_1, p_2, p_3,$\cdots$, p_{10}', then the equation is modified such: $v_1p_1=v_2p_2=\cdots=v_{10}p_{10}$ (p. 72), with the result that 'as the probability is less, the commodity assigned to each day is less, so that v, its final degree of utility, will be greater' (p. 72).[25] This is the distribution, Jevons asserted, 'which should be made, and would be made by a being of perfect good sense and foresight. To secure a maximum of benefit in life, all future events, all future pleasures or pains, should act upon us with the same force as if they were present, allowance being made for their uncertainty. The factor expressing the effect of remoteness should, in short, always be unity, so that time should have no influence' (p. 72).

Jevons insisted, however, that consumers are not in practice constituted in this 'perfect way', since future pleasures are discounted relative to present ones (*TPE,* p. 72). Thus he conceded that a factor, q_i, might be used to take this discounting into account, and the new resulting equation, showing how consumers actually distribute goods through time, would be $v_1p_1q_1=v_2p_2q_2=v_3p_3q_3=\cdots=v_np_nq_n$ (p. 73). In this context, Jevons revealed his disapproval of a characteristic of human nature, even going so far as to suggest that it was non-maximizing behaviour to discount future pleasures relative to present ones: 'But no human mind is constituted in this perfect way: a future feeling is always less influential than a present one' (p. 72). This purported character flaw implied that, without intervention, individuals do not save enough for the future, a problem which Jevons returned to time and again in his analyses of poverty and overpopulation (see Chapter 2 and Part III).[26]

THE THEORY OF EXCHANGE

Laws of utility do not in themselves constitute a theory of exchange; since 'Utility arises from commodities being brought in suitable quantities and at the proper times into the possession of persons needing them'—a phenomenon effected by exchange 'more than any other means'—(*TPE,* p. 75), Jevons turned his attention next to exchange. There follow scathing attacks on Classical treatments of value.[27] Confusion had arisen, Jevons argued, because three popular conceptions of value co-existed, and no attempt had been made to clarify the different meanings attached to these three conceptions:

> 1) Value in use;
> 2) Esteem or urgency of desire;
> 3) Ratio of exchange.
>
> (*TPE,* p. 78)

'Esteem', Jevons maintained, is closely connected with the ratio of exchange, which might also be referred to as 'purchasing power' (*TPE,* p. 80): 'Nothing can have a high purchasing power unless it be highly esteemed in itself; but it may be highly esteemed apart from all comparison with other things;[28] and, though highly esteemed, it may have a low purchasing power, because those things against which it is measured are still more esteemed' (pp. 80–81). Jevons concluded that the three meanings must be distinguished, as:

> 1) Value in use=total utility;
> 2) Esteem=final degree of utility;
> 3) Purchasing Power=ratio of exchange.
>
> (*TPE,* p. 81)

To avoid confusion concerning value he proposed to use 'the wholly unequivocal expression', 'ratio of exchange' to express the idea.

Second in importance to obtaining a proper notion of value for a correct theory of exchange, Jevons maintained, is a properly defined conception of a 'market'. As a consequence of his recognition that transactions involved a set of circumstances much more complex than his theoretical analysis of utility maximization allowed, the distinction between 'theoretically perfect' markets, and the real world—markets 'in practice'—was of paramount importance.[29] Jevons's discussion in the *TPE* focused on three market imperfections that 'more or less' characterize transactions in practice: lack of information; lack of competition; and the existence of capricious motives.[30]

In the theoretically perfect market, information is complete and accurate. In practice, however, information only 'more or less' mirrors this presumption. The key feature of a market in theory was not, Jevons maintained, its location, but instead consisted of the common and complete knowledge held by participants in its exchanges:

> The central point of a market is the public exchange,—mart or auction rooms, where the traders agree to meet and transact business. In London, the Stock market, the Corn Market, the Coal Market, the Sugar Market, and many others, are distinctly localised; in Manchester, the Cotton Market, the Cotton Waste Market, and others. But this distinction of locality is not necessary. The traders may be spread over a whole town, or region of country, and yet make a market, if they are, by means of fairs, meetings, published price lists, the post office, or otherwise, in close communication with each other. Thus, the common expression *Money Market* denotes no locality: it is applied to the aggregate of those bankers, capitalists, and other traders who lend or borrow money, and who constantly exchange information concerning the course of business.
>
> (*TPE,* pp. 84–85)

Jevons then defines the 'market' as 'two or more persons dealing in two or more commodities, whose stocks of those commodities and intentions of exchanging are known to all. It is also essential that the ratio of exchange between any two persons should be known to all the others' (pp. 85–86). The market extends only as 'far as this community of knowledge':

> Any persons who are not acquainted at the moment with the prevailing ratio of exchange, or whose stocks are not available for want of communication, must not be considered part of the market. Secret or unknown stocks of a commodity must also be considered beyond reach of a market so long as they remain secret and unknown.
>
> (*TPE,* p. 86)

'In practice' the theoretical conception of perfect information is only 'more or less completely carried out' (*TPE,* p. 86). Since 'It is of the very essence of trade to have wide and constant information' (p. 87), any exception to this community of knowledge, Jevons argued, meant that trades would occur that violate his equilibrium conditions for exchange, producing 'unnatural' relative prices.

Conspiracies designed to conceal information were singled out as one cause of overthrowing the 'ordinary conditions of the market':

> There must be no conspiracies for absorbing and holding supplies to produce unnatural ratios of exchange. Were a conspiracy of farmers to withhold all corn from market, the consumers might be driven, by starvation, to pay prices bearing no proper relation to the existing supplies, and the ordinary conditions of the market would be thus overthrown.
>
> (*TPE,* p. 86)[31]

Not surprisingly, some markets were said to be characterized by better information flows than others. As an example of a market where information was relatively abundant, Jevons described the situation where brokers 'in any extensive market', are charged with the task of organizing exchange and disseminating information:

> It is only thus that a definite market price can be ascertained at every moment, and varied according to the frequent news capable of affecting buyers and sellers. By the mediation of a body of brokers a complete *consensus* is established, and the stock of every seller or the demand of every buyer brought into the market.
>
> (*TPE,* p. 87)

Jevons proceeds to develop an 'expression for any number of people' who have an 'aggregate influence in a market, either in the way of supply or demand'—a 'trading body' (*TPE,* p. 88).[32] In its theoretical perfection, the key feature of a trading body was not its size, but rather the shared information among the participants in the trades. Because, as he judged it, 'the principles of exchange are the same in nature, however wide or narrow may be the market considered', Jevons urged that 'wide meaning' be attached to his expression, trading bodies (p. 89).[33] The specific constituents of a trading body in any particular setting are defined by the nature of the transaction under consideration:

> England and North America will be trading bodies if we are considering the corn we receive from America in exchange for iron and other goods. The continent of Europe is a trading body as purchasing coal from England. The farmers of England are a trading body when they sell corn to the millers, and the millers both when they buy corn from the farmers and sell flour to the bakers.
>
> (*TPE,* pp. 88–89)

As long as ratios of exchange are public information, and when a good is 'perfectly uniform or homogeneous in quality', Jevons reasoned, 'any portion may be indifferently used in place of an equal portion' (*TPE,* pp. 90–91).

Consequently, one and only one exchange ratio must prevail 'in the same market, and at the same moment' (p. 91).[34] (Quality differences, however, will give rise to 'preference' and thus to variations in exchange ratios.) Thus follows a 'general law', 'of the utmost importance in Economics': 'that *in the same open market, at any one moment, there cannot be two prices for the same kind of article*' (p. 91).[35] In order to emphasize that one price occurs because traders will be indifferent to any two portions of the same commodity (p. 92), Jevons called this the 'Law of Indifference'. It is to these acts of 'indifferent choice', and only to these acts, that his exchange equations are said to pertain: 'Every such act of indifferent choice gives rise to an equation of degrees of utility, so that in this principle of indifference we have one of the central pivots of the theory' (p. 92).

The Law of Indifference enables Jevons to treat only the equilibrium condition for price taking exchange (see pp. 81–83). He recognized, however, that 'The real condition of industry is one of perpetual motion and change. Commodities are being continually manufactured and exchanged and consumed' (*TPE,* p. 93). Consequently, exchange ratios, properly conceived, are 'in a state of continual change': 'Though the price of the same commodity must be uniform at any one moment, it may vary from moment to moment, and must be conceived as in a state of continual change' (p. 92). The fact that at any point in time trades are taking place, implies that

> the effect of exchange upon the ratio of exchange must be conceived to exist in some degree, however small may be the purchases made. Strictly speaking, the ratio of exchange at any moment is that of dy to dx, of an infinitely small quantity of one commodity to the infinitely small quantity which is given for it. The ratio of exchange is really a differential coefficient. The quantity of any article purchased is a function of the price at which it is purchased, and the ratio of exchange expresses the rate at which the quantity of the article increases compared with what is given for it.
>
> (*TPE,* p. 93)

Two metaphors are presented which suggest that observed prices fluctuate around equilibrium values. First (as noted on p. 82) Jevons compared the equilibrium price to the resting point of a pendulum (*TPE,* p. 94). A consumer's spending pattern is further likened to the flow of water 'into hollows':

> The theory [of exchange] thus represents the fact, that a person distributes his income in such a way as to equalize the utility of the final increments of all commodities consumed. As water runs into hollows until it fills them up to the same level, so wealth runs into all branches of expenditure.
>
> (*TPE,* pp. 139–40)

These metaphors, however, bring to mind very different implications for prices. The pendulum conception suggests that each price is independent from others. The water metaphor, on the other hand, implies dependence, since when one branch of water is closed, the water *level* alters.[36] Jevons did not discuss this distinction but, as we will see in Chapter 10, he sometimes assumed independent prices, and he was criticized for that assumption by J.M.Keynes, among others.

But since Jevons is content to treat what he calls the 'purely statical problem' of exchange (*TPE,* p. 93)—and since he is convinced that this serves as a good approximation for many trades (see pp. 108–9)—he regards traders as price takers and sets out to characterize their equilibrium, 'not as continuously passing on these commodities in streams of trade, but as possessing certain fixed amounts which they exchange until they come to equilibrium' (pp. 93–94). The difference is all-important: 'dynamically we could not treat the ratio of exchange otherwise than as the ratio of *dy* and *dx,* infinitesimal quantities of commodity. Our equations would then be regarded as differential equations, which would have to be integrated. But in the statical view of the question we can substitute the ratio of the finite quantities *y* and *x*' (p. 94; see Creedy 1992, p. 121). Then, based on the Law of Indifference, 'even an infinitely small part of *x* must be exchanged for an infinitely small part of *y,* in the same ratio as the whole quantities' (p. 95). Thus, *'the last increments in an act of exchange must be exchanged in the same ratio as the whole quantities exchanged'* (p. 94), and Jevons was able to substitute *y/x* for the ratio *dy/dx* (p. 95).[37]

Having established this key result flowing from the Law of Indifference, Jevons turned to the demonstration of the 'keystone' of his theory of exchange, the proposition that *'The ratio of exchange of any two commodities will be the reciprocal of the ratio of the final degrees of utility of the quantities of commodity available for consumption after the exchange is completed'* (*TPE,* p. 95). In order to proceed, he considered the case of two trading bodies, each possessing stocks of one good, corn or beef respectively. Given the initial distribution, 'it is certain' that trade will 'considerably' increase utility. (Jevons relaxed that assumption later; see below, p. 106.) The question he then posed, is when will trade cease 'to be beneficial', at which point additional trades will not occur. The answer to this question is said to depend on both the ratio of exchange (relative prices) as well as tastes, the degrees of utility.

Jevons next supposes a rate of exchange in place, and then considers whether trades will occur, given the trading parties' tastes. At an exchange ratio equal to ten pounds of corn for one pound of beef, for instance, if ten pounds of corn are less useful than a pound of beef to the trader possessing corn, and more useful to the trader possessing beef, exchange will occur. Exchange continues 'until each party has obtained all the benefit that is possible, and loss of utility would result if more were exchanged' (*TPE,* p. 96). Characterizing the equilibrium, Jevons argues that 'an indefinitely small amount of commodity exchanged in addition, at the same rate, will bring neither gain nor loss of utility' (p. 96); 'if increments of commodities be exchanged at the established ratio, their utilities will be equal

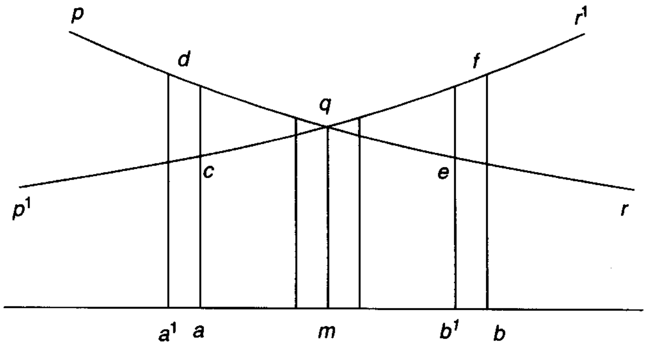

Figure 5.2 Equilibrium in exchange

for both parties. Thus, if ten pounds of corn were of exactly the same utility as one pound of beef, there would be neither harm nor good in further exchange at this ratio' (p. 96).

To show the equilibrium diagrammatically (Figure 5.2), Jevons considers a single transactor, superimposes two utility curves, and supposes that the ratio of exchange is one to one so that *a a* indicates an increase in the first commodity, and a decrease in the second commodity.[38] From this trade the consumer gains (net) utility equal to *cd,* and thus the consumer will make the exchange, reallocating *a a* of good two into *a a* of good one (*TPE,* p. 97). Applying this reasoning further, a trade beyond the point *b* would 'have gone too far' since the movement from *b* to *b* results in a net loss of utility *ef* (p. 97). The trader will thus be willing to make trades as long as the net utility gained from trades is non-negative, that is, up to the point *q,* where utility is maximized: 'where, for an infinitely small quantity, there is neither gain nor loss' (p. 98).

Symbolically, Jevons uses x to represent a small increment of corn, and y to represent a small increment of beef exchanged for it. Relying on the Law of One Price, he maintained that there can be one and only one exchange rate of *x* for *y,* and thus, as noted above, he argues that the increments must be in the same ratio as *y* is to *x:*

$$\frac{\Delta y}{\Delta x}=\frac{y}{x}$$

Since the increment of beef, *y,* is (*y*/*x*) times as great as the increment of corn, *x*, 'in a state of equilibrium', Jevons argues, 'the utilities of these increments must be equal in the case of each party, in order that neither more nor less exchange would be desirable' (*TPE,* p. 98); 'in order that their utilities shall be equal the degree of utility of beef must be *x*/*y* times as great as the degree of utility of corn' (pp. 98–99). This yields Jevons's central result, alluded to above (p. 95), in the context of a consumer who 'trades' by substituting goods in various uses: *'the degrees of utility of commodities exchanged will be in the inverse proportion of the magnitudes of the increments exchanged'* (p. 99).

The symbolic treatment continues with the presumption that consumer A, endowed with *a* units of corn, trades *x* units of corn for *y* units of beef; while consumer B is endowed with *b* units of beef and trades *y* units of beef for *x* units of corn. Using Jevons's notation, after trade A holds *(a—x)* units of corn, and *y* units of beef; while B holds *x* units of corn, and *(b—y)* units of beef (*TPE,* p. 99).[39] For A to be satisfied with these trades it must be the case that:

$$\Phi_1(a-x).dx = \Psi_1(y).dy$$

where ${}_1(a-x)$ represents the final degree of utility associated with the remaining corn, and ${}_1(y)$ represents the final degree of utility associated with beef.

Substituting *y/x* for *dy/dx,* Jevons maintains that

$$\frac{\Phi_1(a-x)}{\Psi_1(y)} = \frac{y}{x}$$

But this principle also holds for consumer B, so that:

$$\frac{\Phi_2(x)}{\Psi_2(b-y)} = \frac{y}{x}$$

Since the ratio of final degrees of utility for each consumer equals the common exchange ratio, *y/x,* the two equations can be rewritten (p. 100):

$$\frac{\Phi_1(a-x)}{\Psi_1(y)} = \frac{y}{x} = \frac{\Phi_2(x)}{\Psi_2(b-y)}$$

And since *y/x* is simply the exchange ratio, (p_x/p_y), Jevons arrived at the equimarginal condition ingrained to those who are familiar with contemporary microeconomic theory.[40]

Having characterized equilibrium price taking trade in the simple case, Jevons set out to consider several complications for his theory. The first entailed transportation costs (the charges of dock, harbour, broker, agent, or other dues) that altered the *de facto* exchange ratio (*TPE,* pp. 106–107). If A gives *x* in exchange, Jevons reasoned that B now receives only *mx,* where *m* is some fraction. Similarly, A now receives only a fraction of the other good, *ny*. The two exchange equations become:

$$\frac{y}{mx} = \frac{\Phi_2(mx)}{\Psi_2(b-y)}$$

and

$$\frac{\Phi_1(a-x)}{\Psi_1(ny)} = \frac{ny}{x}$$

which yield

$$\frac{m\Phi_2(mx)}{\Psi_2(b-y)} = \frac{y}{x} = \frac{\Phi_1(a-x)}{n\Psi_1(ny)}$$

A second complication arises when one trader is extraordinarily small relative to another trader. Here, Jevons proceeds by supposing A to possess 'very large stocks of commodities, *a* and *b*', while trader C possesses a small amount of the second good. In this instance, since $(a—x)$ and $(b+y)$ do not much differ from *a* and *b* respectively, constant marginal utility is presumed as an approximation. Then, for trader A:

$$\frac{\Phi_1(a)}{\Psi_1(b)} = \frac{y}{x} = m$$

and trader C trades until the ratio of marginal utilities equals this (fixed) ratio (*TPE,* pp. 112–13). Thus:

$$\frac{\Phi_1(a)}{\Psi_1(b)} = \frac{\Phi_2(x)}{\Psi_2(c - mx)}$$

Such an equation, Jevons argued, pertains at least approximately to 'the conditions in regard to any one distinct commodity of a very small country trading with a much larger one', or to 'an individual consumer with regard to the aggregate trade of a large community, since he must buy at the current prices, which he cannot in any appreciable degree affect' (p. 113).[41]

In still many other instances, Jevons argued, *y* is a very small part of *c* (since 'we want so little of a commodity, that an individual need not give more than a very small fraction of his possessions to obtain it') (*TPE,* p. 113). Then (again approximately) the marginal utility associated with $(c-y)$ differs little from the marginal utility associated with (c), so that, if *m* is the exchange ratio,

$$\Phi_2(x) = m\Psi_2(c)$$

or

$$\frac{\Phi_2(x)}{\Psi_2(c)} = m$$

Thus, C will buy the commodity 'until its degree of utility falls below that of the commodity he gives' (p. 114). An example of this situation might, Jevons argued, be salt, where what a person spends 'does not make him appreciably poorer' (p. 114). Then, if the 'established price or ratio' is one penny/pound, a person will buy salt until the final degree of utility equals a penny, or until 'an additional pound would not have so much utility to him as a penny' (p. 114).[42]

A third complication arises in the consideration of more than two goods, which, however, does not alter the principles underlying the simple case (*TPE,* pp. 114–15). Here A gives x_1 for y_1 and x_2 for z_1; B gives y_1 for x_1 and y_2 for z_2; *C* gives z_1 for x_2 and z_2 for y_2 (p. 115). As long as these are what Jevons calls 'independent exchanges' (p. 115),[43] the exchange equations characterizing equilibrium now become:

$$\frac{\Phi_1(a - x_1 - x_2)}{\Psi_1(y_1)} = \frac{y_1}{x_1} = \frac{\Phi_2(x_1)}{\Psi_2(b - y_1 - y_2)}$$

$$\frac{\Phi_1(a-x_1-x_2)}{\chi_1(z_1)}=\frac{z_1}{x_2}=\frac{\Phi_3(x_2)}{\chi_3(c-z_1-z_2)}$$

$$\frac{\Psi_2(b-y_1-y_2)}{\chi_2(z_2)}=\frac{z_2}{y_2}=\frac{\Psi_3(y_2)}{\chi_3(c-z_1-z_2)}$$

The final complication considered by Jevons arises when two trading bodies, B and C, compete to sell goods to another, A.Here, suppose that A gives x_1 of a good to B and x_2 of the good to C. B gives y_1 of the second good to A, and C gives y_2 to A *(TPE,* p. 117). By the Law of Indifference, Jevons argues, $y_1/x_1=y_2/x_2$, and the typical marginal conditions hold:[44]

$$\frac{\Phi_1(a-x_1-x_2)}{\Psi_1(y_1+y_2)}=\frac{y_1}{x_1}$$

$$\frac{\Phi_2(x_1)}{\Psi_2(b-y_1)}=\frac{y_1}{x_1}$$

$$\frac{\Phi_3(x_2)}{\Psi_3(c-y_3)}=\frac{y_2}{x_2}$$

Having dealt with these extensions of the simple case, Jevons turned to the investigation of corner solutions, the 'Failure of the Equations of Exchange', situations when, for instance, 'no benefit can arise from exchange', in which case no exchanges occur (*TPE,* p. 119), or when 'the whole quantities of commodity possessed are exchanged, and yet the equations fail' (p. 119). Here, his remarkable grasp of the difficulties involved in solving even a simple two-equation system becomes apparent. In the first instance, 'though B were to receive very little of A's commodity, yet the final degree of utility to him would be less than that of his own commodity, of which he enjoys much more' (p. 119). In the latter, each consumer has a relatively low desire for consuming his own good, and even after each consumer trades away all of his stock of the good, the final degree of utility for an additional increment of the other good would lead to further trades at the exchange ratio, if more of the other goods could be had *(* $U_B/\ y>y/x$, and $U_A/\ x<y/x$*).*

Indivisibilities create further difficulties for the exchange equations. While the assumption of perfect divisibility is 'approximately true' for many trades—especially in the case of international trade between 'great industrial nations' (*TPE,* p. 120)—Jevons recognized that many goods are less than perfectly divisible: 'In every sale of a house, factory, or other building, it is usually impracticable to make any division without greatly lessening the utility of the whole' (p. 121). Under these circumstances the equations of exchange fail, and 'we deal not with the final degree of utility depending on an infinitesimal quantity, but on the whole utility of the complete article' (p. 121). Considering the exchange of two books, for example, where u_1=the utility of A's book to A; u_2=the utility of A's book to B; v_1=the utility of B's book to A; and v_2=the utility of B's book to B, the conditions for exchange to occur become simply: $v_1>u_1$ and $u_2>v_2$.[45]

A more complex problem arises when a divisible good is exchanged for an indivisible good—such as occurred when Russia sold Alaska. In this case the problem is, Jevons argued, indeterminate. Supposing X to be indivisible, with u_1 its (total) utility to A and u_2 its (total) utility to B; while Y is divisible, with v_1 the (total) utility of Y to A and v_2 its (total) utility to B, Jevons posits that v_1 must be greater than u_1, and u_2 must be greater than v_2 in order for exchange to occur (*TPE,* p. 123). But how much Y is given for X is, within these limits, unknown. A similar bargaining problem arises, Jevons argues, with the sale of a house when the reservation buying and selling prices diverge: in which case any price between the reservation selling and buying prices 'will leave a profit on each side, and both parties will lose if they do not come to terms' (p. 124). Bargains of this sort will be struck, Jevons maintains, on 'other than strictly economic grounds', depending on 'motives more or less extraneous to a theory of Economics'—comparative knowledge, 'disposition', 'force of character', 'persistence', 'adroitness', 'experience', 'feelings of justice or kindliness' (pp. 124, 125).

IMPLICATIONS AND `PRACTICAL MANIFESTATIONS' OF THE THEORY

The first implication of the theory to which Jevons turned, concerned the 'accurate' conception of the marginal utility of income (*TPE,* p. 140). Since a penny constitutes 'an inconsiderable portion' of a family's annual fifty pound earnings, Jevons argued, 'it may represent one of the infinitely small increments, and its utility is equal to the utility of the quantity of bread, tea, sugar, or other articles which they could purchase with it' (p. 140). The same increment—a penny—yields far less utility to a family whose earnings are £1000/year 'because their want of any given commodity will be satiated or satisfied to a much greater extent' (p. 141).[46] As a consequence, a 'general result' of exchange theory is that while individuals each maximize utility and equate utility gained on the margin to common price ratios, utility differences persist: 'to produce a certain equality of utility between different commodities, as regards the same individual; but between different individuals no such equality will tend to be produced' (P. 141).

But despite income inequality, Jevons's second implication is that exchange maximizes utility: 'so far as is consistent with the inequality of wealth in every community, all commodities are distributed by exchange so as to produce the maximum of benefit. Every person whose wish for a certain thing exceeds his wish for other things, acquires what he wants provided he can make a sufficient sacrifice in other respects' (*TPE,* p. 141).[47] The benefits from trade were not, Jevons insisted further, equivalent to prices, which are proportional instead to marginal utilities: 'the ratio of exchange gives no indication of the real benefit derived from the action of exchange' (*TPE,* p. 142). Here Jevons maintained that J.S.Mill had mistakenly confused the total utility of a good with its price (p. 143).[48]

Some of Jevons's strongest welfare statements concerning the efficacy of unregulated markets emerge from these results: 'No one is ever required to give what he more desires for what he less desires, so that perfect freedom of exchange must be to the advantage of all' (*TPE,* pp. 141–42); 'perfect freedom of exchange, therefore, tends to the maximizing of utility' (p. 145). But we must interpret these remarks with care. For, as we have seen on a number of occasions, Jevons did let his own evaluations of what is 'desirable' shine through (pp. 87–88). Thus, for instance, since individuals did not weigh the future equally with the present—while they 'should' do so—there is scope for intervention to encourage saving (pp. 96–97). We will see many more examples of intervention specifically designed to alter ('improve') behaviour in Chapters 7 and 8.

While Jevons recognized the great difficulties associated with estimating the total utility of a commodity, he nevertheless urged that we attempt 'to measure the benefit from any trade' (*TPE,* p. 145). Specifically, he argued that interferences with trade, such as tariffs, reduced the gains from trade, a reduction which might eventually be measured (p. 146). In fact, he urged that work in this direction proceed apace, and this constitutes an important implication of the *TPE*. As noted (pp. 83–84), Jevons called for specialization according to subject matter and method within economics. He also lent his weight in *TPE* to a specific direction for this specialization—empirical economics—proclaiming its ultimate usefulness: 'We cannot really tell the effect of any change in trade or manufacture until we can with some approach to truth express the laws of the variation of utility numerically' (p. 146).

To proceed along these lines, Jevons urged that reliable data be collected: 'we need accurate statistics of the quantities of commodities purchased by the whole population at various prices' (*TPE,* p. 146).[49] Thus, he reasoned, 'if we could tell exactly how much people reduce their consumption of each important article when the price rises, we could determine, at least approximately, the variation of the final degree of utility—the all-important element in Economics' (pp. 146–47).[50] The result, 'doubtless' a 'purely empirical' function—a 'mere aggregate of terms devised so that their sum shall vary in accordance with statistical facts'—will serve to render Economics 'as exact as many of the physical sciences' (P. 147).

Jevons recognized the enormous complexity of this task: 'When in the long course of scientific progress a sufficient supply of suitable statistics has been at length obtained, it will become a mathematical problem of no great difficulty how to disentangle the functions expressing the degrees of utility of various commodities' (*TPE,* p. 148).[51] Nonetheless he was convinced that the 'future progress of Economics as a strict science' (p. 146), depended on efforts in this direction, and he was critical of the lack of attention given to this specialization within economics.[52] In this recommendation, Jevons broke irreparably with tradition, for, as will be made clear in Chapters 9 and 10, Classical economists resisted specialization and repudiated empirical economics as a legitimate specialization within political economy.

For Jevons, since the mind of any one individual must always be ‘inscrutable’ to all others, so that individual offers would remain unknown, a priori, in fact the only ‘practical manifestation’ of the theory of exchange constituted (aggregate) laws of supply and demand; the Theory of Exchange was of an ‘abstract’ character, but its ‘practical illustration’ consisted of ‘the ordinary laws of supply and demand’ (*TPE,* p. 108). While the theory of exchange presumed to investigate the motives and speculate about the actions of individuals, the ‘operation of general laws of this kind’ are, practically speaking, observable only in the actions of ‘a large population’:

> With every increase in the price of such a commodity as sugar, we ought, theoretically speaking, to find every person reducing his consumption by a small amount, and according to some regular law. In reality, many persons would make no change at all; a few, probably would go to the extent of dispensing with the use of sugar altogether so long as its cost continued to be excessive. It would be by examining the average consumption of sugar in a large population that we might detect a continuous variation, connected with the variation of price by a constant law.
>
> (*TPE,* p. 15)

The empirical procedure Jevons called for thus presumed that ‘accidental and disturbing causes will operate, in the long run, as often in one direction as the other’ (p. 16; see also, p. 89, and Chapters 9 and 10). Jevons himself attempted to estimate a ‘statistical’ curve (see *TPE* pp. 152–60 and pp. 204–5) using the King-Davenant corn price-quantity data.

But while Jevons departed from his predecessors in his recommendations for the development of empirical economics, he insisted repeatedly that the *TPE* carried with it no new theoretical implications concerning the ‘variation of price’: ‘There is no difficulty in finding in works of Economists remarks upon the relation between a change in the supply of a commodity and the consequent rise of price. The general principles of the variation of utility have been familiar to many writers’ (*TPE,* pp. 148–49). In particular, as noted in Chapter 3, he cited Smith’s reasoning concerning the limited size of the stomach to explain ‘the general rule’ that ‘the variation of price is much more marked in the case of necessaries of life than in the case of luxuries’ (p. 149).[53] The full price variation as a consequence of a supply failure, he remarked in the context of discussing West Indian rum, depends on the availability of substitutes—which in the case of West Indian rum are few and far between—as well as whether the good in question is a necessity or a luxury, and whether it ‘forms a considerable element in expenditure’ (p. 150). The ‘complex case’ is recognized, where a rise in the price of one good influences the consumption of other goods: ‘if sugar becomes scarce, to consume as before would necessitate a reduction of consumption in other directions; and as the degree of utility of more necessary articles rises much more rapidly than that of sugar, it is the latter article which is thrown out of use by preference' (p. 151).

Throughout the *TPE,* Jevons repeatedly emphasized that his theory of exchange is fully consistent with the 'ordinary laws of supply and demand'. Indeed, this implication (or lack thereof) was recognized as early as 1860 when Jevons 'struck out' his *'true theory of Economy'* (see pp. 78–81; and *P&C,* **ii,** pp. 409–12). Here he maintained that his law of diminishing utility 'has in fact always been assumed by Pol. Econ. under the more complex form and name of the Law of Supply & Demand' (P&C, **ii,** p. 410).[54] The 'Introduction' to *TPE* proclaimed that the 'ordinary laws of supply and demand' constituted the 'necessary consequence' of his theory of exchange: 'we have only to trace out carefully the natural laws of the variation of utility, as depending upon the quantity of commodity in our possession, in order to arrive at a satisfactory theory of exchange, of which the ordinary laws of supply and demand are a necessary consequence' (*TPE,* pp. 1–2).[55] The text of *TPE* reiterated this argument:

> our theory is perfectly consistent with the laws of supply and demand; and if we. had the functions of utility determined, it would be possible to throw them into a form clearly expressing the equivalence of supply and demand. We may regard *x* as the quantity demanded on one side and supplied on the other; similarly, *y* is the quantity supplied on the one side and demanded on the other. Now, when we hold the two equations to be simultaneously true, we assume that the *x* and *y* of one equation equal those of the other. The laws of supply and demand are thus a result of what seems to me the true theory of value or exchange.
>
> (*TPE,* p. 101)

Yet, while Jevons himself stressed that his equations did nothing to overthrow commonly understood principles of supply and demand, he took Mill to task for failing 'to reach the root of the matter', in that he failed to 'show how the amount of demand or supply is caused to vary' (*TPE,* p. 101).[56] Jevons's explanation of exchange, by contrast, showed that when the equality above did not hold, offers to trade would be forthcoming, until at last equality was established; thus, in Jevons's mind, unlike Mill, he had explained how the amount of demand or supply is 'caused to vary'.

Jevons was, perhaps overly, insistent on the distinction between his utility theory of exchange and a cost of production theory: 'The Theory of Exchange, as explained above, rests entirely on the consideration of quantities of utility, and no reference to labour or cost of production has been made' (*TPE,* pp. 137–38). Yet he also insisted that his theory would 'for the most part, harmonise with previous views upon the subject' (p. 161), and this is the final, and a controversial, implication of the *TPE,* consideration of which is deferred until our next chapter, 'Production'.

CONCLUSIONS

Although, as we have seen, Jevons maintained that his utility theory of exchange was fully consistent with the 'ordinary' laws of supply and demand, he made few attempts explicitly to link his theory with supply and demand analysis. For this reason, his treatment of utility and exchange has been repeatedly maligned. Second, and related to this, Jevons is said to have possessed but a thin grasp of the mathematics requisite to proceed with the analysis in *TPE*.[57] (The relationship arises when Jevons is said to have fared poorly in the attempt to link utility with demand theory because of his limited grasp of the mathematics involved.)

The investigation above, however, suggests that, rather than muddling along clumsily in the development of his exchange equations, Jevons proceeded with clarity. There can be little doubt that he recognized the difficulties inherent in solving even the simple two-equation system, when, as he argued (pp. 106–7), the equations are generally non-linear and may yield multiple solutions, or none at all. Jevons's subsections in the *TPE* designed to deal with cases of exchange more complex than the simple two-person analysis (discussed above, pp. 104–6), demonstrate a clear understanding of the mathematical reasoning involved.[58] It appears, then, that his choice of presentation was not constrained so much by what G.Stigler called his inability to 'translate any but simple thoughts into mathematics', as by a belief that his presentation, containing and requiring no formal constrained optimization methods (see *P&C,* **iv**, pp. 247–48), was, as he put it, 'clear and convincing to non-mathematicians'.

For Jevons, the key economic phenomenon requiring explanation, was the act of exchange. Given prices, exchange between any two or more economic actors ('trading bodies') occurred as long as a preponderance of utility gain resulted; exchange ceased when the (given) ratio of exchange equalled the inverted ratio of the final degrees of utility. His treatment of exchange was predominantly concerned with the interaction among or between individuals—with general equilibrium market phenomena, the phenomena of what Creedy has called a 'catallactic community' (1992, p. 174). This point requires some emphasis, because it is rarely acknowledged in the literature, and the failure to acknowledge it has led to some harsh interpretations of Jevons's procedure.

Once the general equilibrium nature of Jevons's treatment of exchange is appreciated, the question of why Jevons failed to derive 'standard' (partial equilibrium) demand curves becomes a moot point: they are not the appropriate theoretical tool in this context.[59] Instead, when traders are price takers, the offer curve is appropriate. And it is significant that Edgeworth, who, as Creedy has argued, 'took Jevons as the starting point', developed the offer curve based on indifference curve analysis when consumers are price takers and then extended the analysis to develop the contract curve in the event that consumers influence prices (1992, p. 174; see Edgeworth 1881, pp. 30f). Seen in this light, Jevons's analysis of exchange must be regarded as a pioneering analysis of the conditions of general equilibrium, an analysis which would not come to fruition until the work of Arrow and Debreu in the 1950s.

This interpretation has implications for a second claim concerning Jevonian economics. Mirowski maintains that the transition from Classical to Neoclassical economics redefined value from a substance in Classical economics, to a field in Neoclassical theory: 'prices constitute a conservative vector field—here **F**—such that, given a scalar field of utility, *U(x, y, z),* the price vector field may be deduced from it. Price vectors represent the direction of maximum virtual desire; each dimension of space corresponds to a specific commodity; and in equilibrium prices are proportional to marginal utilities' (1989, pp. 223–24).[60]

Yet while Jevons understood the message of energy conservation applied to economics, Mirowski argues, he failed fully to understand the mathematics of the metaphor,[61] and he made little headway with field formalism.[62] Just so: Jevons did make little headway, although the question arises whether he even seriously made the attempt. Since his utility function is conceptualized as *U(x),* there is—as Mirowski concedes—no need to rely on field formalization (1989, p. 258). It should now be clear (see pp. 82–83; 100–1) that Jevons was adamant about the rationale for his procedure and readily acknowledged that, if he did not restrict attention to the description of a price-taking equilibrium, instead of using ratios of infinitesimals, he would be forced to use 'differential equations, which would have to be integrated'.[63] The substitution of *y/x* for *dy/dx* in the price-taking equilibrium enabled Jevons to avoid this difficulty, and his discussion of the lever analogy was designed to stress that the movement of a lever out of equilibrium requires the treatment of differential equations, but that if attention is restricted to the characterization of the equilibrium position 'no such process as integration is applicable'.[64] There are additional problems with Mirowski's interpretation. For, as shown (pp. 76– 78), Jevons acknowledged the achievements of Gossen, Cournot, and Dupuit, and this despite the facts that:

- there is no evidence that Gossen was familiar with the new physics;
- Dupuit is respected for simply appreciating the law of diminishing marginal utility, which Jevons regarded as 'all important' in its own right;
- Cournot is recognized despite the fact that he relies on no utility theory at all.[65]

While Jevons's treatment of exchange was designed neither to overturn Classical claims concerning the efficacy of the marketplace in enabling individual actors to realize maximum utilities in a static decision-making setting, nor to destroy the current understanding of the 'laws' of supply and demand, it was, nonetheless, a departure from what had gone before him. His formal analysis of the laws of utility—notwithstanding the accompanying disclaimers in *TPE* regarding the measurement of utility—when coupled with his utilitarian welfare analysis in other works, led very neatly to the cardinal utility treatment that has caused so much controversy among economists, and whose place within the profession has yet to be fully resolved. We will turn to a detailed examination of these developments in Chapters 7 and 8.

In addition, Jevons insisted on centring economic analysis on acts of exchange and on the utility laws that underlay those acts. While economists before him certainly were cognisant of utility as a necessary condition for exchange, of the distinction between total and final degrees of utility, of the 'law' of diminishing marginal utility (see Bowley 1972), it was Jevons's *Theory of Political Economy* (and the 'Mathematical Theory' before that) that first placed utility and exchange at the very heart of economic analysis—thus downplaying, though by no means controverting, the importance, as Marshall complained, of production and the determinants of long period equilibria. More importantly perhaps, his emphasis opened up a new series of research topics for economists: into the nature, determinants and measurement of utility and Social Welfare.

APPENDIX 5.1 PHYSICS AND NEOCLASSICAL ECONOMICS

Mirowski's argument may be summarized briefly. If we consider the motion of a mass point through a field of force, then the work accomplished (the change in kinetic energy) is represented by

$$\int_B^A (F_x\,dx + F_y\,dy + F_z\,dz) = \frac{1}{2}mv^2\Big|_B^A = T_B - T_A$$

The concept of the force is primitive (i.e. the forces are simply the posited causes of changes in motion). The force is introduced through the postulation of force fields, which, in order for the work function to be path-independent, must be conservative. This implies that given a vector field **F** there is a scalar potential field U such that:

$$\oint \mathbf{F} \cdot ds = 0$$

or, $\{\mathbf{F} \bullet ds\}$ is an exact differential equation; and

$$\mathbf{F} = \nabla U = \left[\frac{\delta U}{\delta x}\ \frac{\delta U}{\delta y}\ \frac{\delta U}{\delta z}\right]$$

and curl **F**=0. In the economics of the early Neoclassicals, Mirowski maintains, prices constitute a conservative field vector, such that, given a scalar field of utility, the price vector may be deduced from it.[66]

6
PRODUCTION

INTRODUCTION

There can be no disputing that the treatments of exchange, production, and distribution in Jevons's *TPE* are asymmetrical, and commentators have not failed to note that he apparently neglected the production side of economic analysis.[1] But once we appreciate that, as Black has argued (1970, p. 18), and as Jevons stated in his 'Preface' to the first edition (see Chapter 4) his intent in the *TPE* was to apply Benthamite utilitarian philosophy to economics, that central focus renders the organization and content of the *TPE* less puzzling. One no longer anticipates symmetry between the 'exchange' and the 'production' chapters. Instead, Chapters 1 through 3 set out the theory of utility and exchange in great detail, and Chapter 4—'Theory of Labour'—presents what might be regarded as an extension of utility theory, a 'theory of cost of production in terms of disutility' (Black 1970, p. 19). The 'Theory of Rent' follows from this disutility of labour chapter, being an explanation of how rent emerges when labour and land are combined. Finally, Jevons's 'Theory of Capital' is presented as an addition to the Theory of Exchange important enough to be considered in its own right: since 'there is no close or necessary connexion between the employment of capital and the processes of exchange', Economics is not only the science of Exchange, but also of 'Capitalisation' (*TPE,* p. 222). But capital, like labour, is regarded by Jevons as a source of disutility, so that it, too, can be examined in terms of pleasure and pain.

In addition, once we appreciate that the analysis of cost proceeds in terms of negative utility, several puzzling remarks by Jevons concerning value are clarified. For, as is well known, Jevons was quick to juxtapose his theory of exchange to a labour theory of value: 'Economists have not been wanting who put forward labour as the *cause of value,* asserting that all objects derive their value from the fact that labour has been expended on them; and it is thus implied, if not stated, that value will be proportional to labour. This is a doctrine which cannot stand for a moment, being directly opposed to facts' (*TPE,* pp. 162–63). The fact, first, that some commodities are irreproducible, negates for Jevons any labour theory (p. 163; see G.Stigler 1950, p. 85). More significant, his is an *ex ante* theory of cost: labour once spent operates as something of a sunk cost and '*has no influence on the future value of any article:* it is gone and lost for ever' (p. 164).[2] And, in the anticipation of specific labour costs, production decisions are made that themselves influence costs, the result being that anticipated costs in fact are rarely equal to actual outlays:

> In commerce bygones are for ever bygones; and we are always starting clean at each moment, judging the values of things with a view to future utility. Industry is essentially prospective, not retrospective; and seldom does the result of any undertaking exactly coincide with the first intentions of its promoters.
>
> (*TPE,* pp. 164–65)[3]

Yet though 'never the cause of value' labour 'is in a large proportion of cases the determining circumstance' (*TPE,* p. 165). Here Jevons developed his renowned *catena* of causation, that was so roundly rejected by Marshall:

> *Value depends solely on the final degree of utility. How can we vary this degree of utility?—By having more or less of the commodity to consume. And how shall we get more or less of it?—By spending more or less labour in obtaining a supply… Cost of production determines supply; Supply determines final degree of utility; Final degree of utility determines value.*
>
> (*TPE,* p. 165)[4]

As Schabas has argued (1990, p. 46) Jevons was certainly familiar with the notion of transitivity and thus must have recognized that this catena amounts to arguing that cost of production determines value. How could he also hold that value 'depends solely' on the final degree of utility? If cost of production can be recast in terms of (negative) utility, his seemingly contrary positions are reconciled.

In what follows we will therefore be concerned with Jevons's position that labour and capital are commensurate with utility.[5] But we will also see that Jevons never managed to relate the production and exchange chapters of *TPE* satisfactorily: the treatment of production remains distinctly separate from the treatment of exchange, in that Jevons's analysis of production focused on partial equilibrium situations.[6] As in Chapter 5, we shall also see that *TPE* carries strong welfare implications with it. Behavioural patterns of work, for instance, are said to differ with institutional settings, so that policy might be used to promote institutions that encourage 'good' work habits.

DISUTILITY: THE THEORY OF LABOUR

Jevons acknowledged that Adam Smith was 'substantially' correct in his remarks concerning the 'real price of everything', the 'toil and trouble of acquiring it' (*TPE,* p. 167). For Jevons, labour is simply disutility, 'the painful exertion which we undergo to ward off pains of greater amount, or to procure pleasures which leave a balance in our favour' (p. 167).[7] Consequently, his 'theory of labour' is a simple extension of utility analysis; the problem to solve is *'to satisfy our wants with the least possible sum of labour'*—with the smallest possible subtraction of utility arising from the (painful) act of production (p. 168).[8] All exertion (of the physical or mental sort) is included in this analysis, Jevons argued, but the problem becomes somewhat trivial in the case of a purely enjoyable activity, 'under-taken solely for the sake of the enjoyment attaching to it' (p. 168). In that instance, no account need be taken of any future reward for this labour since the activity constitutes its own reward; and participation stops simply 'when we feel inclined', which implies that even this type of activity must at some point entail painful exertion, and become unenjoyable or at least relatively unenjoyable compared to some alternative activity.[9]

Jevons's interest, however, is primarily in the prevalent cases that require rewards (wage payments), to induce exertion, in *'any painful exertion of mind or body undergone partly or wholly with a view to future good'* (*TPE,* p. 168); thus, the case of instant gratification is neglected.[10] For the most part we must 'measure labour by the amount of pain which attaches to it' (p. 169); while labour may initially be wholly pleasurable, eventually it becomes painful or 'irksome':

> It is true that labour may be both agreeable at the time and conducive to future good; but it is only agreeable in a limited amount, and most men are compelled by their wants to exert themselves longer and more severely than they would otherwise do. When a labourer is inclined to stop, he clearly feels something that is irksome, and our theory will only involve the point where the exertion has become so painful as to nearly balance all other considerations. Whatever there is that is wholesome or agreeable about labour before it reaches this point may be taken as a net profit of good to the labourer; but it does not enter into the problem. It is only when labour becomes effort that we take account of it.
>
> (*TPE,* pp. 168–69)

Since labour yields negative utility, it can be conceptualized, Jevons argued, in the same two dimensions he chose for utility (Chapter 5): duration, and intensity. Intensity, however, may refer to the 'quantity of work done' or 'the painfulness of the effort' expended (*TPE,* p. 170). Discussion of the former is deferred until his chapter on rent; his Theory of Labour pertains to the 'variation of the painfulness of labour' (p. 171). Based on experience, he argued that effort is an increasing function of duration: 'as labour is prolonged the effort becomes as a general rule more and more painful' (p. 171).[11] Although the data may be lacking to obtain 'the exact law of the variation', Jevons reiterated the 'general truth' described by Jennings, that effort increases at an increasing rate with duration (p. 172).

Jevons next relates this simple law to the law of diminishing marginal utility. Since exertion eventually yields negative utility and since exertion, being painful, occurs only with an eye to consumption, there will, he argued, occur some duration of work 'such that the pleasure gained is exactly equal to the labour endured' (*TPE,* p. 173). If one were to work more than this amount, 'a balance of pain will result' and, further, because effort increases at an increasing rate with duration, 'there will be an ever-decreasing motive in favour of labour, and an ever-increasing motive against it' (p. 173), a situation 'inconsistent with human nature', and thus resulting in a reduction of exertion (pp. 173–74). Again Jevons is careful to specify that his is an equilibrium notion, so that the worker under consideration must be neither gaining nor losing strength (p. 174). While exceptions might occur, they will not persist: 'Adequate motives may lead to and warrant overwork, but, if long continued, excessive labour reduces the strength and becomes insupportable; and the longer it continues the worse it is, the law being somewhat similar to that of periodic labour' (p. 174). To represent the theory algebraically, Jevons describes four variables:

> t=time, or duration of labour;
>
> l=amount of labour, as meaning the aggregate balance of pain accompanying it, irrespective of the produce;
>
> x=amount of commodity produced;
>
> u=total utility of that commodity (*TPE,* pp. 174–75).

While he allowed that we might 'in fact treat labour as simply one case of *disutility* or negative utility, that is as pain, or at any rate as a generally painful balance of pleasure and pain, endured in the action of acquiring commodity', so that its dimensions 'might be described as identical with those of utility' (*TPE,* p. 178), Jevons preferred to develop a new symbol 'to express the dimensions of labour' (p. 179).[12] Thus he posited that the *intensity of labour* might be represented by E (for Endurance) while the *total quantity of labour* requisite to produce a commodity, is then ME.[13] Since labour is 'often measured and bought and sold by *time,* instead of by piecework or commodity produced', ET is used to represent the dimension of 'amount of labour' (p. 179).

The amount of commodity produced obviously varies with duration, and the rate of production is then (presuming the rate to be uniform across t): x/t. If, however, the rate of production varies at points in time, Jevons held that it is properly denoted $x/\ t$, or at the limit, by dx/dt. Similarly, the degree of painfulness of labour would be l/t if it were uniform in time, but is properly considered $l/\ t$ or dl/dt in the limit.[14] The degree of utility is represented, as outlined in Chapter 5, by *du/dx* (*TPE,* p. 176). The 'amount of reward of labour' is then expressed as *(dx/ dt)(du/dx),* which, in Jevons's reasoning, explains why the 'last two hours of work in the day generally gives less reward, both because less produce is then created in proportion to the time spent, and because that produce is less necessary and useful to one who makes enough to support himself in the other ten hours' (p. 176).

How much should a worker work? Jevons frames this question in terms of an individual's decision, when that person is free to vary work hours; he reasons, again with simple logic, that 'When labour itself is a worse evil than that which it saves him from, there can be no motive for further exertion, and he ceases' (*TPE,* p. 176). Thus, the individual works until 'just at the point when the pain becomes equal to the corresponding pleasure gained', which yields t defined by the equation: $dl/dt=(dx/dt)(du/dx)$ (p. 176).[15] The equilibrium condition for work hours of a labourer confirms, for Jevons, the principle that all questions of Economics depend 'upon the final increments': 'As long as he gains, he labours, and when he ceases to gain, he ceases to labour' (p. 177).[16]

Jevons's theory allows him to consider next the *'Balance between Need and Labour'*. Supposing that exogenous technical change occurs that 'alters the relation of produce to labour', he asks, what influence will this have on the amount of work done? Jevons proposes that two counteracting effects occur: 'When labour produces more commodity, there is more reward, and therefore more inducement to labour' (*TPE,* p. 179).[17] However, the fact that the worker's reward increases also 'lowers the utility to him of any further addition' (p. 180). Since he can produce more with less exertion, the net result 'depends upon the direction in which the balance between the utility of further commodity and the painfulness of prolonged labour turns' (p. 180). Because economists were ignorant of the 'exact form of the functions of utility or of labour', the issue cannot be decided a priori.

In a rare instance of using empirical evidence in his *TPE,* however, Jevons cited some evidence on the matter. The rise in the price of necessaries early in the nineteenth century, he argued, was equivalent to a decline in the produce of labour ('since less of the necessaries of life can be acquired in exchange for the same money wages') (*TPE,* p. 180). As a result of this decline in purchasing power, workers apparently increased hours of work. Thus, he concluded 'that English labourers enjoying little more than the necessaries of life, will work harder the less the produce; or, which comes to the same thing, will work less hard as the produce increases' (p. 180). Similar evidence, Jevons argued, consisted of

> the general tendency to reduce the hours of labour at the present day, owing to the improved real wages now enjoyed by those employed in mills and factories. Artisans, mill-hands, and others, seem generally to prefer greater ease to greater wealth, thus proving that the painfulness of labour varies so rapidly as easily to overbalance the gain of utility. The same rule

> seems to hold throughout the mercantile employments. The richer a man becomes, the less does he devote himself to business.
>
> (*TPE,* pp. 180–81)

For further evidence in the context of an analysis of the effects of the Factory Acts, see also *SRL,* pp. 52–87.

But Jevons cautioned that this is a matter of 'many intricacies', since work hours are not always perfectly divisible; and since increased work hours may be linked to increased probability of prestigious appointments in related fields (as in the case of the successful barrister, hoping, by working longer hours, to influence the probability of an appointment to the bench, or the achievement of a parliamentary position; *TPE,* p. 181). In the 'highest kinds of labour, such as those of the philosopher, scientific discoverer, artist, etc.', he maintained further, work hours were not perfectly divisible: here 'it is questionable how far great success is compatible with ease', since 'the mental powers must be kept in perfect training by constant exertion' (p. 182).

These questions are said, in addition, to 'depend greatly upon the character of the race':

> Persons of an energetic disposition feel labour less painfully than their fellow-men, and, if they happen to be endowed with various and acute sensibilities, their desire of further acquisition never ceases. A man of lower race, a negro for instance, enjoys possession less, and loathes labour more; his exertions, therefore, soon stop. A poor savage would be content to gather the almost gratuitous fruits of nature, if they were sufficient to give sustenance; it is only physical want which drives him to exertion. The rich man in modern society is supplied apparently with all he can desire, and yet he often labours unceasingly for more.
>
> (*TPE,* pp. 182–83)

This position carried with it strong implications for policy-makers who, in Jevons's mind, might be well advised to attempt to influence the labour supply decisions of the poor in England. Jevons linked this claim to the Irish problem, citing Bishop Berkeley's query which suggested that, to encourage a healthy work ethic, policy-makers might simply cultivate the taste for luxuries—beef and shoes—among labourers: 'Whether the creating of wants be not the likeliest way to produce industry in a people? And whether, if our (Irish) peasants were accustomed to eat beef and wear shoes, they would not be more industrious?' (p. 183).[18]

While Jevons conceded that 'We may approximately measure the intensity of labour by the amount of physical force undergone in a certain time', he insisted on the subjective element in effort: 'it is the pain attending that exertion of force which is the all-important element in Economics' (*TPE,* p. 204), pain which, as the paragraph above reveals, varies with occupation and race. The implication regarding occupation is that individual types sort themselves into various occupations. While variations within occupations exist, one can generalize (in Jevons's mind) about average behaviour in one occupation relative to another. The same implication characterizes racial variation, except that, since one cannot choose one's racial make-up, the element of choice which allows for the initial sorting into groups, obviously does not pertain.

Then, through trial and error, an 'unconscious process of experimentation and inductive reasoning', individuals within each occupation find the work intensity that is 'most advantageous' (*TPE,* p. 204). In the simple task of digging, for instance, the spade is chosen 'which does not overtax a labourer and prevent him doing a full day's work, but enables him to accomplish as much as possible' (p. 204).[19] In the case of mail deliveries, 'the maximum useful result would be obtained with the largest load which does not severely fatigue the man', a result 'soon' determined by trial and error (p. 205).[20] Questions 'of this kind' pervade the Economics of Labour:

> When a work has to be completed in a brief space of time, workmen may be incited by unusual reward to do far more than their usual amount of work; but so high a rate would not be profitable in other circumstances. The fatigue always rapidly increases when the speed of work passes a certain point, so that the extra result is far more costly in reality.[21] In a regular and constant employment the greatest result will always be gained by such a rate as allows a workman each day, or each week at the most, to recover all fatigue and recommence with an undiminished store of energy.
>
> (*TPE,* p. 209)

Jevons insisted, purportedly in opposition to Ricardo, that productive capabilities varied as a result of both natural differences among workers—which as the quotation above reveals, might be delineated along racial lines—and also educational attainment: 'I assume, as obviously true, that the abilities of men are infinitely varied, whether by nature or by education, so that both the same person may vary his power in producing different objects, and any two persons may vary in respect to the same objects' (*MT,* p. 284).[22] Thus he maintained that labour is *'essentially variable',* so that *'its value must be determined by the value of the produce'* and not the other way round (*TPE,* p. 166).

Having examined the individual choice of exertion level, Jevons proceeds to the conditions determining production, 'the conditions which regulate the comparative amounts of different commodities produced in a country' (*TPE,* p. 183). Again he chooses to analyse the problem on an individual basis, considering the case of an individual who must decide how much of each of two goods to produce with his labour. The worker's object is to maximize utility, a problem which depends in part on the utility functions associated with the two goods, and second, on his comparative facility for producing the two goods. Letting x and y be the amounts of these goods 'already produced', the question becomes, on which good should a worker spend the next increment of labour? 'Plainly', Jevons argues quite simply, on that which yields the most utility. Thus, the individual takes into account the ratios $x/\ l$ and $y/\ l$, as well as the final degrees of utility that result from these applications of additional labour: $u_1/\ x$, and $u_2/\ y$. Then the product of $x/\ l$ and $u_1/\ x$, yields 'the amount of utility which can be obtained by producing a little more of the first commodity'. If that quantity outweighs the additional utility associated with producing a small additional amount of the second good, the individual should make more of the first good. In equilibrium, when labour is distributed to maximize utility, 'we must have the increments of utility from the several employments to be equal'; in the limit, the equilibrium condition is the equation

$$\frac{du_1}{dx}\cdot\frac{dx}{dl_1}=\frac{du_2}{dy}\cdot\frac{dy}{dl_2}$$

That equilibrium condition contains two unknowns, the amounts of labour to apportion to each good. An additional equation is provided by the constraint, $l=l_1+l_2$. A final equation arises from Jevons's reasoning that labour occurs until the increment of utility from work just balances the increment of pain, which implies that $du_1=dl_1$ (recalling that dl_1 is the negative utility associated with exerting l_1 effort), which in turn means that

$$\frac{du_1}{dx}\cdot\frac{dx}{dl_1}=1$$

These additional equations give Jevons the confidence that, at least in principle, his equilibrium condition might be solved for its unknowns.[23]

Jevons turns next to the relationship between his theory of labour and the theory of exchange, arguing that *'articles will exchange in quantities inversely as the costs of production of the most costly portions'* (*TPE,* p. 187).[24] To show this, Jevons now uses the notation for the rate of production, *dx/dl*. Then, reverting to his notation for the final degree of utility (p. 103), he expresses the equilibrium condition for production using labour as

$$\Phi(x)\cdot\tilde{\omega}_1=\Psi(y)\cdot\tilde{\omega}_2$$

Allowing for exchange to occur, augmenting x to $x+x_1$ and reducing y to $y-y_1$ we have

$$\frac{\Phi(x+x_1)}{\Psi(y-y_1)}=\frac{y_1}{x_1}$$

and the equilibrium condition for production becomes

$$\Phi(x+x_1)\cdot\tilde{\omega}_1=\Psi(y-y_1)\cdot\tilde{\omega}_2$$

or, alternatively expressed:

$$\frac{\Phi(x+x_1)}{\Psi(y-y_1)}=\frac{\tilde{\omega}_2}{\tilde{\omega}_1}$$

which implies the 'all-important equation' (p. 187):

$$\frac{\tilde{\omega}_2}{\tilde{\omega}_1} = \frac{y_1}{x_1}$$

Thus, Jevons argues, he has 'proven' 'that commodities will exchange in any market in the ratio of the quantities produced by the same quantity of labour' (*TPE,* p. 187).[25]

A 'complicated double adjustment' is thus said to occur, of both the consumption and the production of goods, 'in accordance with their ratio of exchange' (*TPE,* pp. 188–89). While he was unable precisely to describe that adjustment process, Jevons chose to illustrate 'the reciprocal relation of exchange and production' with a number of examples revealing how agricultural production adjusted to alterations in relative prices. These examples, like those designed to show how the labourer finds the best production technique (p. 121), emphasize that his treatment of labour often presupposes physical exertion in the context of simple production processes. Further, they reinforce the fact that the formal presentation of Theory of Labour did not entail new implications for the analysis of production and consumption: his examples and analysis are similar to those used by Classical economists to illustrate cost of production theory.

Since the abolishment of the Corn Laws, for instance, Jevons argued that 'The land less suitable to the growth of wheat has been turned to grazing or other purposes more profitable comparatively speaking' (*TPE,* p. 188). The importation of 'hops or eggs or any other article of food' similarly 'prevents the necessity for resorting to more expensive modes of increasing the supply' (p. 188). But 'It is not easy', Jevons maintains, 'to express in words how the ratios of exchange are finally determined': 'They depend upon a general balance of producing power and of demand as measured by the final degree of utility. Every additional supply tends to lower the degree of utility; but whether that supply will be forthcoming from any country depends upon its comparative powers of producing different commodities' (p. 188). Some countries simply do not appreciably affect world output; they must therefore adjust 'productions in accordance with the general state of the market' (p. 188).[26] Others might cause 'a revolution' in specific markets: 'If the whole habitable surface of Australia, instead of producing wool, could be turned to the cultivation of wine, the wool market would rise, and the wine market fall' (p. 189). In such a case, Jevons asserted, Australia would be led 'inevitably' to return to wool production, a result that illustrates the 'reciprocal relation of exchange and production' (p. 189).

RELATION TO THE `RECOGNIZED DOCTRINES OF POLITICAL ECONOMY'

Although Jevons was critical of Classical use of the term 'value', as well as the 'cost of production' theory of value (see pp. 75–76) he devoted a section in the *TPE* to the relationship between his utility based theory of value, and the cost of production theory of value, at least insofar as cost of production 'can be accurately interpreted', and still presuming production by unassisted labour (*TPE,* p. 191).[27] He commenced this discussion by explicitly acknowledging that his exchange ratio, *y/x,* equals the price ratio. Where p_1 is the per unit price of commodity X and p_2 is the per unit price of commodity Y, the exchange rate may be rewritten as

$$\frac{y}{x}=\frac{p_1}{p_2}$$

Second, Jevons maintained that cost of production[28] 'varies as the reciprocal of the degree of productiveness', given the wage rate, so that

$$\frac{\text{Degree of productiveness of Y}}{\text{Degree of productiveness of X}}=\frac{\text{Cost of production of X}}{\text{Cost of production of Y}}$$

But since the ratio of degrees of productiveness equals the exchange rate, *y/x,* Jevons arrives at the expression:

$$\frac{\text{Value per unit of X}}{\text{Value per unit of Y}}=\frac{\text{Cost of production of X}}{\text{Cost of production of Y}}$$

or, in other words, the proposition that *'value is proportional to cost of production'* (*TPE,* p. 192). The familiar interrelationships follow:

> *The quantities of commodity given or received in exchange are directly proportional to the degrees of productiveness of labour applied to their production, and inversely proportional to the values and prices of those commodities and to their costs of production per unit, as well as to their final degrees of utility.*
>
> (*TPE,* pp. 192–93)

The 'principal question in Economics' is now said to be that quantities of commodity exchanged vary 'directly as the quantities produced by the same labour', and inversely as their 'Values'; 'Prices'; 'Costs of production'; and 'Final degrees of utility' (*TPE,* p. 193). Once again, the ratio of exchange is said to be determined by 'a kind of struggle between the conditions of consumption and production', although he declined to elaborate upon how precisely this double adjustment occurred (p. 196).[29]

The implications of this 'principal question' are considered next, and here Jevons moves to the consideration of an aggregate, a nation or industry. First, with respect to trade, Jevons's position remained essentially that of Ricardo and J.S.Mill: 'the absolute facility of producing commodities will not determine the character and amount of trade'; instead, it is the comparative facility that determines trade, a point which, Jevons argued, had been 'correctly conceived by Ricardo' and 'fully explained by J.S.Mill' (*TPE,* p. 193).[30] Second, nations possessing similar productive capacities and 'habits of consumption' will not trade; while two nations possessing similar productive capacities but different 'habits' may benefit from trade (p. 195).

As in the case of exchange (pp. 106–7), Jevons allows in this discussion that his production equations might fail, and he finds an economic explanation for this. If, for instance, trade is prohibited for a particular good, that commodity might 'be produced at an expenditure of labour constantly out of proportion to that at which it may be had by exchange':

> If we could not, for instance, import oranges from abroad, part of the labour of the country would probably be diverted from its present employment to raise them; but the cost of production would be always above that of getting them indirectly by exchange, so that free trade necessarily destroys such a wasteful branch of industry. It is on this principle that we import the whole of our wines, teas, sugar, coffee, spices, and many other articles from abroad.
>
> (*TPE,* p. 196)

Further, the discovery of cost-reducing machinery might lead to the failure of the 'all-important equations' (*TPE,* p. 196). Jevons had in mind the market for a. good characterized by at least approximately constant marginal utility: 'whose desire to consume the quantity y_1 never decreased, however large was the quantity available' (p. 197). In this instance, the exchange rate will not equal the ratio of productiveness, and the producers of *y* make 'large gains of the nature of rent' (p. 197).

A further complication of Jevons's theory, one considered by J.S.Mill in his *PPE,* was the case of joint production, a situation which, Jevons argued, reveals 'all the more impressively that it is not cost of production which rules values, but the demand and supply of the products' (*TPE,* p. 199).[31] Here, since there is no freedom to vary the quantity of each good produced, the exchange and production equations will fail. To bring these cases 'under our theory', Jevons made the simplifying assumption that two goods, X and Y, are produced by some operation in the (fixed) ratio of *m* to *n*. Yet since *dx* 'cannot be produced without *dy*', the relevant ratio of the produce to labour is written:

$$\frac{dx + dy}{dl}$$

Then the aggregate ratio of utility to labour is:

$$\frac{du_1}{dx} \cdot \frac{dx}{dl} + \frac{du_2}{dy} \cdot \frac{dy}{dl}$$

Since no substitutions are possible in this instance, Jevons concludes that the 'ratio of exchange will be governed only by the degrees of utility' (pp. 200–201). Comparing X and Y to a third good, Z, he obtains

$$\frac{du_1}{dx} \cdot \frac{dx}{dl} + \frac{du_2}{dy} \cdot \frac{dy}{dl} = \frac{du_3}{dz} \cdot \frac{dz}{dl}$$

Thus, he argues, ‘the increment of utility obtained by applying an increment of labour to the production of *Z,* must equal the sum of the increments of utility which would be obtained if the same increment of labour were applied to the joint production of *X* and *Y*’ (*p.* 201).[32]

The final implication of the production equations concerned the notion of a general glut discussed above, in the context of economic fluctuations (see pp. 55–61). As noted there, Jevons insisted that his theory showed the doctrine of *‘over-production’* to be ‘evidently absurd and self-contradictory’ (*TPE,* p. 202). But he allowed that ‘supplies must be *suitable*—that is, they must be in proportion to the needs of the population’ (p. 203). Thus, while over-production ‘is not possible in all branches of industry at once’, it is consistent with his theory that over-production occurs ‘in some [industries] as compared with others’ (p. 203). Jevons described a situation where producers mistakenly over-produce in silk. Once again *ex ante* calculations of cost are incorrect; ‘by miscalculation’ too much labour is hired in the silk industry:

> If, by miscalculation, too much labour is spent in producing one commodity, say silk goods, our equations will not hold true. People will be more satiated with silk goods than cotton, woollen, or other goods. They will refuse, therefore, to purchase them at ratios of exchange corresponding to the labour expended. The producers will thus receive in exchange goods of less utility than they might have acquired by a better distribution of labour.
>
> In extending industry, therefore, we must be careful to extend it proportionally to all the requirements of the population. The more we can lower the degree of utility of all goods by satiating the desires of the purchasers the better; but we must lower the degrees of utility of different goods in a corresponding manner, otherwise there is an apparent glut and a real loss of labour.
>
> (p. 203)

If the wage fund operates as described below (p. 133–34), the result of this miscalculation is a temporary shortfall of profits.

THEORY OF RENT

As noted above (p. 75) Jevons found little to criticize in the Classical theory of rent; objecting in the main only to the ‘clumsy arithmetical illustrations’ of the theory which lent itself to treatment using the calculus (*TPE,* p. 210).[33] His own treatment was conventional in that it entailed consideration of combinations of land and labour in both the extensive and then the intensive margin. Differential rent is said to emerge from the Law of Indifference, which implies that ‘if different qualities of land yield different amounts of produce to the same labour, there must be an excess of profit in some over others’ (pp. 211–12). Since the price of the produce from different units of land is uniform, marginal land will 'just pay the ordinary wages', while better land yields an excess, so that the owners of this land 'will be able to exact as rent from the cultivators the whole excess above what is sufficient to pay the ordinary wages of labour' (p. 212; see Note 39). A 'secondary origin' of rent—the intensive case—is also recognized in the fact that, with a fixed quantity of land, 'if more or less labour and capital be applied…the produce will not increase proportionally to the amount of labour' (p. 212).[34] Since the 'last increment of the produce will come to bear a smaller and smaller ratio to the labour required to produce it', it 'soon becomes, in the case of all land, undesirable to apply more labour' (p. 212).[35]

To present the theory of rent mathematically, Jevons considers applications of labour to land.[36] Supposing that labourers work on several plots of land, the question he posed is 'On what principle will they distribute their labour between the several pieces?' (*TPE,* p. 216). Once again the basic principle is straightforward: maximizing behaviour implies that labourers will 'naturally' work on that land which yields the largest product. In equilibrium, 'when they are perfectly satisfied with the distribution made', the increments of produce resulting from an increment of labour, must be the same, or $x_1 = x_2$; in the limit

$$\frac{dx_1}{dl} = \frac{dx_2}{dl}$$

Thus, the general principle is that whenever 'a labourer or body of labourers distribute their labour over pieces of land with perfect economy, *the final ratios of produce to labour will be equal*' (pp. 216–17). Since the 'general law' of diminishing returns pertains, the function dx/dl decreases 'after x has passed a certain quantity' (p. 217).[37]

Letting $P(l)$ represent the production function, Jevons now represents the final rate of production, $dP(l)/dl$. If the labourer is paid his marginal product[38]—'for the last increment of labour'—dx/dl, then the wage bill is $l(dx/dl)$, and the rent (the amount 'more than the necessary return to labour') is then:

$$P(l) - l \cdot \frac{dx}{dl}$$

This expression 'represents the advantage he derives from the possession of land in affording him more profit than other methods of employing his labour' (*TPE,* p. 218).[39] The general result, described in the 'Preface' to the second edition, is that '*each portion of land should be applied to that culture or use which yields the largest total utility, as measured by the value of the produce*…. Thus the rent of land is determined by the excess of produce in the most profitable employment' (p. xlix).

Similar reasoning is said to apply to the determination of wages: 'But when the matter is fully thought out, it will be seen that exactly the same principle applies to wages' (*TPE,* pp. xlix–l). Here all 'is a matter of comparison', each labourer seeking 'the work in which his peculiar faculties are most productive of utility, as measured by what other people are willing to pay for the produce' (p.

l). The ‘parallelism between the theories of rent and wages’ arises, Jevons argued, ‘when labour is turned from one employment to another’, since ‘the wages it would otherwise have yielded must be debited to the expenses of the new product’ (p. l).[40]

CAPITALIZATION

A ‘distinct branch of our subject’ is said to emerge when we consider the nature and principles of Capital (*TPE,* p. 222). Because there is ‘no close or necessary connection between the employment of capital and the processes of exchange’,[41] economics ‘is not solely the science of Exchange or Value: it is also the science of Capitalisation’ (p. 222).[42] Acknowledging here once again that his views were ‘in fundamental agreement with those adopted by Ricardo’,[43] and continuing to rely for many of his examples on agricultural production processes, Jevons defined capital as ‘the *aggregate of those commodities which are required for sustaining labourers of any kind or class engaged in work’,* including stocks of food, clothing, and furniture (p. 223).[44] Instead of Smith’s distinction between fixed and circulating capital, he proposed the distinction between ‘free’ and ‘invested’ capital.[45] He argued in this context that free capital consists of ‘the wages of labour, either in its transitory form of money, or its real form of food and other necessaries of life. The ordinary sustenance requisite to support labourers of all ranks when engaged upon their work is really the true form of capital’ (*TPE,* p. 243).[46] As Steedman (1972) has noted, this latter definition allows that capital can be both a heterogeneous bundle of wage goods, as well as a homogeneous good, money wages. To reconcile these possibilities, one must presume that Jevons makes the bundle of wage goods homogeneous by valuing it at money prices.[47]

Capital enables time-consuming production to occur:[48] The single and all-important function of capital is to enable the labourer to await the result of any long-lasting work,—to put an interval between the beginning and the end of an enterprise’ (*TPE,* p. 224).[49] A tool is constructed with the ‘object of raising corn’, the only ‘essential difference’ between labour expended in making the tool and that expended directly to raise the crop, being ‘that it has to precede the production of corn by a longer interval’ (p. 226):

> If we proceed straight to the work, and use the implements with which nature has furnished us—our fingers—we should spend an enormous amount of painful labour with very little result. It is far better, therefore, to spend the first part of our labour in making a spade or other implement to assist the rest of our labour. This spade represents so much labour which has been invested, and so far spent; but if it lasts three years, its cost may be considered as repaid gradually during those three years. This labour, like that of digging, has for its object the raising of corn, and the only

> essential difference is that it has to precede the production of corn by a longer interval.
>
> (*TPE,* p. 226)

The 'principles of the matter' are unaffected by the fact that in 'modern industry' specialization implies that we 'seldom or never find the same man making the spade or plough, and afterwards using the implement' (*TPE,* p. 227). The 'sole use of capital' is then said to entail lengthening *'the average interval between the moment when labour is exerted and its ultimate result or purpose accomplished'* (pp. 228–29).[50] As a result of this abstinence, the amount of capital is also associated with deferred consumption: 'While the amount of capital is established by the amount of utility of which the enjoyment is deferred, *amount of employment of capital* is the amount of utility multiplied by the number of units of time during which its enjoyment is deferred' (MT, p. 286).[51]

Since capitalization entails deferred consumption, consideration of 'the most advantageous employment of capital' turns upon the length of investment as well as the amount invested. The *'amount of investment of capital'*—distinct from the amount of capital—is the amount of capital multiplied by the amount of time for which it remains invested (*TPE,* pp. 229–30). A pound invested for five years, thus corresponds to *'five pound-years'* of investment (p. 230). If a worker is employed for a year on some project at a daily wage of four shillings, then the amount of investment will be: $4\times364+4\times363+4\times362+\cdots+4\times1$ *'shilling-days'* (p. 230).[52] Invested capital is sustenance that has been 'sunk' in the enterprise: 'To invest capital is to spend money, or the food and maintenance which money purchases, upon the completion of some work. The capital remains invested or sunk until the work has returned profit, equivalent to the first cost, with interest' (p. 243).

But we must also consider the use of invested capital, Jevons argued, and 'conceive the capital as being progressively *uninvested*' (*TPE,* p. 231). Once again, agriculture provides Jevons with an example of his theory: 'Let us, for sake of simple illustration, imagine the labour of producing the harvest to be continuously and equally expended between the first of September in one year and the same day in the next. Let the harvest be then completely gathered, and its consumption begin immediately and continue equally during the succeeding twelve months' (p. 231).[53]

Like the Classical economists, Jevons relied upon mobility of capital turning upon profit rate differentials: *'free capital can be indifferently employed in any branch or kind of industry'* (*TPE,* p. 244). [54] Hence resulted another case of the Law of Indifference; since 'the market for capital is like all other markets', 'the rate of interest for free capital will tend to and closely attain uniformity in all employments' (p. 244); at the same time, Jevons allowed for variations due to 'considerations of risk, trouble, and other interfering causes' (p. 245).

To obtain a 'general expression for the rate of interest', Jevons supposed that capital be invested for a period of time, t. The 'produce for the same amount of labour' is represented by *F(t),* an increasing function of time. If the time that capital is invested is extended to *t*+ *t*, the new produce is *F*(*t*+ t), the increment being *F*(*t*+ *t*)—*F(t)*. The ratio of this increment to the increment of investment, Jevons holds, determines the rate of interest.[55] At the end of time *t,* the produce is *F(t)* and this is the amount of capital that remains invested through *t*. The increased investment is thus *t* • *F(t),* and the ratio of the increment of production to the increment of investment is:

$$\frac{F(t+\Delta t)-F(t)}{\Delta t}\times\frac{1}{F(t)}$$

which in the limit, equals

$$\frac{dF(t)}{dt}\cdot\frac{1}{F(t)}$$

Thus, Jevons concluded, the rate of interest equals *'the rate of increase of the produce divided by the whole produce', F (t)÷F(t).*[56] This expression confirms 'the known fact' for Jevons that the rate of interest must decline over time, since 'this is a quantity which must rapidly approach to zero, unless means can be found of continually maintaining the rate of increase' (*TPE,* p. 246):[57] 'Every new machine or other great invention will usually require a fixation of capital for a certain average time, and may be capable of paying interest upon it; but when this average time is reached, it fails to afford a return to more prolonged investments' (pp. 246–47).[58]

Indeed, it was 'one of the favourite doctrines of economists', that 'as society progresses and capital accumulates, the rate of profit, or more strictly speaking, the rate of interest, tends to fall' (*TPE,* p. 253),[59] a fall confirmed by 'sufficient statistical facts' (p. 254). Only the question of 'the actual cause' of the declining profit rate remained. Dismissing Smith's 'competition of capitals' briefly, Jevons next considered the argument that the fall of interest is due to a 'rise in the cost of labour' (p. 254). In opposition to this view, he argued that 'interest is determined by the increment of produce which it enables a labourer to obtain, and is altogether independent of the total return which he receives for this labour' (pp. 254–55).[60] The rate of interest will, Jevons maintained, be greater where 'the whole produce *Ft* is less, if the advantage of more capital, measured by *F t,* remains unchanged' (p. 255). This instance occurred in many 'ill-governed countries', 'where the land is wretchedly tilled, the average produce is small, and yet the rate of interest is high, simply because the want of security prevents the due supply of capital: hence more capital is urgently needed, and its price is high' (p. 255). While scarce capital in America and the colonies rendered interest high, in older nations such as England, abundance of capital meant that interest rates were lower.[61]

Thus, Jevons insisted, the 'returns to capital and labour' are 'independent of each other', meaning in this context that returns to both capital and labour might be high, or low, or wages might be high while interest is low:

> If the soil yields little, and capital will not make it yield more, then both wages and interest will be low, provided that the capital be not attracted away to more profitable employment. If the soil yields much, and capital will make it yield more, then both wages and interest will be high; if the soil yields much, and capital will not make it yield more, then wages will be high and interest low, unless the capital finds other investments.
>
> (*TPE,* p. 255)

The entire subject, however, is said to be 'much complicated' by the 'interference' of rent, which necessitates the distinction between 'the *whole yield*' and *'the final rate of yield'* (*TPE,* pp. 255–56):

> In the Western States of America the land yields a large total, and all at a high final rate, so that the labourer enjoys the result. In England there is a large total yield, but a small final yield, so that the landowner receives a large rent and the labourer small wages. The more fertile land having here been long in cultivation, the wages of the labourer are measured by what he can earn by cultivating sterile land which it only just pays to take into cultivation.
>
> (*TPE,* p. 256)

CONCLUSIONS: THE PROFIT-WAGE RELATIONSHIP

For Jevons, labour and capital are commensurate with utility; his theory of labour constitutes an extension of utility theory, or what Professor Black has called a 'theory of cost of production in terms of disutility' (1970, p. 19). The theory of rent follows from the disutility of labour, being an explanation of how rent emerges when labour and land are combined. Jevons found little to criticize in the Classical analysis of rent (*TPE,* p. 210), and he maintained that his theory of capital was in accord with that of David Ricardo. We have seen, in addition, another instance of strong welfare implications in *TPE*: behavioural patterns of labour supply differed with institutional settings, so that policy might promote institutions that encourage 'good' work habits.

Jevons never managed to relate the production and exchange chapters of *TPE* satisfactorily: the treatment of production remains distinctly separate from the treatment of exchange in that the analysis of production focused on partial equilibrium situations, while, as we have seen (Chapter 5), the theory of exchange is a general equilibrium analysis. The theory of labour is said to be consistent with a cost of production theory of value whereby quantities exchanged vary 'directly as the quantities produced by the same labour', and inversely as their 'Values'; 'Prices'; 'Costs of production'; and 'Final degrees of utility' (*TPE,* p. 193); Jevons objected to the cost of production theory only insofar as that formulation was presented as an alternative to supply and demand analysis. The ratio of exchange is then said to be determined by 'a kind of struggle between the conditions of consumption and production', but Jevons declined to elaborate upon precisely how these adjustments occurred (p. 196).

In the final chapter of his *TPE,* Jevons turned briefly to a consideration of the relation between wages and profits. Here he was critical of a narrowly interpreted wage fund theory as well as the inverse profit-wage mechanism as general explanations of the relationship between wages and profits on the grounds that these neglect the importance of the (anticipated) value of the final product in determining the amount of investment forthcoming. But he allowed that the wage fund theory had a 'temporary' usefulness, a 'certain limited and truthful application' (*TPE,* p. 268) once investment for the next production period had been put in place.

The 'very simple' wage fund theory used by economists to determine the 'rate at which capital can buy up labour' comes in for harsh criticism, since it is a 'truism' to suggest—as Jevons maintains they do—that the average rate of wages can be determined by 'the whole amount of capital appropriated to the payment of wages' relative to the number of labourers, a proposition which misses what for Jevons constitutes the key question of 'how much [capital] is appropriated for the purpose' (*TPE,* p. 268). As we have seen above, Jevons argued the amount appropriated is determined by producers who invest with an eye on the anticipated amount of produce, as well as the anticipated labour costs.[62]

Jevons is just as critical of the inverse wage-profit theory, a purportedly simplistic view of profits and wages, whereby the entire product is divided into portions paid as 'rent, taxes, profits, and wages' (*TPE,* pp. 268–69). Taxes are excluded from consideration (as 'not very important') and rent is then eliminated, 'for it is essentially variable, and is reduced to zero' on marginal land. Thus occurs the simple equation: produce=profit+wages; as well as the 'plain result', that as long as produce is fixed, 'if wages rise profits must fall' (p. 269). Jevons argued, however, that this supposition is unfounded; the inverse profit-wage theory 'overlooks the fact that the amount received by the employer is unfixed, depending, as we have seen, both on the amount of goods produced and on the price at which the goods can be sold. Even assuming that the former factor cannot be raised, it may be open to the producer to raise the price of his goods, and thus recoup himself for increased payments of wages. Whether he can or cannot do so depends on the state of the market, and especially upon the question whether other producers are under like circumstances' (*SRL,* p. 97).

If wages were fixed (as in 'Ricardo's natural rate of wages') then Jevons grants that 'something might perhaps be made of this doctrine' (*TPE,* p. 269). However, since it is 'utterly impossible' to 'define exactly what are the necessaries of life', and since 'we have to account for the very different rates [of wages] which prevail in different trades', he vehemently rejects the notion of fixed, subsistence wages (p. 269). Instead, he argued, it is *'the wages of a working man [that] are ultimately coincident with what he produces, after the deduction of rent, taxes, and the interest of capital'*; the quantity of the produce is variable in the equation, produce = profit+wages, and profit is determined first according to Jevons's theory of interest (with some adjustment for wages of superintendence and insurance against risk) (p. 270). Then, 'in the long run, and on the average of any one branch of employment' (p. 270), wages are determined by the equation after profits are subtracted from the produce.

But the fact that capitalization, as Jevons put it, enables time-consuming production to take place, introduces 'complexity into the problem' (*TPE,* p. 270), and implies that, in practice, a temporary wage fund is created. In Jevons's account, this process involved 'the temporary application of the wage-fund', since it is the 'proper function of capitalists to sustain labour before the result is accomplished' (p. 271). Entrepreneurs form estimates of the expected produce, and form contractual obligations with labourers in anticipation of producing the final product. Then, if the value of the produce exceeds anticipations, 'those who are first in the field make large profits', which in turn 'soon induces competition' among capitalists. Competition for labour raises wages, so that

> the workmen reap the whole excess of produce, unless indeed the price of the produce has fallen, and the public, as consumers, have the benefit. Whether this latter result will follow or not depends upon the number of labourers who are fitted for the work. Where much skill and education is required, extensive competition will be impossible, and a permanently high rate of wages will exist. But if only common labour is requisite, the price of goods cannot be maintained, wages will fall, to their former point, and the public will gain the advantage of cheaper supplies.
>
> (*TPE,* p. 271)

Consequently, the wage fund operates 'in a wholly temporary manner. Every labourer ultimately receives the due value of his produce after paying a proper fraction to the capitalist for the remuneration of abstinence and risk' (p. 273).[63]

Significantly, in Jevons's view, this theory of distribution provided the rationale for an end to the conflict between labour and capital, which was ultimately misguided, mistaken, and wasteful. If labourers received their 'due' rewards through the smooth uninterrupted functioning of competitive markets, disruptions (such as strikes) could only serve needlessly to waste resources.[64] We will see below (Chapter 8) that this argument would underlie Jevons's recommendation in favour of co-operation, as well as his strictures against trade unions' attempts to raise wages.

Part III

ECONOMIC POLICY

7
JEVONS AND UTILITARIANISM

INTRODUCTION

A major theme of Chapters 1, 4, 5 and 6 has been that Jevons's *Theory of Political Economy* emphasized utility as the primary object of economic investigations. As a consequence, his analysis led to new economic problems to be investigated subsequently—problems focusing on the nature, measurability and maximization of utility. While his new way of 'doing economics' carried with it few subsequent implications for specific policy recommendations, it did lead quite readily to the investigation of 'Social Welfare'—aggregate utility—which has, as yet, to be fully resolved either theoretically or empirically.[1]

Many of the contemporary debates concerning the nature and constituents of the 'social good', as well as the measurability of utility and the relationships among individual good, preferences, and Social Welfare, have historical precedents in nineteenth-century policy analysis. J.S.Mill and Jevons both struggled with the issue of defining and measuring the 'greatest good'. Mill was ambivalent about equating welfare with preference fulfilment.[2] Jevons, by contrast, took a step towards the approach of modern welfare economists by opposing Mill in this regard, and identifying welfare with choices made. Both Mill and Jevons explicitly considered 'liberty' (carefully defined) as a constituent of the social, as well as individual, good. While Welfare, for Mill, was measurable in principle, he was stopped by the difficulty of reconciling different pleasures into one whole, 'Pleasure'. Jevons was intensely critical of Mill's allowance that pleasures differed qualitatively as well as quantitatively; he attempted to overcome the measurement problem by allowing that pleasures differ only in their (quantifiable) characteristics. But he was unable to define a means of measuring these characteristics, and ultimately also stopped short of attempting to measure Social Happiness.

The precise nature of Jevons's utilitarianism as a guiding rule for economic policy has been neglected (Black 1972a), and that will be a second main concern of this chapter.[3] In terms of presumptive guidelines for economic policy there was a remarkable degree of common ground between Jevons and Mill, a matter formally recognized by Jevons himself. Jevons's policy writings, like those of Mill, must be understood in the context of a wide-ranging programme for social reform. They shared an intense desire to correct perceived social and economic injustices, as well as a common method of weighing predicted benefits and costs in the light of their overall goal of social reform. These goals largely coincided. For both, the primary welfare problem was what Jevons termed the 'deep and almost hopeless poverty in the mass of people', a problem which was to be corrected by a variety of policies designed to encourage self-improvement on the part of labourers.[4] 'Improvement' encompassed the achievement of intellectual, moral and economic independence; intervention was justified if it forwarded this goal, providing always that the (expected) costs of intervention did not outweigh the (expected) benefits of improvement.

BENTHAM, J.S.MILL AND UTILITY

As Wesley Mitchell has noted, what distinguished Jeremy Bentham's work was not the idea of utilitarianism per se—the 'greatest good of the greatest number'—but rather the argument that net pleasures might be measured via the 'felicific calculus' (1918, p. 163). In a passage that Jevons would return to close to one hundred years later, Bentham described how these measurements might proceed:

> To a person considered *by himself,* the value of a pleasure or pain considered *by itself,* will be greater or less, according to the four following circumstances:
>
> 1. Its *intensity*
> 2. Its *duration*
> 3. Its *certainty*…
> 4. Its *propinquity*
>
> But when the value of any pleasure or pain is considered for the purpose of estimating the tendency of any *act* by which it is produced, there are two other circumstances to be taken into the account; these are,
>
> 5. Its *fecundity*…
> 6. Its *purity*… [When a community is considered, it is also necessary to take account of]
> 7. Its *extent;* that is, the number of persons to whom it *extends*.
>
> (Bentham 1952–54, pp. 435–36)

In principle, the calculation was to proceed as follows. Intensity was to be measured in units of the 'faintest sensation that can be distinguished'.[5] Units of intensity are multiplied by the duration units, and then by fractions expressing certainty and proximity. If additional pleasures (fecundity) or pains (purity), are produced by an act, these are measured in the same way, and added to the measure of direct pleasure. The measurement is completed by multiplying the result by the number of individuals affected (Mitchell 1918, p. 165).

Bentham realized that this last step required a simplification that was generally unwarranted, because not all individuals are alike in their capacities for enjoying pleasures and pains. Health, strength, firmness of mind, occupations, income, sex, age, rank, education, climate, lineage, government, religious status, and other 'circumstances', all influenced the individual's 'sensibility' to experience and register pleasures and pains (Bentham 1952–54, Vol. iii). Indeed he acknowledged that measurement of Social Utility was approximate at best:

> 'Tis in vain to talk of adding quantities which after the addition will continue distinct as they were before, one man's happiness will never be another man's happiness: a gain to one man is no gain to another: you might as well pretend to add twenty apples to twenty pears…. This addibility of the happiness of different subjects, however, when considered rigorously it may appear fictitious, is a postulatum without the allowance of which all political reasoning is at a stand: nor is it more fictitious than that of the equality of chances to reality, on which that whole branch of the Mathematics which is called the doctrine of chances is established.
>
> (cited in Halévy 1928, p. 495)

Thus, while there was no way to measure Social Welfare or Happiness precisely, expediency required some attempt at approximate weighing of the net balance.

The contribution of J.S.Mill

For J.S.Mill, like Bentham, the unifying principle of public policy was 'the greatest good of the greatest number'. He was, however, much concerned with the precise nature of the general rule, in particular, with 'what things [Utilitarianism] includes in the ideas of pain and pleasure' (*CW,* **x,** p. 210). Two problems emerged. First, whom to include in the maximand—a question which, as the quotation below reveals, he answered on pragmatic grounds to include all living persons, thereby eliminating (in contrast with Jevons) considerations of intergenerational utility transfers. Second, and more complex for Mill, is how to define individual, let alone social, 'happiness'. Here, in one of his strongest reactions against Bentham, Mill distinguished between an individual's 'happiness', and 'good': '"The greatest happiness of the greatest number" is to be our invariable guide! Is it so?—the greatest happiness of men living, I suppose, not of men to come; for if of all posterity, what legislator can be our guide? Who can prejudge the future? Of men living then?—well—how often would *their* greatest happiness consist in concession to their greatest errors' (*CW,* **x,** pp. 501–502).[7]

Mill reformulated the utilitarian goal, rejecting what he perceived to be Bentham's excessively narrow definition of utility (cf. *CW,* i, pp. 99–100).[8] Because he stressed man's spiritual nature, Mill argued that material gain is not the ultimate goal for society. A moral tone, and a wide notion of 'improvement' were therefore integrated into the utilitarian goal; 'utility', he maintained, constitutes 'the ultimate source of moral obligations' (**x**, p. 226). This perspective had major implications for economic policy, which at the least, he argued, was to suit, and at best might improve, the moral character of the public.[9] Consequently, Mill questioned the effectiveness of institutional reforms which did not aim at moral improvement and would consequently not achieve lasting effects.[10]

In 'Utilitarianism', Mill insisted that 'equal amounts of happiness are equally desirable, whether felt by the same or by different persons'.[11] He championed 'impartiality' and 'equality'—'exalted' both 'popularly' as well as by the 'enlightened'—not as a corollary of Utilitarianism, but instead as 'involved in the very meaning of Utility': a principle that is 'a mere form of words without rational signification, unless one person's happiness, supposed equal in degree (with the proper allowance made for kind), is counted for exactly as much as another's' (*CW,* **x,** p. 257). Each has 'an equal claim to all the means of happiness', although that right is qualified: 'except in so far as the inevitable conditions of human life and the general interest, in which that of every individual is included, set limits to the maxim' (p. 258).

The greatest happiness notion remained problematic nonetheless, since the amount of happiness (of the same kind) was not directly measurable, as Mill's choice of verb above ('supposed') reveals. An 'anterior principle' of Utilitarianism, it is allowed, is 'that the truths of arithmetic are applicable to the valuation of happiness, as of all other measurable quantities' (**x**, p. 258, Note 62). Yet the only measure of quantity, Mill argued, consisted of the verdict of those who had experienced different quantities of pleasurable sensations:

> What means are there of determining which is the acutest of two pains, or the intensest of two pleasurable sensations, except the general suffrage of those who are familiar with both? Neither pains nor pleasures are homogeneous, and pain is always heterogeneous with pleasure. What is there to decide whether a particular pleasure is worth purchasing at the cost of a particular pain, except the feelings and judgment of the experienced?
>
> (*CW,* **x**, p. 213)

The evaluation as to whether a particular degree of a specific kind of pleasure warranted the associated painful cost of acquisition could be reliably made only by those who had experienced both the pleasure and the pain. Unlike recent contemporary procedures to measure utility (pp. 167–68), Mill maintained that individuals differed in their capacity for feeling (see *CW,* **viii,** pp. 856f; DeMarchi 1972), so that this exercise involved some very real difficulties.

Even more serious, Mill maintained that pleasures differed in kind as well as amount; but he was never able to provide a clear-cut means of either measuring total pleasure, or, indeed, ranking types of pleasures. Thus, he argued that 'It is quite compatible with the principle of utility to recognise the fact, that some *kinds* of pleasure are more desirable and more valuable than others' (*CW,* **x**, p. 211).[12] Given his 'anterior principle' noted above, 'qualitatively' and 'quantitatively' different pleasures might, somehow, be combined into 'total pleasure', or 'social utility'. But the means of this reconciliation was unsatisfactory and elicited harsh criticism from Jevons, since it entailed a potential loss of individual sovereignty. The moralist like Mill who attempts to promote improvement, might not accept that pleasures which attract more people are those which should be ranked more highly than ones which attract fewer people[13]. Mill maintained that popular pleasures were not necessarily to be ranked above less popular ones, and sought an alternative means of ranking pleasures. He suggested instead that 'those who are competently acquainted' with two pleasures might pronounce judgment on their relative merits:

> If I am asked, what I mean by difference of quality in pleasures, or what makes one pleasure more valuable than another, merely as a pleasure, except its being greater in amount, there is but one possible answer. Of two pleasures, if there be one to which all or almost all who have experience of both give a decided preference, irrespective of any feeling of moral obligation to prefer it, that is the more desirable pleasure. If one of the two is, by those who are competently acquainted with both, placed so far above the other that they prefer it, even though knowing it to be attended with a greater amount of discontent, and would not resign it for any quantity of the other pleasure which their nature is capable of,[14] we are justified in ascribing to the preferred enjoyment a superiority in quality, so far outweighing quantity as to render it, in comparison, of small account.
>
> (*CW,* **x**, p. 211)[15]

As a last resort, apparently, Mill relied upon the evaluation of 'competent judges' who were to perform the difficult task of 'valuing' the quality of pleasures. Yet he travelled some distance towards equating 'quality' with 'quantity' differences: intellectual pleasure is preferred to physical pleasure because it leads to additional future pleasure, and it is less frequently associated with pain, thus entailing, on the whole, a larger quantity of pleasure.[16] He maintained, also, that constancy of pleasure is to be preferred over intensity, and that active pleasures are preferred to passive pleasures (although we must bear in mind that intellectual pleasures are seen as mentally active). Here the suggestion is that intense pleasure is—by its nature—fleeting, and thus compares poorly with less intense but longer lasting pleasure. It is in this context that we must understand Mill's warning that individuals should not expect 'more from life than it is capable of bestowing', meaning that one should not expect to achieve a life filled with intense pleasure:[17]

> If by happiness be meant a continuity of highly pleasurable excitement, it is evident enough that this is impossible. A state of exalted pleasure lasts only moments, or in some cases, and with some intermissions, hours or days, and is the occasional brilliant flash of enjoyment, not its permanent and steady flame. Of this the philosophers who have taught that happiness is the end of life were as fully aware as those who taunt them. The happiness which they meant was not a life of rapture; but moments of such, in an existence made up of few and transitory pains, many and various pleasures, with a decided predominance of the active over the passive, and having as the foundation of the whole, not to expect more from life than it is capable of bestowing.
>
> (*CW,* **x**, p. 215)

The alleviation of poverty is not, however, expecting too much from life and constitutes a key element in the 'happy' life for individuals, and for social happiness: 'Poverty, in any sense implying suffering, may be completely extinguished by the wisdom of society, combined with the good sense and providence of individuals' (*CW,* **x**, p. 216). Education was regarded as a key means to alleviating poverty. Somewhat naively, Mill believed that education might also 'indefinitely' reduce disease: 'Even that most intractable of enemies, disease, may be indefinitely reduced in dimensions by good physical and moral education, and proper control of noxious influences; while the progress of science holds out a promise for the future of still more direct conquests over this detestable foe' (p. 216).[18] The 'present wretched education, and wretched social arrangements', he concluded, are the 'only real hindrance' to achieving social utility and progress (p. 215).

Since the moral, economic and intellectual independence of each is integral to 'happiness', Mill emphasized 'liberty' as an additional component in the utilitarian goal. This is a carefully specified liberty, pertaining to 'self-regarding' actions ('liberty of thought and feeling'; 'liberty of tastes and pursuits'; and the liberty 'of combination among individuals'), and it is regarded as a human need, requisite to attaining happiness: 'Where, not the person's own character, but the traditions or customs of other people are the rule of conduct, there is wanting one of the principal ingredients of human happiness, and quite the chief ingredient of individual and social progress' (*CW,* **xviii,** p. 261; cf. p. 264).

As a result, significantly, so-called progress cannot be imposed on individuals; the effectiveness of institutional reforms is limited by the ability of individuals to understand and to embrace reform measures. Mill stressed that specific reforms should be encouraged, but voluntary,[19] and preferred local to central control of reforms on the grounds that this preserved liberty; his praise for the Poor Law ran along precisely these lines.[20] Further, diversity, reflecting the liberty to formulate and to question one's beliefs and habits, was not to be eroded by the oppression of public opinion but was instead to be actively encouraged:

> It is not by wearing down into uniformity all that is individual in themselves, but by cultivating it and calling it forth, within the limits imposed by the rights and interests of others, that human beings become a noble and beautiful object of contemplation; and as the works partake the character of those who do them, by the same process human life also becomes rich, diversified, and animating, furnishing more abundant aliment to high thoughts and elevating feelings, and strengthening the tie which binds every individual to the race, by making the race infinitely better worth belonging to.
>
> (*CW,* **xviii,** p. 266)

In instances of 'social acts', however, intervention was admissible, and here a weighing of the net benefits was required, taking into account the predicted influence of intervention on liberty (*CW,* **xviii,** p. 293; cf. **iii,** pp. 803–804).[21] Each case required examination to determine whether intervention was warranted; if unimpeded action led to undesirable results, this behaviour might be restricted on utilitarian grounds. Laws preventing fraud, and sanitary and safety regulations were justified on this basis **(xviii,** pp. 293–94).[22]

Throughout, Mill's programme for social reform is designed to encourage self-reliance among labourers.[23] The distribution of rewards to labour in nineteenth-century Britain, 'almost in an inverse ratio to the labour', was viewed as an impediment to the acquisition of independence among the labouring classes (*CW,* **ii,** p. 207; cf. 'The Claims of Labour', **iv,** p. 385; **v,** p. 444). Education, understood in the widest sense of 'whatever acts upon the minds of the labouring classes'—including 'the whole of their social circumstances'—constituted a 'most obvious remedy' to the plight of the labouring poor (**iv,** p. 376; cf. pp. 377f).[24] The attainment of high general wages should 'be welcomed and rejoiced at' **(iii,** 929; cf. p. 930). Most importantly, 'the right of making the attempt' to raise wages by trade unions was a matter of justice, and not to be denied. In short, 'the improvement and elevation of the working classes' through 'the liberty of association' was championed (p. 903).[25] As a preferable means of improvement, however, Mill favoured co-operation, on the grounds that co-operative arrangements would encourage the achievement of independence among the labouring classes.[26]

In summary, Mill's utilitarian standard entailed allowance for qualitative and quantitative differences in pleasures, while equal amounts of equally ranked pleasures were to count equally for all. Measurement of Social Utility was nonetheless difficult, and he maintained that those who had wide experience with pleasures might pronounce judgement on the most 'desirable' pleasures, from the perspective of society. His own vision of Social Happiness entailed a prominent role for liberty, which presupposed improved material well-being and the acquisition of self-reliant behaviour among the labouring classes. Undoubtedly he was overly optimistic in this regard, arguing that ‘no one whose opinion deserves a moment’s consideration can doubt that most of the great positive evils of the world are in themselves removable, and will, if human affairs continue to improve, be in the end reduced within narrow limits’ (*CW,* **x,** p. 216). By way of contrast, as we shall see below, Jevons argued that qualitative differences in pleasures could be reduced to quantities of (Benthamite) characteristics of pure pleasure. While his own vision of Social Utility—and thus his general policy guidelines—remained similar to those of Mill, Jevons was somewhat less willing to trust that reform could substantially alter the character of the labouring classes and thereby achieve lasting improvement.

JEVONS'S DENIAL OF MILL'S STANDARD

In his review of Mill’s ‘Utilitarianism’ Jevons charged that ‘Mill was intellectually unfitted to decide what was utilitarian and what was not’ (1879, p. 523).[27] In fact, ‘In removing the obstacles to the reception of his favourite doctrine he removed its landmarks too, and confused everything’ (p. 523). The crux of the matter was this: ‘Do pleasures differ in quality as well as in quantity?’ (p. 525). Are there ‘elevated’ pleasures which can outweigh large amounts of ‘low quality’ pleasures? This question was complicated by the fact that people’s estimation of pleasures must differ, there being no evident way to make interpersonal comparisons: ‘The tippler may esteem two pints of beer doubly as much as one; the hero may feel double satisfaction in saving two lives instead of one; but who shall weigh the pleasure of a pint of beer against the pleasure of saving a fellow-creature’s life’ (p. 526).[28]

Jevons sided with Bentham and opposed Mill in this matter. He contended that all types of pleasure might be reduced to quantities of:

1 *intensity;*
2 *duration;*
3 *certainty* or *uncertainty;*
4 *propinquity* or *remoteness;*
5 *fecundity* (the ‘chance that [pleasure] has of being followed by sensations of the same kind’;
6 *purity* (‘the chance it has of *not* being followed by sensations of the *opposite* kind’);
7 *extent* (to other people).[29]

‘In all that Bentham says about pleasure and pain’, Jevons argued, ‘there is not a word about the intrinsic superiority of one pleasure to another. He advocates our seeking *pure* pleasures; but with him a pure pleasure was clearly defined as one not likely to be followed by feelings of the opposite kind’ (1879, p. 527). An impure pleasure such as 'opium-eating', by contrast, leads to the pain ('evil consequence') of ill health. Jevons maintained that 'the ledger and the balance-sheet' should be sufficient to measure 'pleasure': 'all feelings were reduced to the same denomination of value, and whenever we indulge in a little enjoyment, or endure a pain, the consequences in regard to subsequent enjoyment or suffering are to be inexorably scored for or against us, as the case may be. Our conduct must be judged wise or foolish according as, in the long-run, we find a favourable "hedonic" balance-sheet' (p. 527).

Like Bentham, Jevons allowed, Mill regards 'pleasure' as 'the ultimate purpose of existence' (1879, p. 528), a pleasure that is distinct from 'Egoism' *because* it is an aggregate: 'the happiness of the race, is, of course, made up of the happiness of its units, so that unless most of the individuals pursue a course ensuring happiness, the race cannot be happy in the aggregate' (p. 529).[30] Thus, the distribution of happiness matters: the utilitarian social welfare function would be mistakenly represented by the sum of individual utilities in the form $W=u_1+u_2+\cdots+u_n$.[31]

To achieve happiness, the individual must 'select that line of conduct which is likely to—that is, will in the majority of cases—bring happiness'.[32] It is here that he begins to part company with Mill who, according to Jevons, erred when he argued that there are higher and lower feelings:

> Then Mill proceeds to point out, with all the persuasiveness of his best style, that there are higher feelings which we would not sacrifice for any quantity of a lower feeling. Few human creatures, he holds, would consent to be changed into any of the lower animals for a promise of the fullest allowance of a beast's pleasures; no intelligent human being would consent to be a fool, no instructed person would be an ignoramus, no person of feeling and conscience would be selfish and base, and so forth…. Mill overflows with genial and noble aspirations; he hardly deigns to count the lower pleasures as worth putting in the scale; it is better, he thinks, to be a human being dissatisfied than a pig satisfied; better to be Socrates dissatisfied than a fool satisfied. If the pig or the fool is of a different opinion, it is because they only know their own side of the question. The other party to the comparison knows both sides.
>
> (1879, p. 528)

Jevons objected on a number of grounds to Mill's characterization of the constituents of 'happiness'. First, he recoiled at Mill's description of the 'good life', suggesting that, on a close reading of Mill's recommendations for achieving happiness (p. 142), the best thing for an individual to do would be to 'aim at moderate achievements in life' and altogether to forgo 'higher aspirations' (1879, pp. 529, 530).

Just as strongly, Jevons reacted against Mill's implicit suggestion, alluded to in the quotation above, that individuals are not always the best judge of their own interests and, as a consequence, that individuals are not always best able to achieve 'happiness'. Here Jevons referred to Mill's admission that 'men often do, *from infirmity of character,* make their selection for the nearer good, though they know it to be the less valuable. Many who begin with youthful enthusiasm for everything noble, sink in later years into indolence and selfishness' (1879, p. 531). If that were really the case, Jevons argued, then on Mill's own terms, this constitutes evidence that the baser pleasure should be ranked ahead of the noble pleasure: 'If such men, with few exceptions, decide eventually in favour of the lower life, they are parties who *do* know both sides of the comparison, and deliberately choose not to be Socrates, with the prospect of the very imperfect happiness (probably involving short rations) which is incident to the life of Socrates' (p. 531). Indeed, Mill's insistence in the face of conflicting evidence—many individuals reverting from so-called higher to lower pleasures—that the life of Socrates entailed a 'higher' pleasure, rankled with Jevons:

> Although, then, millions and millions are continually deciding against Socrates' life, for one reason or another (and many in all ages who make the ineffectual attempt at a combination break down), Mill gratuitously assumes that they are none of them competent witnesses, because they must have lost their higher feelings before they could have descended to the lower level; then the comparatively few who do choose the higher life and succeed in attaining it are adduced as giving a large majority, or even a unanimous vote in favour of their own choice. I submit that this is a fallacy probably best classed as a *petitio principii;* Mill entirely begs the question when he assumes that every witness against him is an incapacitated witness, because he must have lost his capacity for the nobler feelings before he could have decided in favour of the lower.
>
> (1879, p. 532)

Jevons concluded that Mill's call for competent judges amounted to a verdict 'in favour of his high quality pleasures' by 'a packed jury', a verdict comparable to that 'given by vegetarians in favour of a vegetable diet' (p. 532).[33]

But Jevons himself insisted that 'I am not denying the moral superiority of some pleasures and courses of life over others' (1879, p. 532). Instead, his objection was to 'Mill's attempt to reconcile his ideas on the subject with the Utilitarian theory' which, he concluded, 'hopelessly fails' (p. 532). Mill failed in this attempt, Jevons argued, because he departed from the Benthamite argument that pleasures differed only in quantifiable characteristics of pleasure itself. In opposition to Mill, Jevons maintained that the difference between 'high' and 'low' pleasures might be analysed in terms of the (quantifiable) Benthamite characteristics of intensity, length, certainty, fruitfulness, and purity; and 'when we take Altruism into account, the feelings must be of wide extent—that is, fruitful of pleasure and devoid of evil to great numbers of people' (p. 533).[34] The Social Happiness created by various government policies could be quantified and compared, in order then to reveal which contributed most to overall happiness. Thus 'after the model of inquiry given by Bentham, [we may] resolve into its elements the effect of one action and the other upon the happiness of the community':

> It is a higher pleasure to build a Free Library than to establish a new Race Course; not because there is a *Free-Library-building emotion,* which is essentially better than a *Race-Course-establishing emotion,* each being a simple unanalyzable feeling; but because we may, after the model of inquiry given by Bentham, resolve into its elements the effect of one action and the other upon the happiness of the community.
>
> (1879, p. 533)

Jevons's philosophical objections to Mill's 'Utilitarianism' centred on what might, broadly speaking, be termed measurement issues.[35] By allowing that pleasures differed qualitatively Mill created a seemingly intractable measurement problem: how was one to measure Happiness if it consisted of the weighted sum of qualitatively different pleasures? How was one, indeed, to determine these weights, and how to combine weighted sums of qualitatively different pleasures? Since Mill was reform-minded, he has a firm subjective notion of 'higher' and 'lower' pleasures. As an individualist reformer, he was loath to give up sovereign choice as the means to maximize pleasure. He did, however, come close to this in the suggestion that 'competent judges' might rank higher and lower pleasures. Jevons strongly opposed the recommendation, insisted on the sovereignty of individual choices, and maintained that pleasures differed only quantitatively (i.e. in their attributes).

Not surprisingly, however, Jevons was unable fully to overcome the measurement problem himself. It is by no means clear how to rank any two policies until a means of measuring 'intensity', 'fruitfulness', etc. for each person affected by the policy has been devised, and then a weighting scheme has been designed and justified for total pleasure, the (weighted) sum of each type of pleasure (summed across all individuals).[36] Without having measured the pleasure associated with various attributes, Jevons concluded that some pleasure attributes (such as length) contributed more to Social Utility than others (such as intensity).[37] Policies that might be expected to promote these more worthwhile characteristics, were, in his estimation, better than policies which did not. He suggested, for instance, that the construction of a library, which entails lasting pleasure, results in 'a higher pleasure' than the establishment of a race course that creates intense, short-lived pleasure (1879, p. 533). Despite his objections to the subjective nature of Mill's pleasure ranking (to the 'packed jury'), Jevons did not escape this problem; his Utilitarianism was intimately bound up with subjective judgements concerning the general development of society and the amelioration of working class conditions. Here, he followed closely in the reformist tradition of Mill.

PRESUMPTIVE GUIDELINES FOR ECONOMIC POLICY[38]

Can we, notwithstanding, infer anything more precise about how Jevons proposed to measure 'Happiness'? On balance, although he was cautious in this regard, he did take a step towards the 'cardinalist' approach outlined above (Note 1). He sometimes insisted that individual utility, *even in its narrowest, strictly economic sense,* was not measurable.[39] He did, however, maintain that individual utility might be measured indirectly, from its effects (although he recognized that individuals differed in their evaluation of pleasures, and that interpersonal comparisons are not possible). At the same time, Social Utility, entailing broader concerns than individual actions in the marketplace, is said to involve a (subjective) weighing of a wide range of pleasures and pains. Here, Jevons called for intertemporal and interpersonal weighing of the balance of utility.

In the *Theory of Political Economy* Jevons acknowledged that measuring pleasure and pain was no simple matter, since 'A unit of pleasure or of pain is difficult even to conceive' (p. 11). As we have seen (Chapter 5), however, for the purposes of his theory of exchange the measurement problem could be avoided; Jevons proposed an indirect measure of these feelings: *'it is from the quantitative effects of the feelings that we must estimate their comparative amounts'*.[40] In correspondence with J.E.Cairnes, Jevons reiterated that the only feasible means of measuring utility consisted of using prices:

> The fundamental objection which you make to my theory of exchange is that I defined value by utility and then propose to use prices to measure the variation of utility.[41] This seems a *vicious circle*—but I do not think you will find it to be so really, and the method seems to me exactly analogous to that employed in other theoretical subjects such as that of light, heat, electricity, &c…. there is no means of measuring pleasure & pain directly, but as those feelings govern sales and purchases, the prices of the market are those facts from which one may argue back to the intensity of the pleasures concerned.
>
> (14 January 1872, *P&C,* **iii,** p. 246)[42]

Notwithstanding, Jevons maintained that no attempt was or could be made to measure total utility, or to measure one total pleasure relative to another. Further, interpersonal comparisons of utility were ruled out in this context: 'I see no means by which such comparison can be accomplished…. Every mind is thus inscrutable to every other mind, and no common denominator of feeling seems to be possible' (*TPE,* p. 14; see Chapter 4). It is this conclusion, cited by Lionel Robbins in his 1981 Richard Ely Address to the American Economics Association, that yields the 'fundamental implication' in economics that 'all recommendations of policy involve judgments of value' (1981, pp. xxi, xxiv).

Finally, Jevons insisted in his *TPE* that in the evaluation of policy, when one must consider how 'to employ that wealth for the good of others as well as himself ', a 'higher calculus of right and wrong' was required:

> It is the lowest rank of feelings which we here treat. The calculus of utility aims at supplying the ordinary wants of man at the least cost of labour…. A higher calculus of moral right and wrong would be needed to show how he may best employ that wealth for the good of others as well as himself.
>
> (*TPE,* p. 27)[43]

Insistence upon a broad perspective for this 'higher calculus' emerges when Jevons turned specifically to policy analysis. In *The State in Relation to Labour* he suggested that policy-makers who sought general happiness must consider not only 'economic' but also 'moral', 'sanitary' and 'political' probabilities associated with any policy (*SRL,* p. 30). Further, interpersonal comparisons of utility (not only at a point in time, but also through time) were now explicitly called for, this being the 'outcome' of utilitarian doctrine: 'It is not sufficient to show by direct experiment or other incontestable evidence that an addition of happiness is made. We must also assure ourselves that there is no equivalent or greater subtraction of happiness,—a subtraction which may take effect either as regards other people or subsequent times' (*SRL,* p. 28).

Did Jevons's actual policy guidelines differ from those of Mill? Only slightly. For Jevons, like Mill, Utilitarianism involved the alleviation of poverty, including its consequences, 'vice' and 'ignorance'. In *The Coal Question* he referred to 'the poverty' and 'ignorance, improvidence, and brutish drunkenness of our lower working classes' which he linked to rapid population growth in the face of stagnating demand for agricultural labour, and which was to be corrected by a system of general education (*TCQ,* pp. xlvii-xlviii). His 1870 'Opening Address' to the British Association for the Advancement of Science decried the results of overpopulation, the 'deep and almost hopeless poverty in the mass of the people', and advocated policies which would enable the labourer to become self-sufficient (*MSR,* pp. 196, 197). In 1878, Jevons called for wide-ranging social reform to eliminate 'the citadel of poverty and ignorance and vice' and to secure 'the ultimate victory of morality and culture' ('Amusements of the People', *MSR,* p. 2).

Since for Jevons as well as Mill 'happiness mainly consists in unimpeded and successful energising', liberty constituted a second major component of the utilitarian goal, being envisaged as both a basic requisite to happiness, and the means to achieving it (*SRL,* p. 13; cf. p. 5). At the same time, man is a social being, and consequently the 'mere fact of society existing obliges us to admit the necessity of laws, not designed, indeed, to limit the freedom of any one person, except so far as this limitation tends on the whole to the greater average freedom of all' (p. 14). Here, interpersonal trade-offs were the norm; yet since liberty ranked highly as a pleasure, Jevons was inclined to argue that 'a heavy burden of proof was required in order to show that a liberty-reducing intervention is warranted. Although there is 'on the whole, a certain considerable probability that individuals will find out for themselves the best paths in life' (*MSR,* p. 176), if evidence reveals exceptional cases to the contrary, intervention is justified.[44] As we will see below (pp. 157–58), these exceptional cases entailed situations where individuals acting in the absence of intervention were unable to verify the quality of goods or services, or where unimpeded actions by some individuals were seen to harm the welfare of other family members. The principle of free trade also rested on this basis: 'it is a probability of advantage which, however, must be set aside in case of greater probability of evil' (*SRL, p.* 17).

Like Mill also, Jevons was characteristically reform-minded: 'no social transformation would be too great to be commended and attempted', provided that 'it could be clearly shown to lead to the greater happiness of the community' (*SRL,* p. 11). On utilitarian grounds 'the State is justified in passing any law, or even in doing any single act which without ulterior consequences, adds to the sum total of happiness. Good done is sufficient justification of any act, in the absence of evidence that equal or greater evil will subsequently follow' (p. 12). Such reforms, however, might require a generation before any real improvements would be forthcoming. Furthermore, if piecemeal reforms were instituted while 'important causes of social mischief ' were left unremedied, attempts at improvement would be neutralized ('Amusements of the People' [1878], *MSR,* p. 2). Again, interpersonal and intertemporal weighing of the net balance was required in each specific instance, this being 'the outcome of the Benthamist doctrine' (*SRL,* p. 17). While he recognized that a policy such as a tax on matches would impose hardship upon labourers in the industry as a result of a fall in demand for their product, for instance, Jevons stressed the short-run nature of this hardship, and concluded (in what is very likely his most dogmatic utilitarian justification of policy) that 'It is the law of nature and the law of society that the few must yield to the good of the many' (a reference to those citizens outside the industry who benefit from the imposition of a sound tax), 'provided that there is a clear and very considerable balance of advantage to the whole community' (*The Match Tax: A Problem in Finance* [1871], *PE,* p. 221).

For the most part, however, Jevons's approach to legislation was cautious, and appreciative of the fact that policy must take public opinion into account: The Government cannot always engage to teach people what is best for them' (*PE,* p. 223). In 1880 he stressed the limitations which popular opinion placed on policy-makers, so that while Parliament might 'to a certain extent, guide, or at any rate restrain, the conduct of its subjects', its 'powers' were 'very limited' ('Experimental Legislation and the Drink Traffic', *MSR,* p. 261; cf. p. 256; *SRL,* p. 20):

> legislators ought, in many branches of legislation, to adopt confessedly this tentative procedure, which is the very method of social growth. Parliament must give up the pretension that it can enact the creation of certain social

> institutions to be carried on as specified in the 'hereinafter contained' clauses. No doubt, by aid of an elaborate machinery of administration and a powerful body of police, Government can, to a certain extent, guide, or at any rate restrain, the conduct of its subjects. Even in this respect its powers are very limited, and a law which does not command the consent of the body of the people must soon be repealed or become inoperative.
>
> (*MSR,* p. 261)

On balance, Jevons emerges as somewhat more cautious than Mill, of whom he was critical in his review of 'Utilitarianism' for overestimating the malleability of human nature: 'The fact is that the whole tone of Mill's moral and political writings is totally opposed to the teaching of Darwin and Spencer, Tylor and Maine. Mill's idea of human nature was that we came into the world like lumps of soft clay, to be shaped by the accidents of life, or the care of those who educate us' (1879, p. 536).[45] In opposition to the 'lumps of clay' conception of humanity, Jevons maintained that 'Human nature is one of the last things which can be called "pliable". Granite rocks can be more easily moulded than the poor savages that hide among them. We are all of us full of deep springs of unconquerable character, which education may in some degree soften or develop, but can neither create nor destroy. The mind can be shaped about as much as the body; it may be starved into feebleness, or fed and exercised into vigour and fullness; but we start always with inherent hereditary powers of growth' (p. 536).[46]

JEVONS'S DEBT TO MILL

Despite the difference outlined above regarding the nature and measurability of 'Pleasure' (pp. 144–47), and the malleability of human nature (pp. 151–52), a remarkable similarity exists concerning the roles of liberty and self-reliance in Mill and Jevons, as well as the specific policies recommended by them. Jevons appreciated this commonality with Mill.

Jevons's earliest remarks concerning the theory of public policy reveal a deep appreciation for Mill's notion of liberty. In 1866 he wrote, 'For my part I wish to see cherished and developed in England such liberalism as Mr.Mill has deliberately described in his brief but great essay on liberty' (to the *Manchester Examiner and Times,* 22 October; *P&C,* **iii,** p. 132). His lecture delivered at Owens College the same year, on 'The Importance of Diffusing a Knowledge of Political Economy', reiterated that 'By liberty I do not mean merely what is vulgarly regarded as liberty by many, the privilege to vote for a representative in Parliament. I mean what Mr.Mill upholds as true liberty, in that noble essay which is perhaps the best of his great works' (*P&C,* **vii,** p. 42).

Jevons also recognized Mill's precedence regarding the criteria for the provision of public services.[47] In the 1875 Lectures this is said to involve in each case 'Mill's result', a comparison of relative public and private advantages.

Jevons reiterated Mill's distinction between 'necessary and optional' functions of government, the latter being provided when 'the public utility of these things is exceedingly obvious and when it is plain that they can be more cheaply and effectively done by a single agency'. In short,

> The truth on this subject I should say is that there is no general principle, except that of adding up the comparative advantages in each particular case, i.e. you must make the best observation you can of the results of experiments one way or the other.
>
> The Manchester Omnibus Company ought to be in the hands of the local government.
>
> What I have stated is Mill's result.
>
> (*P&C,* **vi**, p. 133)

In 1882 Jevons cited Mill's remarks from the *PPE* in a passage which is enlightening, since it reveals agreement with Mill's recommendations that labourers recognize their common interests, and also a common concern about the population issue:

> J.S.Mill, after expressing some opinions in which I cannot coincide,[48] has added the following striking passage, which cannot be too much read:—'…partial combinations…might be looked upon as simply intrenching round a particular spot against the inroads of overpopulation, and making their wages depend upon their own rate of increase, instead of depending on that of a more reckless and improvident class than themselves. The time, however, is past when the friends of human improvement can look with complacency on the attempts of small sections of the community, whether belonging to the labouring or any other class, to organise a separate class interest in antagonism to the general body of labourers.'
>
> (*SRL,* pp. 108– 109)

Throughout his career Jevons also relied on Mill's authority in the discussion of co-operation. In the 1866 plea for partnership, he added his 'small voice to that of men like Mr.Mill' (*P&C,* **iii**, p. 138). An 1867 letter published in *The Times* suggested that co-operation was 'Neither in principle nor in practice' 'really new', since 'J.S.Mill, in advocating it many years ago…pointed out many instances where labourers share results' (p. 153). The 1870 lecture 'On Industrial Partnerships', referred to passages in Mill's *PPE* on co-operation. And in 1882 Jevons acknowledged again that 'The outlines of the scheme are familiar to all who have read with proper care John Stuart Mill's *Principles of Political Economy'* (*SRL,* p. 143).

At the same time (as noted on pp. 151–52) there was a subtle but significant difference between Jevons and Mill. Jevons was in some instances less willing than Mill to call for intervention. He objected to Mill's 'lumps of clay' characterization of British citizens, and he cautioned that governments had limited powers to mould individuals. As we will see below also (pp. 159–63), he opposed Mill's calls for wide-ranging land reform in Ireland, and maintained a less radical stance on co-operation than Mill.

CONCLUSIONS

Utilitarian evaluation of policy measures involved more than a simple-minded observation of prices, but Jevons refrained from specifying precisely how to measure Social Utility, relying instead in the discussion of policy guidelines on loose evaluations concerning the net balance of good created by particular policies. In a rare instance of furnishing policy rules, he did suggest that government inspections and labelling might occur under the following conditions: '1) When some special danger is to be avoided, or some special considerable advantage to be attained by Government intervention; 2) When the individual is not able to exercise proper judgment and supervision on his own behalf; and 3) When the intervention required is of a simple and certain character, and the result can be certified in a manner comprehensible to all' (*SRL,* p. 49).

In general, however, Jevons's procedure contained no mechanism, or alternative to that of Mill's competent judges, to estimate consumers' pleasures or Social Welfare when prices are not allowed as proxies for indicators of happiness.[49] This measurement is certainly called for, if interpersonal trade-offs of happiness are required. Given this inadequacy, it is not surprising that in 1882 Jevons fully acknowledged that estimates of 'utility' might differ: 'We cannot expect to agree in utilitarian estimates, at least without much debate. We must agree to differ, and though we are bound to argue fearlessly, it should be with the consciousness that there is room for wide and *bonâ fide* difference of opinion' (*SRL,* p. 166).

While Jevons failed fully to resolve the problems associated with measuring utility, however, the foregoing suggests that he made two significant departures from Mill. First, he was highly critical of Mill's 'competent judges' framework and, notwithstanding his reform-minded stance, he took a step towards the identification of 'pleasure' with choices made. Connected to this, is the fact highlighted above, that Jevons was somewhat less willing than Mill to trust the efficacy of reform measures for altering ('improving') human nature.

Second, and perhaps more importantly, Jevons attempted to overcome the measurement problems he saw as inherent in Mill's formulation of qualitative and quantitative pleasure differences. While he was ultimately unsuccessful at defining a precise means of measuring pleasure himself, he insisted that in principle individual pleasures were commensurable, and thus he forwarded what has become a tradition of welfare analysis that attempts to combine individual pleasures into a whole, and to measure that whole, Social Welfare.

8
JEVONS'S ANALYSIS OF POLICY

INTRODUCTION

In his account of late nineteenth-century political economy, Vincent Bladen has maintained that a decline of the *laissez-faire* doctrine occurred by 1870.[1] Economists from Adam Smith to J.S.Mill are said to have been 'so impressed with the possibility of the automatic functioning of the economic system that they preached the doctrine of laissez-faire' and reduced 'the agenda of government…to a minimum'; whereas by 1870 there is discernible a 'collectivist trend in legislation' in the writings of professional economists—including, conspicuously, Jevons (1959, pp. 302, 303).[2] In this account, throughout the late nineteenth century economists gained a new and realistic appreciation of the complexities of the economic system, a responsible attitude towards policy analysis, and a 'diminished faith in a priori reasoning': 'Economists became more careful in applying theory, valid under certain postulated conditions of great simplicity, to the problems of the real world, and more sensitive to those changes in the characteristics of the real world which undermined views of public policy which had been well founded in the conditions of an earlier time' (p. 309; cf. pp. 303–308).[3] These increased calls for intervention reflected altered economic conditions rather than late nineteenth-century developments in economic theory (p. 306).[4]

By examining Jevons's specific policy recommendations, this chapter confirms the argument above (Chapter 7) that Jevons and Mill shared a common method as well as a common set of value judgements defining 'the greatest good'. Both saw a role for intervention, but one which took account of individual initiative, and aimed at encouraging 'self-reliance'. For both, Utilitarianism entailed a presumption in favour of encouraging independent and responsible behaviour, and liberty constituted a key element in the utilitarian goal. On balance, a slight difference is discernible between Jevons and Mill in terms of interventionary zealousness; on a number of occasions Jevons was less willing than Mill to endorse wide-ranging economic reforms, and maintained instead that human nature was less pliable than Mill had presumed.[5] Apparently, Jevons was less convinced than Mill that human beings would respond to reform. If, as Hutchison argues, Mill's optimism regarding improvement was constrained by Malthusian difficulties, Jevons's faith in improvement was limited by Darwinian evolutionary constraints.[6]

But Jevons trod a fine line in this respect. For he placed great faith in the ability to educate labourers about the need to alter savings and family size decisions. The second important theme of this chapter centres on Jevons's position concerning intertemporal decision-making, an issue alluded to in Chapters 2, 3, and 5. We have seen that, for Jevons (as well as many of his contemporaries) intertemporal decision-making is in some sense harder to 'get right' than decisions made at a point in time.[7] Thus, savings rates are said to be 'too low' among labourers both throughout their life cycle and during the course of cyclical fluctuations in aggregate demand; investors are myopic throughout the course of economic fluctuations; and family size and marriage decisions are systematically incorrect among the labouring classes. As a remedy for this recognized limited rationality of—especially—labourers, Jevons advocated a broad system of education designed to 'improve' these intertemporal decision-making skills (this is the subject of pp. 163–65).

SPECIFIC APPLICATIONS OF POLICY ANALYSIS

Jevons's major works on economic policy, the *State in Relation to Labour* and *Methods of Social Reform,* reveal his overriding concern with ameliorating working-class conditions. Throughout, we find evidence of a wide-ranging reform programme designed to encourage self-improvement and the acquisition of self-reliance on the part of the labouring classes.[8] Throughout also, we find evidence of Jevons's presumption in favour of liberty, as well as his willingness to call for intervention in situations where the benefits of such interference were seen to outweigh the costs of the resultant reduction in liberty.

The presumption in favour of liberty as well as a faith in the power of education are evident throughout his analysis of trade unions. Here he argued that 'Anything,…which tends to interfere with the exercise by any person of the utmost amount of skill of which he is capable, is *prima facie* opposed to the interests of the community' (*SRL,* p. 99); but he conceded that there may be 'counterbalancing advantages', such as the educative function of trades societies. In such cases, the trade union might be sanctioned, provided it be 'fully justified and carefully regulated by the State' to ensure that its '*raison d être* must be the good of the people outside, not of the privileged few inside the monopoly'. Failing this, it should 'be either reformed or destroyed'. Since, in Jevons's evaluation, attempts to prohibit combinations were 'impracticable' and would 'suppress with much evil many germs of good' (p. 109), he urged Parliament 'finally to give up its jealousy of associative action, by recognizing in law courts every society of whose existence formal evidence can be given' (pp. 114–15; see pp. 160–63).

The State might also justifiably restrict liberty in 'many cases' when 'the expert is a far better judge than the individual purchaser' (*SRL,* p. 42). In these situations, the ignorance of one party to an exchange (generally the buyer) implies that the consumer lacks the requisite information to strike a well-informed bargain, and as such the consumer's liberty is in some sense curtailed. The government might intervene to prevent sellers from taking advantage of such ignorance, a case described in 1882: 'While it is a fact that people live in badly-drained houses, drink sewage water, purchase bad meat or adulterated groceries, it is of no use urging that their interests would lead them not to do so. The fact demolishes any amount of presumption and argument' (pp. 42–43).[9] Lack of information on the part of consumers constituted the key justification for such intervention:

> But it is a totally different question whether a purchaser in certain cases knows what he is buying. A man, for instance, about to buy a mansion tries the water out of the well, and is satisfied by its sparkling limpidity and its brisk taste. A chemist would have pointed out that these are suspicious symptoms, and analysis might have detected deadly sewage poison. The drains of a mansion, again, are a different matter from its style of architecture, or the view from its windows. It is a pure matter of technical skill to say whether the existing drains ensure freedom from infectious sewer gases.
>
> (*SRL,* p. 42)

Here, Jevons reasoned that *laissez-faire* policy might be maintained and a 'whole profession of food analysts would spring into existence' (p. 42). But he predicted that a serious problem would remain; since 'the very point of the matter is that ignorant people cannot take precautions against dangers of which they are ignorant', intervention was required to correct this problem (p. 42).

Such intervention is said actually to give effect to people's desires, and thereby (presuming the legislator knows the consumer's desires), to promote liberty: the 'Government officer who steps in and prevents the faulty article from being exposed to sale does not really restrict the liberty of the purchaser…[but] actually assists the purchaser in carrying out his own desires' (*SRL,* p. 43). Such a policy consequently ensures 'an immense increase of efficiency and multiplication of utility is secured by appointing officers to assist and protect the public in certain special points' (p. 43).

On similar grounds Jevons recommended that mothers of young children be restricted from working in factories, a policy which is said to ensure that the interests and liberty of children were protected ('Married Women in Factories' [1882], *MSR,* pp. 156–79). In 1882 he referred to this issue—'the employment of child-bearing women away from home'—as 'the most important question touching the relation of the State to labour which remains unsolved' (p. 160). Because the employment of such women relegated infants to 'that scourge of infant life, the dirty fungus-bearing bottle' (p. 161), it was 'plain' that 'thorough' legislation was required. The evils associated with restrictive legislation were in this instance 'overbalance[d]' by the 'infanticide' that followed from unrestricted action:

> The objection may no doubt be made, that the exclusion of childbearing women from works in public factories would be a new and extreme case of interference with the natural liberty of the individual…. But I venture to maintain that all these supposed natural entities, principles, rules, theories, axioms, and the like, are at the best but presumptions or probabilities of good. There is, on the whole, a certain considerable probability that individuals will find out for themselves the best paths in life, and will be eventually the best citizens when left at liberty to choose their own course. But surely probability is rebutted or destroyed by contrary certainty.
>
> (*MSR,* p. 176)

Here, then, the liberty of the child was justifiably protected by the State at the expense of the parents' liberty, and Jevons recommended the complete exclusion of child-bearing women from factory work (*MSR,* p. 175).[10] Recognizing that such a policy entailed a severe curtailment of the liberty of married women, he proposed a number of qualifications to 'mitigate' the 'violence of the change' (p. 175). Thus, he recommended licensing large factories to employ women on the condition that these establishments set up respectable crèches under medical supervision, that mothers might visit (p. 175). Legislation must, he also argued, deal 'gently' with widows and single parents, and in 'the long-run' it might be cost effective 'for the State to employ them as nurses of their own children' (p. 175). All such difficulties would have to be resolved 'by trial' (p. 175).

The presumption in favour of encouraging self-reliance is evident also in Jevons's praise for the 1834 Poor Law which provided for local control of poor law policy. Jevons called for policy experiments (to be followed, he argued, by subsequent imitation of successful experiments) and incrementalism, and he recommended experimental legislation in the punishment of debtors, sanitary regulations, and the London Water Supply ('Experimental Legislation and the Drink Traffic' [1880], *MSR,* pp. 265, 273f).[11]

Indeed, he extended the principle by calling for the creation of 'a strong executive commission framed somewhat on the lines of the Poor Law Commission' to authorize and supervise plans 'proposed by local authorities' in the Liquor Trade; successful plans would 'by degrees' be adopted in other locales (*MSR,* 1880, p. 271). This incremental method—allowing for local variation of policy—is said to have been used in 'all the more successful legislative and administrative reforms of later years' (p. 266), including incremental steps towards regulating factory hours. The 1878 Factory Act thus received praise for 'the several more tentative acts by which this was preceded' as well as 'the thorough inquiries of the Factory Act Commissioners of 1875'

(*SRL,* p. 52; cf. p. 65). By contrast, Mill's proposal for land reform in Ireland was criticized for being overly expansive, or revolutionary:

> The proper resource then is to *try the thing*—not by some vast revolution in the land-owning of Ireland, as proposed by the late Mr.Mill, a measure which, in the first place, would never pass Parliament, and, if it did, would cost an enormous sum of money, and probably result in failure—but by a small and progressive experiment.
>
> (*MSR,* p. 274)

On taxation

In Jevons's treatment of taxation we find additional evidence of his desire to make a (synthetical) utilitarian estimate of the benefits and costs of specific taxes in order to impose 'theoretically' sound taxes (*PE,* 1871, p. 211). The 1875 lecture on taxation outlined 'four ['classical'] maxims of taxation which Adam Smith laid down as to the qualities proper in a tax' (*P&C,* **vi,** p. 134).[12] The first, proportionate taxation, was said to be 'a doubtful proposition theoretically' requiring examination 'from many sides'. Since proportionate taxation 'only bears a very small real proportion to [the rich man's] total income compared with the proportion which the poor man's taxation bears to his', it imposed relatively more suffering on the poor than the rich and was not 'fair' (*P&C,* **vi,** p. 135).[13]

Jevons raised several objections, however, to progressive taxation. He argued, first, that if the poor were exempt from taxation a situation would result where 99 per cent of the population taxed the hundredth per cent (*P&C,* **vi,** p. 136).[14] More importantly, relatively high tax rates on the rich were said to create adverse incentive effects for capital accumulation, and a resulting negative impact on the rate of 'progress'. On balance, Smith's proportionate scheme was deemed most reasonable. Most interestingly and subtle, proportionate taxation was regarded as a means of inculcating responsibility and self-reliance among citizens. No class other than those who were 'actually paupers' was to be exempt from taxation, and taxation was to be 'coincident with representation':

> We must carefully guard against imposing upon the very poor any charge disproportionate to their income, and from those who are actually paupers we cannot really take anything. But if representation is to be coincident with taxation, then taxation must be coincident with representation. We may strive privately to alleviate the extreme differences between the incomes of the poor and the rich, but to allow any exemption from the duties and responsibilities of citizenship would be a concession ultimately fatal to the welfare of all.
>
> (*PE,* 1871, p. 239)

Jevons in fact evaluated a broad range of policies in the light of their perceived abilities to inculcate responsible ('prudent') behaviour and improve the 'general low tone' of the labouring classes. The notion that education was of paramount importance to the economic and intellectual independence of the working classes, and a necessary preliminary to resolution of problems associated with over-population, prompted him to call for its public provision.[15]

Once the 'education question was put in a fair way of solution', Jevons enlarged his vision of education to entail a remarkably broad programme of cultural activity (*MSR,* 1878, p. 26). Since the 'vulgarity' of the working classes was due in part to the suppression of amusements 'by a dominant aristocracy', improvement of 'the low state of musical education' was a means to 'a higher civilization' (pp.6, 7, 11). Consequently, he recommended the provision of outdoor concerts by volunteer and unpaid musicians, it being the duty of the upper classes to frequent the concerts in order to spread their popularity (pp. 13, 24). This would result in an 'enormous increase of utility…acquired for the community at a trifling cost' (pp. 28–29); minimal state interference, and local variation, were involved. Public libraries, also—the 'most permanent' and 'progressive' institutions—were recommended as a low-cost means of broadening the education of the working classes, provided they entailed local direction and minimal government agency ('The Rationale of Free Public Libraries', *MSR,* p. 48; cf. pp. 28–52).[16] Jevons objected to large public museums on the grounds that they were an ineffective educative tool; he regarded local collections of geological artifacts as more effective ('The Use and Abuse of Museums', pp. 55–56, 62).

TRADE UNIONS AND CO-OPERATION

Evidence relating to the analyses of trade unions and co-operation reinforces the notion that Jevons favoured incremental social change. Confining the analysis within a partial equilibrium setting, he argued in 1868 and 1882 that labour supply restrictions within particular trades resulted in artificially high wages and prices in the affected industries: 'Each trade which maintains a strict union' endeavours 'to secure an unfair share of the public expenditure' (*SRL,* p. 106; cf. *MSR,* 1868, pp. 111–12). This 'private taxation' was said to be borne by consumers, who were, for the most part, labourers (pp. 103–104, 106).[17] Further, since those 'who most need combination to better their fortunes are just those who are the least able to carry it out', unions exacerbated distributive injustices. Jevons concluded:

> Though workmen, in respect of belonging to the same social class, may try to persuade themselves that their interests are identical, this is not really the case. They are and must be competitors, and every rise of wages which one body secures by mere exclusive combination represents a certain amount, sometimes a large amount, of injury to the other bodies of

> workmen….success in maintaining exclusive monopolies leads to great loss and injury to the community in general.
>
> (*MSR,* p. 106)

Trade unions also created technical inefficiencies, since unionized workers resisted the introduction of cost-reducing innovations ('On Industrial Partnerships' [1870], *MSR,* p. 126).[18]

Notwithstanding his disapproval of restrictive union attempts to raise wages, Jevons allowed in 1868 that trade unions performed an educative function: 'some kind of association' being 'indispensable to the progress and amelioration of the largest and in some respects the most important class of our population', and 'one of the best proofs of the innate capacity for self-government which I believe we all possess' ('Trade Societies: Their Objects and Policy' [1868], *MSR,* pp. 102, 103; cf. 'On Industrial Partnerships', *MSR,* p. 123). Unions were also said to enable the labourer to guard his 'health, convenience, comfort, and safety' (p. 108).

Because trade unionism encouraged self-reliant behaviour, and since experience revealed that legislation to restrict trade union activity would 'suppress with much evil many germs of good', Jevons recommended in 1882 that the legislature 'finally' relinquish 'its jealousy of associative action' (*SRL,* pp. 109, 114–15).[19] He insisted, however, that the 'imperative needs' of society be met, and favoured the establishment of an authority to ensure that 'in the last resort' duties such as the stoking of gas retorts be performed in the event of a strike. In addition, Jevons favoured voluntary union membership.

But all this was second best. As a solution to the labour problem Jevons preferred 'one more useful and beneficial form of organisation', which he referred to interchangeably as co-operation and partnership ('On Industrial Partnerships', *MSR,* p. 123), an arrangement whereby labourers would contribute 'on a small scale' to the 'sinking fund', and receive their usual wage payments as well as some share of profits. (Profits in this context are treated as a return to investment, plus a residual which varies from year to year depending on the realized output price.)[20]

In 1866 Jevons wrote an impassioned plea to the *Manchester City News:*

> I hope to see the time when workmen will be to a great extent their own capitalists…. I believe that a movement of workmen towards co-operation in the raising of capital would be anticipated by employers admitting their men to a considerable share of their profits.
>
> (*P&C,* **iii,** p. 138)

Co-operation, which divided the produce of labour 'as it has always been recognized by political economists—the wages of labour, the interest of capital, the wages of superintendence, the compensation for risk in the sinking fund, and the extra profits of successful years', is said to implement 'the great vivifying principle of political economy—that reward should be in proportion to desert' (Letter to *The Times,* 19 January 1867; **iii,** p. 152).[21] Its advantages are said to include the increased 'diligence' of workers as a result of their interest in the enterprise, a decline of discontent among the labourers who share in the enterprise's concerns, increased savings of labourers, fewer strikes, and a decline of the notion that incomes should be equal (p. 153). In 1870, Jevons reiterated that partnership would 'efface in some degree the line which now divides employers and employed' ('On Industrial Partnerships', *MSR,* p. 148). Again he anticipated increased efficiency since workers would gain a 'direct interest in the work done'. There would also be a role for competition, an 'honourable rivalry' among firms (p. 142).

Most importantly, partnership would correct the 'one great defect of character' of the working class—the 'want of thrift and providence' ('On Industrial Partnerships', *MSR,* pp. 144, 145). Labourers who received a lump sum bonus in yearly dividends would begin 'to look beyond the week' and become independent; thus co-operation would stimulate self-reliant behaviour and 'millions may be ultimately raised above the chance of pauperism' (pp. 145–46, 148). '[It] is only in becoming small capitalists', Jevons wrote, 'that the working-classes will acquire the real independence from misfortune, which is their true and legitimate object' (p. 147).[22]

It is significant that there is little distinction between partnership and co-operation in Jevons's work.[23] Apparently in consequence of perceived wealth constraints precluding workers from gathering the requisite capital together, from 1870 he favoured industrial partnership which in 1875 he defined as the 'truest form of co-operation' (*P&C,* **vi,** p. 76; cf. **iii,** p. 153, *MSR, p.* 141). He did not proceed as far in this matter as Mill, who distinguished carefully between partnership and co-operation, and preferred the latter. Notwithstanding, Jevons accorded a fundamentally important role to partnership and co-operation, which, by enabling labourers to become ('small') capitalists, could most certainly alter the distribution of income, and allow labourers to become increasingly self-reliant. Modification of existing institutions thus constituted a powerful means of social reform for Jevons.

ON EDUCATION: THE PROBLEM OF INTERTEMPORAL DECISION-MAKING

Jevons's views regarding 'desirable' and 'less desirable' behaviour in the context of consumer choices further reveal his trust that institutional reform could ameliorate conditions for the labouring classes. Referring to the intertemporal consumption decisions of, especially, the labouring classes, he maintained that their reckless spending was unwarranted, and thus should be discouraged.[24] In many of his written works, he called for policy reforms designed specifically to 'improve' the decision-making skills of the labouring classes. In particular, a broad system of education was to inculcate habits of prudence and, consequently, increase savings among workers.[25]

In the discussion of the 'hierarchy of motives' we find evidence of Jevons's firm belief that, especially among the uneducated labouring classes, economic decisions are persistently incorrect. As we have seen (pp. 87–88), Jevons circumscribed his purpose in the *Theory of Political Economy,* to treat only 'the lowest rank of feelings' there. His purported task was therefore not to assess what people should desire or consume, but instead to analyse what they do consume, treating consumers 'not as they ought to be, but as they are' (p. 38; cf. p. 39).[26]

Nonetheless, Jevons's disapproval of consumption choices is particularly evident in his discussion of intertemporal consumption decisions. In fact, as demonstrated above (pp. 96–97), he maintained that consumers' choices are systematically mistaken.[27] He described a situation where the usefulness of a good is distributed over time and insisted that 'all future pleasures and pains' should by reckoned 'as if they were present', in which case the utility maximizing solution was formally identical to the case of a good distributed across different uses (*TPE,* p. 71). In practice, however, human nature discounts future pleasures relative to present ones, and as such intertemporal decisions made by uneducated consumers are systematically flawed (p. 72; see pp. 96–97). This implied that, without intervention, individuals do not save enough for the future.[28]

Indeed, throughout both the *Theory of Political Economy* and his policy-oriented works, a theme of Jevons's writing is that, when it comes to intertemporal decision-making, uneducated consumers make persistent mistakes.[29] In short, intertemporal decision-making is in some way harder to 'get right' than static decisions. Because they purportedly overvalued present relative to future consumption, the labouring classes were unable to make correct savings and family size choices without the proper course of education. In his many discussions of population pressures, as well as co-operation and trade unions, Jevons recommended a broad system of education to correct this 'one great defect' of the working classes, their 'want of thrift and providence'.

Indeed, the most persistent theme of Jevons's major works that deal with economic policy, is that poverty results in large part from bad (ignorant) intertemporal decision-making, and thus can be mitigated by education. For Jevons, pauperism is an institutional failing, 'the general resultant of all that is wrong in our social arrangements'. The 1870 piece on industrial partnership reiterated that the labouring classes were myopic, improvident and ignorant; consequently over-population and poverty resulted: 'Hence arises the distress at every temporary oscillation of trade; the early marriages; the crowds who need employment; the young who cannot go to school because they must add their pence to their parents' shillings; the necessity of medical charities; and, most sad of all, the crowding of the old into the wards of the workhouse' (*MSR,* p. 146). 'Married Women in Factories' maintains, in addition, that individuals frequently make 'improvident' marriage choices:

> It must be evident, too, that the facility with which a young married woman can now set her children aside, and go to earn good wages in the mills, forms the strongest possible incentive to improvident and wrongful marriages. There are many statements in the Reports of the factory inspectors to the effect that dissolute men allure capable young women into marriage with the idea that the wives can earn wages, and enable their husbands to idle away their time.
>
> (*MSR,* p. 172)[30]

The solution to such institutional failings is clear: 'it can only be reduced by such exertions as raise the intelligence and provident habits of the people' ('Inaugural Address as President of the Manchester Statistical Society' [1869], *MSR,* p. 186).[31] The 'solution' to 'over-population' (to a subsistence wage or to 'the deep and almost hopeless poverty in the mass of people') lay in the cultivation of a desire 'to appreciate or accumulate the wealth which science brings' ('Opening Address as the President of Section F' [1870], *MSR,* pp. 196, 197; cf. *TCQ,* pp. xlvii–xlix; see above, pp. 33–36). That only education would enable labourers to gain the requisite 'habits of providence and foresight' is spelled out also in Jevons's 1869 'Inaugural Address' to the Manchester Statistical Society, where he argued that increased wages would do little to improve the conditions of the labouring classes in the absence of improved savings behaviour: 'No people can be really well off unless to their material prosperity be joined habits of providence and foresight, which will lead them to fortify themselves in the position they have once attained. General education is, doubtless, the measure which most nearly approaches to a panacea for our present evils' (*MSR,* pp. 186–87; cf. *P&C,* **vii,** p. 28).[32]

LATE NINETEENTH-CENTURY DEVELOPMENTS ON UTILITY MEASUREMENT

Mill and Jevons were utilitarians in two broad senses. First, they both adhered to 'the greatest good' doctrine, where 'good' is defined quite broadly, and evaluation of the social good entails subjective weighing of the gains and losses associated with policy measures. While Jevons disagreed strongly with the evaluation process outlined by Mill, and argued that qualitative differences in pleasures might be reduced to Benthamite characteristics of pleasure that were quantifiable, he, like Mill, was aware that Social Happiness was at best a fuzzy and, worse still, inherently a subjective concept. Second, Jevons and Mill were utilitarians in the original sense of that word, in that both had in mind a programme of social reform, according a prominent role to greater liberty—broadly defined, to include economic and intellectual independence—and, as a prerequisite to greater liberty, improved living conditions among the working classes. At least by the end of his career, Jevons emerges as somewhat less willing to allow that policy can effect lasting improvement (though here, one must bear in mind that Mill, too, warned against the ineffectiveness of policy that did not aim at altering character; see p. 143).

Since 1880, utilitarians have largely disassociated themselves from this broad-ranging reform programme and focused their attention on the more narrow issues associated with measurement per se. Late in the nineteenth century it still seemed at least possible to foresee the application of Jevons's mathematical logic to policy analysis: Edgeworth hoped to see the establishment of 'exact Utilitarianism', and called for the development of a 'hedonimeter', whereby pleasure might be precisely measured, and then, through the use of 'wide averages', individual utilities might be combined into social utility (1881, pp. 80, 101–102). He called for the creation of a 'psychophysical machine, continually registering the height of pleasure experienced by an individual, exactly according to the verdict of consciousness, or rather diverging therefrom according to a *law of errors*' (p. 101). He also presumed that utility units are cardinal, consisting of 'just perceivable increments of pleasure'.[33] Since each person registered these units individually, however, measuring total utility presented the same type of difficulties alluded to by Bentham and Jevons (pp. 139; 147–48). Edgeworth's procedure was to argue that 'the greater uncertainty of hedonimetry in the case of others' pleasures' could be 'compensated by the greater number of measurements, a wider average; just as, according to the theory of probabilities, greater accuracy may be obtained by more numerical observations with a less perfect instrument' (p. 102).[34]

In 1890, Alfred Marshall introduced the notion of consumer surplus as an approximate measure of Social Utility, while at the same time carefully qualifying the concept. Thus, he pointed out that in order to use consumer surplus to measure the 'surplus satisfaction which the sale of tea affords, say, in the London market', one must 'neglect' 'the fact that the same sum of money represents different amounts of pleasure to different people' (1890, p. 128; cf. Note 1).[35] The importance of the assumption of equal marginal utilities of money is reiterated in a nearby passage:

> This involves the consideration that a pound's worth of satisfaction to an ordinary poor man is a much greater thing than a pound's worth of satisfaction to an ordinary rich man: and if instead of comparing tea and salt, which are both used largely by all classes, we compared either of them with champaign or pineapples, the correction to be made on this account would be more than important: it would change the whole character of the estimate.
>
> (1890, pp. 130–31)

In 1894, J.Shield Nicholson claimed that 'some sort of measurement [of utility] is not only theoretically possible but [also] is actually adopted in practical life' (p. 343). Yet he opposed using money as a measuring rod for utility on the grounds that doing so added an 'unreal' assumption to the analysis: 'the essence of my contention is that we cannot use money as the measure, without making the problems unreal by the multiplication of hypotheses…. It is this appearance of exact simplicity—where from the nature of the case exactness is impossible—which seems to me illusory and misleading…what we seem to gain in exactness we lose in reality' (p. 343).[36] Not only did individuals differ, so that the marginal utility of income differed for different individuals, but also, 'even with the same individual', Nicholson foresaw problems: 'even with the same individual a change in the cost of some things must change his so-called subjective valuation of other things. The money measure, then, of the final utility of anything varies not only with his desires and means of satisfaction in respect of that thing, but [also] with his desires and means in respect of all other things' (p. 344). By contrast with Edgeworth, Nicholson argued that the difficulties were compounded when the number of individuals was increased (p. 345).[37]

CONCLUSIONS

In his 1981 Richard Ely Address to the American Economics Association, Lionel Robbins reasserted his conviction, originally posed in his famous 1932 essay, that policy analysis and, indeed, applied economics more generally, necessarily relies on value judgements and, therefore, lies outside the scope of scientific ('value-free') economics. Instead of repudiating policy analysis on these grounds, however, he called for the (re)creation of 'political economy'—'covering that part of our sphere of interest which essentially involves judgments of value. Political Economy, thus conceived, is quite unashamedly concerned with the assumptions of policy and the results flowing from them' (1981, p. xxvii).[38] In the face of a seemingly intractable measurement problem created by the impossibility of interpersonal comparisons of utility or welfare, Robbins's recommendation is that economists redirect their efforts away from welfare economics in the tradition of the felicific calculus and into 'political economy' as such.

In their policy evaluations, Mill and Jevons made the type of explicit value judgements that Robbins called for, based on their 'own estimates of the happiness afforded or the misery endured by different persons or groups of persons' (1981, p. xx). While Mill and Jevons appreciated the need for intervention to help the labouring classes acquire habits of foresight and providence, both retained a firm commitment to 'self-reliance'. And both believed that policy should be used to create self-reliant citizens. Intervention might be required if self-reliant action failed to achieve just results, but the long-term aim of policy was the eventual achievement of independent and responsible behaviour by workers, behaviour which under existing social and economic arrangements was not forthcoming. Thus, for both Mill and Jevons, the utilitarian objective encompassed not only purely economic but also social and ethical goals—the encouragement of the virtue of self-reliance. Their agreement about many policy recommendations—those dealing with education, with the provision of public services, with the grounds for restricting individual liberty, and with co-operation—reflects the similarity of their visions of a reformed society, whose citizens were, broadly speaking, intellectually as well as economically independent.

Once that vision of the basis for reform largely disappeared from economic analysis—which was accompanied by a perceptible decline in optimism about the prospects for reform via policy—the problem of measuring Social Welfare began to take precedence in utilitarian policy analysis, and the concept of Social Welfare became more narrowly identified with the sum of individual utilities. The foregoing two chapters have suggested that the shift in focus begins in the transition of economics from Mill to Jevons, for it was Jevons who focused so directly on the issue of Welfare measurement per se (Chapter 7), while his own policy recommendations reflected a subtle decline in optimism regarding the ability of policy-makers to effect reforms.

By the turn of the century, many of the difficulties associated with measuring Social Utility had been outlined, though by no means resolved. At least in part because of the problems associated with specifying and measuring Social Welfare, as well as, perhaps, the increasing awareness of the complexity of achieving the reformed society—evident in Jevons's 'lumps of clay' remarks—economists by and large disassociated themselves from the broad ranging reform programmes that served as the under-pinning for policy evaluation in the mid-to-late nineteenth century.

The issue of utility measurement per se subsequently has re-emerged in welfare economics. Among others, Pigou (1903), Pareto (1909), Robbins (1932), Bergson (1938), Hicks and Allen (1934), Kaldor (1939), Hicks (1939), and, of course, Arrow (1951), all wrestled with the problems of the measurability of utility, and in increasingly technical work, described the conditions under which preferences might be aggregated. Considering the fundamental importance of measurement to policy evaluation, as well as the tendency—noted by Robbins—for household members as well as policy-makers routinely to make evaluations of interpersonal utility trade-offs, not surprisingly, debates on these issues have resurfaced.

What may be surprising, however, is that recent work within the economics profession has now sought to enlarge the notion of Social Utility, returning it to something closer to the nineteenth-century conception that underlies the analysis of policy by Mill and Jevons. Tinbergen's approach to the empirical estimation of social utility functions, for instance, argues in favour of a wider range, as well as a larger number, of determinants of welfare than were included in earlier attempts at Welfare measurement—including 'learning', 'productive activities', and 'international security' (1991, pp. 10–11). He calls for the inclusion of some fifty categories in his determinants of well-being, only a handful of which might be described as 'goods and services', as economists usually use that phrase, but many of which would naturally enter into an estimation of 'Social Welfare' by Mill or Jevons.

At the same time as the empirical measurement of 'welfare' has been revived as a legitimate concern for economists, some attempt has been made further to define the nature of 'Social Welfare'. In traditional welfare economics, the Welfare of any state is determined only by individual utilities or the well-being of individuals in that state. Individual welfare or utility is identified with the fulfilment of individual preferences. As a result, individual preferences between one social state and another constitute the basis for ranking those two states. But Sen has recently argued in favour of giving a more central and constitutive role to the freedoms of individuals in the evaluation and determination of Social Welfare (1991, p. 18). In his formulation, freedom is 'primarily related to the specification of the set from which one can choose'; generally, freedom is not independent of the preference ordering over the constituents of these respective sets (pp. 21–22). Thus, the evaluation of the freedom enjoyed from a given menu, depends on how the elements in the menu are valued by the individual (p. 22–25).[39] In short, both Tinbergen and Sen are effectively restoring nineteenth-century concern with liberty and self-reliance to economic thinking about Social Welfare.

Part IV

METHODOLOGY

9
THE RISE OF EMPIRICAL METHODS
Jevons's methodology of economics

INTRODUCTION

A key theme of Chapter 1 is that Jevons's methodology constituted a revolutionary contribution to economics. We are now in a position to demonstrate this argument in detail. Jevons believed that his methodological work, *The Principles of Science: A Treatise on Logic and Scientific Method* [1874, *PS*], was strikingly original and that it corrected many of J.S.Mill's methodological errors.[1] The method that Jevons described for applied economics in his *Principles of Science,* had little in common with that of his precursors. He called for the use of new techniques of data manipulation and combination that the Classical economists, most notably Mill, rejected on principle. Such procedures entailed a break with Classical methods that opened the door for the systematic use of data and measurement in economics.[2]

Historians of economics have recognized for some time that statistical procedures were available for use in social science long before they were appropriated into economic methods.[3] But the resulting puzzle of why economists resisted appropriating even simple statistical techniques, such as those designed to establish regularities in a single variable, has not yet been solved. This chapter suggests that the method of Mill erected a road-block between economists and such elementary statistical procedures. For Mill's insistence that the economist, in application, turn attention to 'disturbing causes', and treat each observed outcome as a case study, precluded a role for combining observations, for measurement in economics, or for the use of Jevons's 'wide averages'.

A major purpose in what follows, then, shall be to demonstrate that Jevons did indeed initiate a departure from the method of J.S.Mill.[4] For while Jevons, like Mill, allowed that abstraction from causal influences was the procedure for theoretical analyses, he recommended what effectively amounted to abstraction from disturbing causes in application also. In practice, the social scientist was to ensure that disturbing causes 'balanced'; only failing that might the scientist adjust for disturbing causes. Thus Jevons's methodology for practice or application did indeed downplay the importance of 'disturbing causes', which no longer needed to be explained or accounted for, but might instead be ignored.[5]

Jevons, of course, is most widely known today for his contribution to marginal utility theory. In the light of what follows, however, it seems particularly relevant to highlight some of his important contributions to applied fields.[6] His work on the value of gold attracted wide attention in the 1860s and well into this century (pp. 21–23); as a consequence Fisher concluded that Jevons was the 'father of index numbers' (1922, p. 459). Keynes praised Jevons's ability in this regard to 'survey his material with the prying eyes and fertile, controlled imagination of the natural scientist' (1933, p. 268). In the 1862 study of periodic commercial fluctuations Jevons is said to have 'compiled and arranged economic statistics for a new purpose and pondered them in a new way', thus approaching 'the complex economic facts of the real world, both literally and metaphorically, as a meteorologist' (p. 267). This method—a 'revolutionary change, for one who was a logician and a deductive economist'—purportedly 'carried economics a long stride from the *a priori* moral sciences towards the natural sciences built on a firm foundation of experience' (p. 278). Jevons's attempts to decompose time series into secular and cyclical components also earned him high praise (Mitchell 1928, p. 384) and the title 'founder of econometric method' (Robertson 1951, p. 247).[7] How Jevons's achievements in these areas relate to his methodological recommendations will be clarified below.

These developments carried wide-ranging implications for the subsequent course of economics. Mill's method implied an important role for specific observations, which were to be used to assess the reliability of the theoretical analysis and, more importantly, might feed into the theory by uncovering causes illadvisedly omitted from the axiomatic framework. But his recommendations ruled out the development of empirical techniques in economics. Jevons broke with the presumption that the social scientist must treat specific observations separately, as case studies. Instead of following Mill in the attempt to explain all the varied influences on each specific outcome, he argued that one might (indeed, one must) proceed in terms of averages, finding overall regularities and patterns. Thus, Jevons removed a major obstacle to the development and appropriation of statistical methods in economics.

That Jevons's methodology in economics entailed a new role for empiricism is supported by what follows. For although the demonstration below reveals that Jevons was at one with Mill in his views of causation and chance (see pp. 175–77), as well as in his choice of methods for economic theory (pp. 177–85), it transpires that in applied economics Jevons insisted upon the use of approximation techniques, techniques which Mill repudiated for the social sciences. The examination below thus elaborates upon Black's evaluation that the 'true hallmarks' of Jevons's originality consisted in his attempt to complement 'logic' with 'measurement' (1972c, p. 378).[8]

OF CAUSATION AND CHANCE

Mill conceived of a world governed by fixed, but sometimes unknown, laws. Uncertainty and the consequent inability to predict the future were the result only of the scientist's ignorance concerning the existence of or interrelationships among causes. 'Whatever happens', he insisted, 'is the result of some law; is an effect of causes and could have been predicted from a knowledge of the existence of those causes, and from their laws' (*A System of Logic* [1843]; *CW,* **vii,** p. 526). What appears to be a chance event, 'the occurrence of a phenomenon in certain circumstances, without our having reason on that account to infer that it will happen again in those circumstances', reveals a lack of knowledge concerning these circumstances (pp. 526–27).

Like Mill, Jevons insisted in *The Principles of Science* that the universe was governed by deterministic, though sometimes unknown, laws. Apparently random events were not produced by 'chance' but were caused instead by unknown forces. In this conception of deterministic laws, Jevons closely followed Mill, although, as we shall see below, there is some evidence of 'cracks' in Jevons's determinism.[9]

For Jevons, a cause is the 'necessary or invariable antecedent of an event, so that when the cause exists the effect will also exist or soon follow' (*PS,* p. 222). If the scientist, by experiment and observation, could know the cause of an event, experience would yield 'certain knowledge of future events', the aim of scientific research. But since experience does not generally yield accurate predictive knowledge, while 'there is in nature some invariably acting mechanism, such that from certain fixed conditions an invariable result always emerges', Jevons reasoned that knowledge of causation is incomplete: we 'can never penetrate the mystery of those existences which embody the Will of the Creator, and evolve it throughout time'.[10]

Jevons endorsed the 'invariable antecedent' definition of cause with the key qualification that 'our knowledge of causes in such a sense can be probable only' (*PS,* p. 224; cf. p. 226). In a passage remarkable for its similarity to the views of Mill, Jevons described a universe ruled by deterministic laws, in which there are no random elements, and 'chance' signifies ignorance of underlying causes:

> Happily the Universe in which we dwell is not the result of chance, and where chance seems to work it is our own deficient faculties which prevent us from recognizing the operation of law and of Design. In the material framework of this world, substances and forces present themselves in definite and stable combinations…. With suitable precautions we can calculate upon finding the same thing endowed again with the same properties. The constituents of the globe, indeed, appear in almost endless combinations; but each combination bears its fixed character, and when resolved is found to be the compound of definite substances.
>
> (*PS,* p.2)[11]

Like Mill, Jevons argued that uncertainty was the result of ignorance; uncertainty arises, first, because the scientist may be ignorant of existing causal relationships: 'There is always a possibility of causes being in existence without our knowledge and these may at any moment produce an unexpected event' (*PS,* p. 239; cf. p. 172). Second, and again in line with Mill, knowing causal relationships at a point in time leaves a further source of uncertainty, since the scientist may be ignorant of how these evolve through time:

> Even when by the theory of probabilities we succeed in forming some notion of the comparative confidence with which we should receive inductive results, it yet appears to me that we must make an assumption. Events come out like balls from the vast ballot-box of nature, and close observation will enable us to form some notion,…of the contents of that ballot-box. But we must still assume that, between the time of an observation and that to which our inferences relate, no change in the ballot-box has been made.
>
> (*PS,* p. 239; cf. pp. 2–3, 765)

Notwithstanding this formulation, however, there are a number of instances when Jevons allowed for a hint of non-determinateness to creep into his analysis of causation. The first resulted from his conviction that nature is 'a progressive existence, ever moving and changing as time, the great independent variable, proceeds' (*PS,* p. 221); as a consequence, one observes 'constant variety and ever-progressing change' (pp. 750–51). In contrast with Mill, Jevons did not conclude that change, or progression, is subject to deterministic law(s).[12] The second entailed a discussion of 'rare events' which are said to 'proceed only from an unusual conjunction of accidental events, and from no really exceptional causes' (p. 655). Here Jevons insisted that 'divergences from the average' 'sometimes' result from 'the principles of probability', but are sometimes 'due to deeper reasons'. He did not elaborate upon the meaning of 'accidental events' or 'deeper reasons' in this context. In a discussion of the 'Hierarchy of Natural Laws', Jevons referred to 'hidden springs' which, although acting according to 'fixed laws', cause 'sudden and unexpected changes' (p. 742): 'The Universe might have been so designed that it should go for long intervals through the same round of unvaried existence, and yet that events of exceptional character should be produced from time to time'. While a 'simple law of action' might work 'invariably' for a time, 'a single breach of law' might suddenly, unexpectedly, occur (p. 743). Finally, he allowed for the possibility of divine intervention (cf. p. 765). In human affairs, the possibilities for unexpected events were especially pronounced:

> A nation is not a mere sum of individuals whom we can treat by the method of averages; it is an organic whole, held together by ties of infinite complexity. Each individual acts and re-acts upon his smaller or greater

> circle of friends, and those who acquire a public position exert an influence on much larger sections of the nation. There will always be a few great leaders of exceptional genius or opportunities, the unaccountable phases of whose opinions and inclinations sway the whole body. From time to time arise critical situations, battles, delicate negotiations, internal disturbances, in which the slightest incidents may change the course of history.
>
> (*PS,* p. 761)

THE METHODOLOGY OF J.S.MILL[13]

Perhaps more than any economist of his time or since, Mill was a synthesizer. But, for reasons of practicality in the face of multiple causation, Mill called for specialization within the social sciences. The argument for specialization presumed that to discover how humans behave under the influence of all causes, one should first isolate causes and study the resulting effects separately.[14] Mill endorsed a methodology that was hypothetical, deductive, and based upon an incomplete representation of reality: '["The Social Science"] infers the law of each effect from the laws of causation on which that effect depends; not, however, from the law merely of one cause, as in the geometrical method, but by considering all the causes which conjunctly influence the effect, and compounding their laws with one another. Its method, in short, is the Concrete Deductive Method' (*CW,* **viii,** p. 895; cf. **viii,** p. 900).

Multiplicity of cause and the consequent diversity of causal influences on human behaviour rendered each observed outcome distinct; there being 'never any two cases exactly similar' (*CW,* **viii,** p. 847). Three problems obfuscated the scientist's attempt to delineate precise laws governing human behaviour. First, experimental possibilities were limited:

> How, for example, can we obtain a crucial experiment on the effect of a restrictive commercial policy upon national wealth? We must find two nations alike in every other respect, or at least possessed, in a degree exactly equal, of everything which conduces to national opulence, and adopting exactly the same policy in all their other affairs, but differing in this only, that one of them adopts a system of commercial restrictions, and the other adopts free trade.
>
> (*CW,* **iv,** p. 328)

In addition, because of multiple causation and limited experimental possibilities, inductive methods were ruled out as a means of discovering causal relationships, 'the causes on which any class of phenomena depend are so imperfectly accessible to our observation, that we cannot ascertain, by a proper induction, their numerical laws' (*CW,* **vii,** p. 620). The complexity of interrelationships implied that 'even supposing their laws known, the computation of the aggregate effect transcends the power of calculus' (p. 620). Finally, although laws and their causes are deterministic, 'the causes themselves are in a state of perpetual fluctuation' which the social scientist could not foretell (**vii,** p. 620; cf. **viii,** p. 878).[15] As a consequence, it was impossible to make general predictions about how humans would act (*CW,* **viii,** p. 846).

The methodological consequences of these problems were profoundly significant. First, as noted above, multiplicity of cause implied that induction was insufficient to establish causality, and also rendered the geometrical method inadequate for the analysis of social phenomena.[16] Second, although social laws might in principle be numerical, deriving numerical laws to describe relationships was possible only 'at the expense of the reality of the inquiry', an expense which outweighed the potential benefits of precision (*CW,* **vii,** p. 621). In social science, using 'the laws of quantity' to 'calculate forward to an effect' is inappropriate (p. 620), and numerical laws were appropriate, 'if at all', only as an imprecise guide (p. 531).[17]

Consequently, the economist was directed to reason based upon a few main causes (such as greater gain is preferred to lesser gain)[18] while acknowledging the existence and even importance of other causal influences:

> By reasoning from that one law of human nature, and from the principal outward circumstances (whether universal or confined to particular states of society) which operate upon the human mind through that law, we may be enabled to explain and predict this portion of the phenomena of society, so far as they depend on that class of circumstances only…. A department of science may thus be constructed, which has received the name of Political Economy.
>
> (*CW,* **viii,** p. 901)

Economic reasoning was, consequently, hypothetical and approximate, in the sense that it was a necessarily incomplete representation of reality (cf. *CW,* **viii,** p. 900). Specifically, the political economist 'considers mankind as occupied solely in acquiring and consuming wealth; and aims at showing what is the course of action into which mankind, living in a state of society, would be impelled, if that motive, except in the degree in which it is checked by the two perpetual counter-motives above adverted to, were absolute ruler of all their actions' (iv, p. 322).[19] From the desire for wealth, the economist reasons to numerous effects or conclusions, and although many of these effects 'are really the result of a plurality of motives', Political Economy considers them as 'flowing solely from the desire of wealth' (p. 322).

Mill insisted, however, that no political economist 'was ever so absurd as to suppose that mankind are really thus constituted'. The method of abstracting from the plurality of motives was a matter of expediency,[20] and the economist must continually be aware of the distinction between theory, based upon an incomplete model, and practice, when the economist must consider those causes omitted in the theoretical specification (*CW,* **iv,** p. 322). Most importantly, the approximate theoretical analysis must subsequently be ‘corrected’ by allowing for the influence of additional causes:

> The political economist inquires, what are the actions which would be produced by this desire, if, within the departments in question, it were unimpeded by any other. In this way a nearer approximation is obtained than would otherwise be practicable, to the real order of human affairs in those departments. This approximation is then to be corrected by making proper allowance for the effects of any impulses of a different description, which can be shown to interfere with the result in any particular case.
>
> (*CW,* **iv,** p. 323)

Because political economy relied on an explicitly recognized incomplete specification of the causes affecting social phenomena, then, a purely deductive method was less than satisfactory. As a ‘remedy’ to the resulting lack of realism Mill focused on ‘the third essential constituent part of the Deductive Method; that of collating the conclusions of the ratiocination either with the concrete phenomena themselves, or, when such are obtainable, with their empirical laws’ (*CW,* **viii,** p. 896). In practice, empirical measurement was ruled out.

Instead, the process of comparing the model’s conclusions with observed outcomes, was the key to determining its reliability for applications (*CW,* **iv,** p. 330; cf. **viii,** p. 710). The scientist must examine the data for any anomalies which have not been incorporated into, or explained by, the model. Here the procedure entailed (precise) specification of the conditions outlined in the model (‘examining to which of the sets of circumstances contemplated by the abstract science the circumstances of the case in question correspond’), as well as consideration and specification of ‘what other circumstances may exist in that case, which not being common to it with any large and strongly-marked class of cases, have not fallen under the cognizance of the science’, i.e. of *‘disturbing causes’* (iv, p. 330).[21] In general, the effects of disturbing causes, when known, could be added to the effect(s) in question.[22]

The ‘discrepancy’ between the predicted and the actual outcome, Mill argued, may call attention to ‘some important disturbing cause which we have overlooked’ (*CW,* **iv,** p. 332; cf. **vii,** p. 710). The economist was instructed to make ‘proper allowance’ for any causes omitted from the analysis that ‘can be shown to interfere with the result in any particular case’ (p. 323). Mill focused on the importance of investigating ‘disturbing causes’, which were not to be ignored, but instead cried out for the scientist’s attention:

> The disturbing causes are not handed over to be dealt with by mere conjecture. Like *friction* in mechanics, to which they have been often compared, they may at first have been considered merely as a non-assignable deduction to be made by guess from the result given by the general principles of science; but in time many of them are brought within

> the pale of the abstract science itself, and their effect is found to admit of as accurate an estimation as those more striking effects which they modify.
> (*CW,* **iv,** p. 330)

The method of comparing outcomes with ‘specific experience’ was thus the means by which hitherto unrecognized disturbing causes were discovered, and by which could be reduced the ‘uncertainty’ ‘arising from the complexity of every particular case, and from the difficulty (not to say impossibility) of our being assured *a priori* that we have taken into account all the material circumstances’ (*CW,* **iv,** p. 331):

> The discrepancy between our anticipations and the actual facts is often the only circumstance which would have drawn our attention to some important disturbing cause which we had overlooked. Nay, it often discloses to us errors in thought, still more serious than the omission of what can with any propriety be termed a disturbing cause. It often reveals to us that the basis itself of our whole argument is insufficient; that the data, from which we had reasoned, comprise only a part, and not always the most important part, of the circumstances by which the result is really determined.
> (*CW,* **iv,** p. 332)

Mill clearly recognized the enormity of the task he set out for the political economist, who, as collator of the theoretical anticipations and observed outcomes, is recognized to be superior to any one-sided practitioner of theory or observation: ‘But while the philosopher and the practical man bandy half-truths with one another, we may seek far without finding one who, placed on a higher eminence of thought, comprehends as a whole what they see only in separate parts; who can make the anticipations of the philosopher guide the observation of the practical man, and the specific experience of the practical man warn the philosopher where something is to be added to his theory’ (*CW,* **iv,** pp. 334–35). No simple rule could be devised to ascertain when a model was suitable for application, although here Mill insisted that a necessary though not a sufficient condition for suitability was the ability to ‘explain and account for what *is*’:

> Though it is impossible to furnish any test by which a speculative thinker, either in Political Economy or in any other branch of social philosophy, may know that he is competent to judge of the application of his principles to the existing condition of his own or any other country, indications may be suggested by the absence of which he may well and surely know that he is not competent. His knowledge must at least enable him to explain and account for what is, or he is an insufficient judge of what ought to be.
> (*CW,* **iv,** p. 335)

Mill emphasized improvement of the analysis through the use of specific experience.[23] Rarely is the analysis rejected, although 'improvement' is a broad notion, involving, first, adding to the axiomatic framework (i.e. by 'inserting among its hypotheses a fresh and still more complex combination of circumstances', *CW,* **iv,** p. 331). In addition, the procedure might reveal that the axioms have been inferred from an incomplete set of 'circumstances', so that the entire axiomatic framework must be revised. Mill never clarified, however, how to distinguish between these two situations.

One test of whether the scientist might confidently apply a model 'to his own or any other country' was its ability to explain or account for the full amount of an observed effect. Yet even in this case the political economist must continue to seek out and try to account for differences between theoretical outcomes and new observations.[24] A confirmatory result increases the scientist's confidence in the hypothesis, but is not conclusive (cf. *CW,* **vii,** p. 492).[25]

Mill's insistence that in application the political economist must account for the influence of causes outside the general cause(s) of interest is evident in his own examination of the relative merits of small- and large-scale agriculture in the *Principles of Political Economy* [1848]. This discussion constituted one of the rare instances in that work when Mill examined empirical data. He discussed farming techniques in nineteen areas, ranging from Ireland to Holland and France. Significantly, his attention focused largely on the causes other than scale that influenced farm productivity (*CW,* **ii,** pp. 142–52). He examined each specific case in detail, focusing on 'customs', tenancy arrangements, available capital stock, skill and knowledge, and entrepreneurial talents. In accord with his methodological recommendations that a purpose of the *a posteriori* method consisted of the explanation of the discrepancy between theoretical prediction and observed outcome, he insisted here that the political economist allow for or explain the effects of these influences before drawing a conclusion regarding scale (p. 145).

Importantly for what follows, and not surprisingly in the light of his method outlined above, Mill was reluctant to endorse the possibility of deriving empirical laws in social science:[26]

> Specific experience affords nothing amounting to empirical laws. This is particularly the case where the object is to determine the effect of any one social cause among a great number acting simultaneously; the effect, for example, of corn laws, or of a prohibitive commercial system generally. Though it may be perfectly certain, from theory, what kind of effects corn laws must produce, and in what general direction their influence must tell upon industrial prosperity, their effect is yet of necessity so much disguised by the similar or contrary effects of other influencing agents, that specific experience can at most only show that on the average of some great number of instances, the cases where there were corn laws exhibited the effect in a greater degree than those where there were not.

(*CW,* **viii,** pp. 908–909)[27]

In order empirically to derive a relationship, Mill maintained, 'the whole round of combinations of the various influential circumstances' would have to be observed.[28] Paucity of data implied that all of these possibilities were rarely exhausted, since the number of 'necessary' observations 'never can be obtained' (*CW,* **viii,** p. 909).

Mill did allow, however, that empirical regularities might be discovered in rare situations where the data were plentiful enough to allow the researcher to observe all possible combinations of these 'partial causes' (*CW,* **viii,** p. 932). The 'singular degree of regularity *en masse*' in murder rates, 'combined with the extreme of irregularity in the cases composing the mass' constituted a 'felicitous verification *a posteriori* of the law of causation in its application to human conduct'. The 'general circumstances of the country and its inhabitants; the moral, educational, economical, and other influences operating on the whole people, and constituting what we term the state of civilization' were general causes affecting murder rates. In addition, a 'great variety of influences special to the individual' affected individual conduct, and the murder rate (p. 933).[29] Discovery of the empirical law required the 'elimination of chance', by taking 'the whole of the instances which occur within a sufficiently large field to exhaust all the combinations of these special influences' (p. 933; cf. p. 934). Then, as long as 'all these instances have occurred within such narrow limits of time', so that 'no material change can have taken place in the general influences' causing murders, 'we may be certain, that if human actions are governed by invariable laws, the aggregate result will be something like a constant quantity' (p. 933).[30]

With the rare exception of such cases entailing extremely large data sets, however, Mill ruled out the empirical discovery of law; in general, his method precludes empirical measurement of causal relations in social science. This does not imply that there is no role for specific observation of real world outcomes in Mill. But that role is clearly different from the role assigned to observation in Jevons, or in contemporary procedures. For Mill maintained that the social scientist in application was not only to allow for previously omitted circumstances anticipated in the specific case at hand, but also to account *ex post* for the gap between anticipation and outcome. The study of each specific outcome was akin to a case study in which the scientist investigated the existence and influence of causal factors unaccounted for in the theory, evaluated the merits of the theory in terms of its ability to explain that outcome, and, possibly, revised the theory by the alteration of the axiomatic framework.

As we will see below, Jevons also acknowledged that multiple causation created difficulties for the precise determination of laws in social science (*PS,* p. 750). But multiple causation governing human phenomena carried a second, fundamentally important, implication for Mill's method. For Mill insisted that while the theoretical analysis necessarily entailed abstracted from causal influences at work, in practice, or application, the social scientist must correct the analysis by accounting for those abstracted from causal influences, and by making a judgement as to whether those influences warranted a change in the theory. Thus, Mill maintained that in application the scientist pay particular attention to 'disturbing causes': he insisted that the realism lost by abstraction in theory be reintroduced at the level of application.

JEVONS'S METHODOLOGY

Even in the event that fully deterministic law prevailed, Jevons stressed that in social science the ballot box and the consequent realm of ignorance were vast. Like Mill, he alluded to the 'complexity' of economic relationships, which hindered precise theoretical specification of laws: 'as soon as we attempt to draw out the equations expressing the laws of demand and supply', for instance, 'we discover that they have a complexity entirely surpassing our powers of mathematical treatment'.

Consequently, the political economist can only 'lay down the general form of the equations, expressing the demand and supply for two or three commodities among two or three trading bodies' (*PS,* pp. 759–60).[31] Jevons endorsed a 'comparatively abstract and general' method, 'treating mankind from simple points of view, and attempting to detect general principles of action' (p. 760).[32]

In his *Theory of Political Economy,* Jevons expanded on this methodological recommendation.[33] Like Mill, he argued that 'we may start from some obvious psychological law, as for instance, that a greater gain is preferred to a smaller one, and we may then reason downwards, and predict the phenomena which will be produced in society by such a law' (pp. 16– 17).[34] Like Mill also, Jevons recognized that because of the pronounced multiplicity of causes affecting social phenomena The causes in action in any community are, indeed, so complicated that we shall seldom be able to discover the undisturbed effects of any one law' (p. 17). Thus only insofar 'as we can analyse the statistical phenomena observed' was verification of the *a priori* reasoning obtained.

In the face of pronounced multiple causation, Jevons's methodological recommendations for the social scientist explicitly followed the method attributed to Mill. That method entailed three components:

1 Establishment of axioms based largely on observation, introspection, or intuition.
2 Deductive reasoning to conclusions.
3 Use of specific experience to confirm or refute those conclusions.

> Possessing certain facts of observation, we frame an hypothesis as to the laws governing those facts; we reason from the hypothesis deductively to the results to be expected; and we then examine these results in connection with the facts in question; coincidence confirms the whole reasoning;

> conflict obliges us either to seek for disturbing causes, or else to abandon our hypothesis.
>
> (*TPE,* pp. 17–18)[35]

Two elaborations on this methodological position are outlined in the *TPE,* and both are attributed to Mill. First, Jevons suggested that the 'ultimate laws' of economics, the axioms upon which its reasoning may be 'confidently' based, are known by 'intuition', or 'furnished to us ready made by other mental or physical sciences' (*TPE,* p. 18). These 'simple inductions' include: That every person will choose the greater apparent good; that human wants are more or less quickly satiated; that prolonged labour becomes more and more painful' (p. 18). Second, Jevons alluded to the difficulties created for the process of direct verification in economics, 'because, as J.S.Mill has fully explained, the circumstances of a nation are infinitely complicated, and we seldom get two or more instances which are comparable' (p. 18). Experimentation was thus extremely difficult in economics:

> To fulfil the conditions of inductive inquiry, we ought to be able to observe the effects of a cause coming singly into action, while all other causes remain unaltered. Entirely to prove the good effects of Free Trade in England, for example, we ought to have the nation unaltered in every circumstance except the abolition of burdens and restrictions on trade. But it is obvious that while Free Trade was being introduced into England, many other causes of prosperity were also coming into action—the progress of invention, the construction of railways, the profuse consumption of coal, the extension of the colonies, etc. etc. Although, then, the beneficent results of Free Trade are great and unquestionable, they could hardly be proved to exist *a posteriori;* they are to be believed because deductive reasoning from premises of almost certain truth leads us confidently to expect such results, and there is nothing in experience which in the least conflicts with our expectations.
>
> (*TPE,* pp. 18–19)

Notwithstanding the enormous difficulties involved in direct experimentation, as well as his endorsement of Mill's methodology for economic analysis, Jevons called for the use of techniques to approximate relationships in economics, an exercise designed to 'verify' and 'render useful' the 'deductive science of Economics' by investing 'theory' with 'the reality and life of fact' (*TPE,* p. 22).[36] While he made 'hardly any attempt to employ statistics' in the *TPE,*[37] Jevons did discuss techniques of measurement and approximation in detail in his major methodological work, *The Principles of Science*.

Here Jevons approached the problem of multiple causation in social as well as natural sciences from the perspective of isolating particular 'constant' causal relationships from 'variable' causes, which he also termed 'interfering causes', and 'noxious errors'.[38] He argued that 'the object of the experimentalist [is] to measure a single effect only', in which case one 'endeavours to obtain that effect free from interfering effects' (*PS,* p. 339). The key task for the scientist attempting to 'disentangle' 'the complicated phenomena of nature', consists of rendering the effects of 'interfering causes' as negligible as possible (p. 339). In the face of multiple causation, the recommendation is that the scientist 'make the effects [of the 'constant cause'] as considerable as possible compared with the other effects, which he reduces to a minimum, and treats as noxious errors'.

Jevons outlined five methods for treating 'variable causes' or 'noxious errors':

1 The method of avoidance.
2 The differential method.
3 The method of correction.
4 The method of compensation.
5 The method of reversal (*PS,* pp. 339–40).

The first of these involved avoiding error altogether through careful experimental design; the differential method entailed comparing outcomes when errors were present with those when errors were absent. The method of correction called for estimation of the effect of error; compensation involved neutralising the interfering cause by 'balancing' it against 'an exactly equal and opposite cause'. The scientist attempting to apply the method of reversal was directed to set up an experiment so that the error cause worked in opposite directions for different outcomes, with the result that errors balance each other, 'the mean result being free from interference' (p. 340).

Whenever possible, error should be altogether avoided. But failing this, Jevons argued, careful experimental design should ensure that errors were 'as small, but more especially as constant, as possible' (*PS,* p. 353). Since in Jevons's mind the complexity of natural and social phenomena rendered the existence of error inevitable, the method of reversal is said to be 'most potent and satisfactory' (p. 354): 'We may look upon the existence of error in all measurements as the normal state of things. It is absolutely impossible to eliminate separately the multitude of small disturbing influences, except by balancing them off against each other' (p. 357). If the reversal method were successfully applied, 'If we can get two experimental results, one of which is as much too great as the other is too small, the error is equal to half the difference, and the true result is the mean of the two apparent results' (p. 354; cf. p. 359).[39] Unlike Mill, Jevons did not suggest that the use of a mean implied that all combinations of error must be present.

Jevons concluded that elimination of error remained 'absolutely impossible, except by balancing them off against each other'. Instead, he placed the method of reversal—balancing noxious errors—on the same level conceptually as elimination of error: 'The elimination of errors of unknown sources, is almost always accomplished by the simple arithmetical process of taking the *mean,* or, as it is often called, the *average* of several discrepant numbers' (*PS,* p. 359; cf. p. 357).[40]

The method of reversal was then especially powerful because it allowed for application of the Law of Error, to which Jevons paid high tribute:

> To bring error itself under law might seem beyond human power. He who errs surely diverges from law, and it might be deemed hopeless out of error to draw truth. One of the most remarkable achievements of the human intellect is the establishment of a general theory which not only enables us among discrepant results to approximate to the truth, but to assign the degree of probability which fairly attaches to this conclusion.
>
> (*PS,* p. 374)

Successful application of the 'reversal method' justified use of the Law of Error. Jevons allowed also, however, that the Law of Error might be applied in the absence of knowledge of 'sources of error'. This latter case was equivalent to application of the reversal method, since it 'may certainly be assumed' that 'positive and negative errors shall be equally probable' ('because we are supposed to be devoid of any knowledge as to the causes of the residual errors', p. 376). Thus the Law of Error

> is to be used in the dark, when we have no knowledge whatever of the sources of error. To assume any special number of causes of error is then an arbitrary proceeding, and mathematicians have chosen the least arbitrary course of imagining the existence of an infinite number of infinitely small errors, just as, in the inverse method of probabilities, an infinite number of infinitely improbable hypotheses were submitted to calculation.
>
> (*PS,* p. 380)[41]

Justification of the Law of Error, and least squares methods, constitutes a central theme of *The Principles of Science*.[42] A second, related, theme of that work is that of measurement and approximation. Here, least squares techniques were said to be the means to finding the most probable values for constants, once a functional form had been obtained (see Aldrich 1987, p. 248).

Jevons left no doubt as to the importance of obtaining precise, numerical, hypotheses. To facilitate 'satisfactory comparison with experience', he reasoned that hypotheses must entail 'mathematical exactness' whenever possible (*PS,* p. 513). 'Vagueness and incapability of precise proof or disproof', in contrast, 'often enable a false theory to live' (p. 513). But much more was involved. Jevons had in mind a process whereby 'inductive quantification' moves the scientist closer to the 'true' function.[43] Thus 'the history of scientific problems' occurs 'a single step at a time': 'A problem is solved for the first time by making some bold hypothetical simplification, upon which the next investigator makes hypothetical modifications approaching more nearly to the truth' (p. 465; cf. pp.

456f).[44] ‘Inductive quantification’, the ‘processes of reasoning which have for their object to disclose laws of nature expressed in quantitative equations’ (p. 483), consequently not only helped prevent error, but also actually facilitated scientific discovery.

The procedure for approximation involved directing ‘reasoning faculties’ to the ‘numerical facts’ of inquiry, to discover the ‘mathematical laws to which varying quantities conform’. If a connection were envisaged between a variable and variant, Jevons posed the following questions:

1 Is there any constant relation between a variable and a variant?
2 What is the empirical formula expressing this relation?
3 What is the rational formula expressing the law of nature involved?

In one variable instances, the discovery of a precise cause/effect relationship by experimental methods was straightforward:[45] ‘take the mean of all those in which the effect to be measured is present, and compare it with the mean of the remainder in which the effect is absent, or acts in the opposite direction’ (p. 554). Then ‘mathematical processes’, entailing graphical procedures or least squares calculations, enabled discovery of ‘a mathematical formula yielding numbers in more or less exact agreement’ with the observed data (pp. 487–88, cf. pp. 492–93). In general cases where an effect, y, is caused by a cause, x, the form of the ‘empirical formulae and laws’ might be assumed to be: $y=A+Bx+Cx^2$, which can be solved for the parameters A, B, and C (p. 487). The appropriate procedure was thus to use a polynomial of degree 1, 2, or 3, and to use least squares to estimate the coefficients (p. 487). These formulae are not the true natural laws, but ‘only approximations to the results of natural laws founded upon the general principles of approximation’ (p. 489). Jevons never clarified, however, how the scientist distinguishes between a ‘close’ approximation, and the ‘true’ function.

In the more general case of multiple (constant) causation, Jevons recommended reliance upon a key assumption which he termed the ‘approximate independence of small effects’. The investigator’s task ‘is immensely simplified when we may consider each cause as producing its own effect invariably, whether other causes are acting or not. Thus if the body P produces x, and Q produces y, the question is whether P and Q acting together will produce the sum of the separate effects, $x+y$’ (*PS*, p. 475). A general principle of scientific method allowed that ‘if effects be of small amount, comparatively to our means of observation, all joint effects will be of a higher order of smallness, and may therefore be rejected in a first approximation’ (p. 476). Thus, as long as the effects under consideration were ‘small’, the scientist might proceed in cases of multiple causation under the assumption of additive and independent effects (p. 478).[46] Jevons often assumed additive effects in economics, where observed outcomes were ‘aggregates of an immense number of separate results’ (p. 501).[47]

In the case of 'quantities indicated by theory, but empirically measured', theory aids in the correct specification of multiple cause relationships, and thus in the application of the method of means and the Law of Error:

> If we have a great number of empirical measurements, each representing the joint effect of a number of causes, our object will be to take the mean of all those in which the effect to be measured is present, and compare it with the mean of the remainder in which the effect is absent, or acts in the opposite direction. The difference will then represent the amount of the effect, or double the amount respectively…. In this case we trust to chance that all other effects will lie about as often in one direction as the other, and will neutralise themselves in the drawing of each mean. It is a great advantage, however, to be able to decide by theory when each principal effect is present or absent; for the means may then be drawn so as to separate each such effect, leaving only minor and casual divergences to the law of error.
>
> (*PS,* p. 554)

In the case of 'explained results of measurement', when 'purely empirical application[s] of measuring instruments' are shown subsequently to agree with some hypothesis, the same method also came into play. Comparison of the hypothesis with additional observations was required; if 'the divergences between theory and experiment be comparatively small, and variable in amount and direction', they may be 'attributed to inconsiderable sources of error' (*PS,* pp. 554–55). In these cases, 'the probability of the theory is much increased' and the scientist may use the theory 'with more confidence' in the anticipation of further results in the future (p. 555).

Jevons urged that these procedures, which he termed broadly 'inductive quantification', be directed towards 'the raw materials of knowledge'—'numerical facts'—in order to 'draw forth the principles of nature' (*PS,* p. 483).[48] In some instances, the scientist might only establish causality, although the precise relationship between the variant and the variable remained undetermined. These circumstances involved data established introspectively, for which interpersonal comparisons were not yet possible:

> Fatigue increases with exertion; hunger with abstinence from food; desire and degree of utility decrease with the quantity of commodity consumed…. The facility with which we can time after time observe the increase or decrease of one quantity with another sufficiently shows the connection, although we may be unable to assign any precise law of relation. The probability in such cases depends upon frequent coincidence in time.
>
> (*PS,* p. 487)[49]

The 'empirical formulae' resulting from the application of techniques of inductive quantification to data are 'only approximations to the results of natural laws founded upon the general principles of approximation'. Jevons distinguished between these 'approximations', and 'the true laws of nature' although, as noted above, he failed to provide any criteria whereby the scientist might evaluate whether a true law or a close approximation had been obtained (*PS,* p. 489). Inaccuracies might remain indefinitely: 'Careful examination, however, will show that a series of minor inaccuracies remain to be corrected and explained, were our powers of reasoning sufficiently great, and the purpose adequate in importance' (p. 465; cf. pp. 456f, 467, 499).[50] In fact, despite the fact that laws of nature are precise (p. 462), knowledge must indefinitely remain approximate: 'All laws and explanations are in a certain sense hypothetical, and apply exactly to nothing which we can know to exist. In place of the actual objects which we see and feel, the mathematician substitutes imaginary objects, only partially resembling those represented, but so devised that the discrepancies are not of an amount to alter seriously the character of the solution' (p. 458; cf. p. 456).[51]

A rational function, derived using theory or analogy,[52] yields, in contrast, 'the actual relation between the quantity of the cause and that of the effect…the *reason* or exact nature and origin of the law in question' (*PS,* p. 489).[53] Yet these relationships might lie indefinitely beyond the scope of scientific endeavour, as in 'many important branches of science', where 'no precise laws have yet been detected' (p. 499; cf. pp. 456f). This was especially the case in economics, where 'all the functions involved are so complicated in character that there is not much fear of scientific method making rapid progress' (p. 760).

If hypothesized results and observations are 'close', however, then at the next stage of the procedure the scientist might assume that the hypothesis is correct and measurement errors with a zero mean exist (*PS,* pp. 554– 55). Subsequent comparison of the hypothesis with observations was then required; if 'the theoretical result falls within the limits of probable error', 'the probability of the theory is much increased, and we may employ the theory with more confidence in the anticipation of future results' (p. 555).[54] For Jevons, confirmation renders a hypothesis 'probable' or 'approximately certain' (p. 514). Confirmed hypotheses can be stated as true natural laws, with the qualification that the future resembles the past (pp. 532–33; cf. p. 525). Even these, however, yielded limited grounds for predictions:

> It is a question of profound difficulty on what ground we are warranted in inferring the future from the present, or the nature of undiscovered objects from those which we have examined with our senses…. All predictions, all inferences which reach beyond their data, are purely hypothetical, and proceed on the assumption that new events will conform to the conditions detected in our observation of past events. No experience of finite duration can give an exhaustive knowledge of the forces which are in operation.

(*PS,* pp. 149–50)

Since Jevons believed this type of exercise led the scientist closer to the 'true' laws of nature, however, he repeatedly called for the collection and use of statistics to aid the social scientist in these endeavours. In 1870, he urged Section F (Economic Science and Statistics) of the British Association for the Advancement of Science (BAAS) to 'analyse', 'arrange', and 'explain' economic facts: 'In order, however, that any subject can be fitly discussed by a Section of this Association [BAAS], it should be capable of scientific treatment. We must not only have facts, numerical or otherwise, but those facts must be analysed, arranged, and explained by inductive or deductive processes' ('Opening Address as President of Section F', *MSR,* pp. 194–95). Further, data were to be collected systematically; the 1870 Census, Jevons complained, was useless for making cross-sectional comparisons, since enumeration and tabulation methods varied in England, Scotland and Ireland (*MSR,* p. 209).[55] As we have seen above (pp. 83; 85), Jevons reiterated his calls for the collection and use of economic data in the *Theory of Political Economy:*

> The very abundance of our data is perplexing. There is not a clerk nor book-keeper in the country who is not engaged in recording numerical facts for the economist. The private-account books, the great ledgers of merchants and bankers and public offices, the share lists, price lists, bank returns, monetary intelligence, Custom-house and other Government returns, are all full of the kind of numerical data required to render Economics an exact mathematical science. Thousands of folio volumes of statistical, parliamentary, or other publications await the labour of the investigator. It is partly the very extent and complexity of the information which deters us from its proper use. But it is chiefly a want of method and completeness in this vast mass of information which prevents our employing it in the scientific investigation of the natural laws of Economics.
>
> (*TPE,* pp. 10–11; cf. p. 22)[56]

In sum, the purpose of comparison of the hypothesis with specific experience was:

1 Quantification of the hypothesis.
2 Confirmation, thereby increasing the scientist's confidence in the hypothesis.
3 Improvement of the hypothesis, entailing more accurate or precise specification of the mathematical formulae involved, and (possibly) addition of omitted causes.[57]

In these formal methodological writings the emphasis is not upon 'falsification', entailing rejection or qualified acceptance of the hypothesis based upon an analysis of data.[58] We will see in Chapter 10 that Jevons's procedures in applications also emphasized confirmation and quantification, as opposed to falsification.

In the formal discussions of approximation, Jevons is curiously silent on the assumptions required in order to use the method of means with confidence. Instead, he seemed content to qualify his recommendations with the caveat that scientists ensure—in some unspecified manner—that variable causes 'balance' in the drawing of means. But he did emphasize two features which would eventually be integrated into statistical inference procedures. First, the scientist was to choose observations with care, so that they were affected by the cause(s) of interest and 'accidental' causes, which might be assumed to cancel, as opposed to unmodelled 'constant' causes. Second, as the number of observations confirming the hypothesis (or underlying the measurement) increased, the scientist's confidence in the outcome increased.

CONCLUSIONS

The use of specific experience was important in Mill's methodology, since only through that process was the economist's necessarily abstract analysis rendered a realistic description of economic phenomena. For Mill, Jevons's 'inductive quantification' signified unrealistic neglect of disturbing causes and unfortunate simplification; statistical forecasting was inappropriate in social science. Mill's methodology reflects a deep-seated reluctance to assign numerical precision, a reluctance which emerges from his conviction that in social science no two observed settings are ever similar enough to combine in a statistical sense.

Jevons appreciated that Mill's method for theoretical economics was at one with his own, and he explicitly endorsed Mill's 'substantially correct' method of starting from an 'obvious psychological law', reasoning to a hypothetical conclusion, and then verifying the results. And he, too, was aware of the pronounced difficulties that multiple causation created for the social scientist who tried to disentangle causal relationships or to make precise predictions. But while Mill focused on differences across observations, and asserted that human characters 'are never in any two cases exactly similar', Jevons was concerned with uniformities, defined science as the discovery of uniformity, and maintained that 'certain uniformities of thinking and acting…can be detected' in economics. This alteration of focus allowed Jevons to come to a very different conclusion concerning the role of specific experience in applied social science—that approximation in economics was justified. He placed faith in procedures whereby phenomena were affected by 'constant' cause(s), as well as disturbing causes that were treated as 'balancing', and thus effectively ignored. Jevons made a key contribution to the development of statistical techniques in social science—the recognition that data be free of the influence of 'constant' causes, other than those cause(s) of interest, as well as the hypothesis that unmodelled causes 'cancel' in the drawing of a mean. For Jevons, this lent a much sought after numerical precision to the notion of ‘tendency’, precision which possessed a claim to scientific appeal since the procedure was based upon general scientific principles, and which contributed to scientific progress by assisting the theorist in discovering ‘laws’.

A study of the methodology of economics contends that ‘in economics, as Mill had explained, we test the *applications* of theories to determine whether enough of the disturbing economic causes have been taken into account to explain what actually happens in the real world after allowing, in addition, for noneconomic causes’ (Blaug 1980, pp. 76–77). The foregoing has demonstrated that Mill was indeed convinced of the need to explain or account for ‘disturbing causes’. To ascertain empirical regularities, all possible combinations of specific causes must first be observed while the general causes of interest remained unchanged, a condition rarely met in social science. Consequently, Mill urged the social scientist to turn careful attention to ‘disturbing causes’ which, unlike Jevons’s ‘noxious’ errors, consisted of specific and often quantitatively important causal influences—such as tenancy arrangements or capital stock availability in farming. For Mill, the ‘theory-practice’ distinction corresponded to abstraction from disturbing causes (in theory), and then attending to disturbing causes (in practice). While Mill’s insistence that one examine each case for the operation of disturbing causes constituted the central methodological stance within British social science, empirical methods could not be appropriated into economic analysis.

Jevons’s methodology de-emphasized the disturbing causes instrumental to Mill’s method. In contrast to Mill, Jevons called for the use of techniques to ensure that ‘noxious’ causes ‘balanced’. ‘Extraneous’ or ‘noxious’ causes might be presumed quantitatively insignificant and, moreover, distributed around a zero mean, so that underlying uniformities might be detected even amidst their presence. As a result, for Jevons the theory-practice distinction loses potency: in application as well as in theory the social scientist might abstract from disturbing causes.[59] His recommendation that social scientists proceed by way of ‘wide averages’ without regard to the peculiarities of specific cases, as well as his own pioneering attempts at empirical measurement—to which we turn next—paved the way for the subsequent development of empirical economics.

10
JEVONS'S EMPIRICAL STUDIES

INTRODUCTION

Jevons's emphasis on 'inductive quantification', entailing procedures to measure, approximate, or establish economic relationships, constituted a key departure from the method of Classical economists such as J.S.Mill. In addition, as we have seen, Jevons was known to his contemporaries as an applied economist, and he made repeated calls for the collection, arrangement, and explanation of economic statistics. This chapter examines his attempts to collect and use economic data, with an aim to confirming that his methodological recommendations were, indeed, revolutionary for economics.[1] Of particular relevance for what follows, shall be Jevons's investigation of the value of gold, the study of currency weights, his use of the Davenant corn data, and his attempts to fit economic data to the sunspot cycle.[2]

In what follows, we first examine two examples of Jevons's attempts to measure economic phenomena and to use his measurements in support of economic hypotheses. Between 1863 and 1869 he established the fact of a depreciation of gold and attempted to explain the depreciation using a spectacular array of data on prices (this is the subject of pp. 195–201). Here, the theoretical principle on which Jevons's exercise relied (the Quantity Theory of Money) was well established in the literature. Since prices were subject to a wide variety of influences, however, establishing the depreciation proved no simple matter. The studies of currency weights, designed to support Gresham's Law, reveal the same painstaking care and attention to detail, and relied on the argument (outlined as a general principle on pp. 186–88) that influences on currency wear other than age would balance, so that average age could serve as a measure of average currency wear. (We turn to that investigation on pp. 201–3.)

In a rare foray into application in the otherwise abstract *Theory of Political Economy,* Jevons attempted to fit estimates of corn prices and quantities to a functional form (we investigate that attempt on pp. 204–5). Here he commenced with raw data which revealed an apparent relation between price and quantity. This relationship he had explained in the *TPE,* using the newly developed mathematical marginal utility theory; his estimation was regarded as a complement to that mathematical theory, which had left the precise nature of the relationship unspecified.[3] He then proceeded to manipulate the data, in order to measure the cause-effect relationship more precisely.

On pp. 205–10 we examine Jevons's attempts to relate economic variables to the estimated sunspot cycle. Here, as we have seen in Chapter 3, the theoretical basis for Jevons's empirical investigations was less well formulated and relatively complex. In fact, he altered his explanation for the transmission mechanism of the cycle in about 1878, when he began to argue that the fluctuation was transmitted to Britain via cyclical fluctuations in aggregate demand for British manufactured goods throughout India and China. Not surprisingly, given the difficulties in outlining the precise mechanisms involved, as well as the profound difficulties entailed with the measurement of 'moods' or expectations—which formed a key part of Jevons's explanation for the cycle (Chapter 3)—his work in this area was unsuccessful and has been the subject of much criticism.

We turn, finally, to some reactions to Jevons's procedures, in order further to assess my argument that his methods were, indeed, a departure from those of Mill. The reactions of T.E.C.Leslie and J.M.Keynes provide additional evidence that the use of averaging, the method of means, and the assumption that unmodelled causes 'balanced', constituted a departure from earlier methods, and one that encountered some resistance among social scientists.

THE VARIATION OF PRICES

Spectacular manipulation of data and attempts to ascertain underlying regularities are evident in *A Serious Fall in the Value of Gold ascertained, and its Social Effects set forth* [1863].[4] Here Jevons observed the raw data, and relied upon economic theory to provide a working hypothesis concerning these observations. He then used data to confirm his theoretical argument, and attempted to measure the size of the gold effect. That his hypothesis (the Quantity Theory of Money) contained 'nothing revolutionary in its implications for monetary theory' has been recognized by R.D.C.Black (1981, p. 19).[5] The basic argument was that the 'value' of gold, meaning its long run, or 'permanent' purchasing power, had fallen as a result of a large supply influx following the discovery of new gold mines.[6] Evidence of 'a fall in the value of gold', he suggested, 'is the fact that more gold is now usually required to purchase an article than in former years' (*ICF,* p. 18). Simple-minded observation, however, was uninformative:

> This alteration [of value] may arise from circumstances affecting the supply or demand of either article, just as a balance may be disturbed by an upward or a downward force, applied to either arm. There is nothing in the simple motion to indicate from which side the change comes…. The value

> of A [gold] may fall from a lessened demand or an increased supply. The value of each of B, C, D, E may likewise rise from an increased demand or a lessened supply.
>
> (*ICF,* pp. 18–19)[7]

But the situation was even more complex than this, since both gold and goods might be influenced by temporary as well as permanent forces. 'Temporary' forces affected prices 'due to varying demand, and dependent on the manias for permanent investment, and the inflations of credit', as well as the 'natural variations of supply' (*ICF,* p. 35). Permanent increases in prices occurred because 'gold is become more abundant and easily obtained', or because goods were 'more scarce and troublesome to procure'—apparently an allusion to diminishing returns (p. 18).[8]

A key presumption was that any one observed price was an indication of the value (expressed in gold) of that good. But observation of a single variation in price provided little information concerning whether the variation were a short-term fluctuation or a long-term change. Jevons's first substantive task was to eliminate 'the various causes of temporary fluctuations in prices, in order that we may the more surely recognize the effect of the permanent cause in question' (*ICF,* p. 16). He hypothesized that 'temporary' price alterations, 'the distinct and contrary variations peculiar to [goods] B, C, D, etc.' would 'destroy each other more or less completely in drawing the average [price]' (p. 20).[9] An average price across many goods would reveal the permanent 'common variation' which all goods 'equally suffer' 'in being measured against A [gold]' (p. 20; cf. p. 58). By assumption, then, 'temporary' forces were seen to affect prices of different goods independently and with a mean of zero.[10]

Jevons's second task was to argue that the permanent variation in prices which he had in the first place measured, reflected a change in the value of gold.[11] In thus proceeding he relied upon the 'common cause' argument. It was eminently more reasonable that the values of all goods had changed for one (common) reason—a change in the value of gold generated by an alteration in gold supply conditions—than it was to propose that values of goods had all altered for disconnected reasons:

> There is something, however, which we may say in the case of five articles, but cannot say in the former case of two articles. *It is more likely that the alteration should have arisen on the side of A than on the side of B, C, D, E,* because one cause affecting A will suffice to explain the change, whereas four separate but concurring causes respectively affecting B, C, D, E will be needed on the other side. The odds, then, are four to one in favour of the cause of alteration being in A, and not in B, C, D, E.
>
> (*ICF, p.* 19)[12]

This was all the more reasonable, he maintained, since the circumstances of gold production had recently altered (*ICF,* pp. 22, 59).

Turning to Jevons's calculation in more detail, the measurement in *ASF* followed Newmarch by first attempting to eliminate cyclical influences on prices, which were seen to leave the permanent value of goods undisturbed (*ICF,* p. 35). Using the rate of interest as an indicator of the cycle, Jevons selected 1844–50 as years spanning a cyclical trough to peak, and drew the arithmetic mean price of each of thirty-nine goods in twelve product groups for these years, yielding, by assumption, 'the true or natural average according to the undisturbed value of gold' (p. 43).[13]

Jevons then proceeded to calculate the ratio of the post-gold-discovery (i.e. post-1851) yearly price of each good to this six-year average. Having thus attempted to eliminate cyclical influences from his data, he argued that the ratios represented 'the rise of prices above their former ordinary level', still, however, affected by 'any temporary fluctuations'. To eliminate these, he grouped similar goods into categories (metals, cottons, and dyes, for instance),[14] and found the geometric mean within groups.

Jevons insisted that the geometric mean constituted the correct method of averaging in economics, when the quantities of interest were ratios. To justify using the geometric mean, he maintained that if the price of good A is one hundred and first doubles and then falls to one half its original value, the correct mean price of A is given by one hundred, the geometric mean $(200\times50)^{1/2}$ (*ICF,* p. 23).[15] Apparently, his choice of mean was influenced by his presumption, noted in Chapter 4, that absolute price is meaningless, while price ratios are meaningful:

> There is no such thing as an average of prices at any one time. If a ton of bar-iron costs £6, and a quarter of corn £3, there is no such relation or similarity between a ton of iron and a quarter of corn as can warrant us in drawing an average between £6 and £3; and similarly for other commodities. If a subsequent time a ton of iron costs £9, and a quarter of corn £3 12s. there is again no average between these quantities. We may, however, say that the iron has risen in price 50 per cent. or by 1/2; what was previously 100 has become 150; corn has risen 20 per cent. or by 1/5: what was 100 has become 120. Now the ratios 100:150 and 100:120 are things of the same kind, but of different amounts, between which we can take an average.
>
> (*ICF,* p. 23)

In 'The Variation of Prices', Jevons acknowledged that Laspeyres's argument concerning the arithmetic mean held 'some ground'; yet he insisted on retaining the geometric mean for his own 'approximate results', since it is a mean of means (the arithmetic, geometric and harmonic), it is easily calculated using logarithms, and it seems 'to give in the most accurate manner such general changes in prices as is due to a change on the part of gold' (*ICF,* p. 121).[16] This latter argument entailed the presumption that

> any change in gold will affect all prices in an equal ratio; and if other disturbing causes may be considered proportional to the ratio of change of price they produce in one or more commodities, then all the individual variations of prices will be correctly balanced off against each other in the geometric mean, and the true variation of the value of gold will be detected. (pp. 121–22)[17]

The average of these ratios was then found to reveal a 13 per cent permanent rise in prices or, equivalently, depreciation of gold values, 'the fact of an alteration in the usual ratios at which gold is exchanged against the great mass of other commodities' (*ICF,* p. 59).

Jevons considered omitting goods that appeared to be relatively susceptible to temporary supply fluctuations, and argued, in opposition to this procedure, that a preferred method consisted instead of enlarging the sample (*ICF,* p. 26). He thus constructed a second measure of price changes using 118 commodities, 'comprising nearly all the great staple articles', in 39 product groups (p. 54; see Appendix 10.1).[18] Of this larger sample, six product groups fell in price; yet 'on the whole' the conclusion was favourable to his case: '*The groups of articles which have risen are twice as numerous as those which have fallen, comprise immensely more important articles of wealth, and have risen more than the others have fallen*. There can be no room to doubt, then, the great preponderance of the rising prices over the falling prices….' (p. 56). This calculation yielded a measured average price increase after 1851 equal to 10¼ per cent.

In 'The Variation of Prices', Jevons relied on a similar method and enlarged the scope of his investigation still further. Here he examined prices over a lengthy time span, arguing that 'We cannot safely assert a given change of prices to be occasioned by an alteration in the supply of gold, unless we observe the general course of prices for a considerable interval, and show that there was an *unusual change* in the course of prices subsequent to an *unusual change* in the supply of gold' (*ICF,* p. 119). Here again he found that since 1852 'prices have risen in a permanent manner'—a result which, he argued, 'points to the effect of the Californian and Australian [gold] discoveries' (p. 129).

In *The Depreciation of Gold,* Jevons replied to Cliffe Leslie's criticism that one must have 'allowed for all the particular causes which may have elevated or depressed the price of each commodity' before a fall in gold could be ascertained,[19] with the argument that the social scientist must rely on the use of averages:

> Were a complete explanation of each fluctuation thus necessary, not only would all inquiry into this subject be hopeless, but the whole of the statistical and social sciences, so far as they depend upon numerical facts, would have to be abandoned. It has been abundantly shown by Quetelet

> and others, that many subjects of this nature are so hopelessly intricate, that we can only attack them by the use of averages, and by trusting to probabilities.
>
> (*ICF,* pp. 155–56)

If the study were inclusive enough, Jevons reiterated, as ‘when we take a large list of fifty commodities’, ‘particular influences’ on individual prices ‘will not all act the same way’; with an almost ‘infinite’ probability, ‘a rise in one case will balance a fall in another’ (p. 156).[20] He now calculated that the average price rise was 16 per cent, found the probable error of his result using ordinary least squares,[21] and constructed a confidence interval for the true mean price alteration. Presuming that mean price changes were normally distributed, Jevons concluded that *‘it is as likely as not that the true alteration of gold lies within 2 1/2 per cent, of 16 per cent., or between 13 1/2 and 18 1/2 per cent’* (p. 157).

In 1863 Jevons confided in correspondence to his brother that his statistical analyses of prices, ‘consisting in a simple curve of the value of gold, would be one of the most important and interesting statistical conclusions that could be got’ (15 September; *P&C,* **iii,** p. 42). In the light of the assumption that ‘temporary’ variations in prices ‘balanced’ in the drawing of a mean, Jevons's work with prices constitutes an attempt to trace a value curve for gold, generated by increases in the supply of gold, and assuming a fixed velocity and transactions demand for real cash balances.[22] Jevons, indeed, posited a rectangular hyperbola as a theoretical curve for the value of gold: ‘if *a* be the quantity of gold in the world at any time, and *b* the quantity added in each succeeding year, then at the end of *n* years, the value of gold is reduced as 1 to $a/(a+nb)$, which is always growing less as *n* increases, but at a constantly less rate’ (*ICF,* p. 65).

Diagrammatically, this implies that if the supply of gold doubles from year 1 to year 2, the nominal value of gold falls from V_1 to V_2, to one half its former level (Figure 10.1). Jevons never drew Figure 10.1. What he estimated statistically—or measured—were alterations in $V_1 - V_2, \ldots, V_T - V_{T-1}$. Then, assuming stock supply schedules for gold induced the alterations, the market equilibrium curve is statistically determined.

Establishing the causal relationship

In order to establish the cause of the measured price increases, Jevons relied on two arguments. First, as noted above, he argued that it was more probable that one cause acted on all prices than it was that many concurrent causes did. Second, Jevons emphasized that the measured rise of prices followed the influx of gold (*ICF,* p. 119).[23]

Jevons was, however, overly eager to conclude that his research ‘proved’ gold caused the alteration in values; in his 1869 ‘Depreciation of Gold’ he inferred that ‘the chances are 10,000 to 1 against a series of disconnected and casual

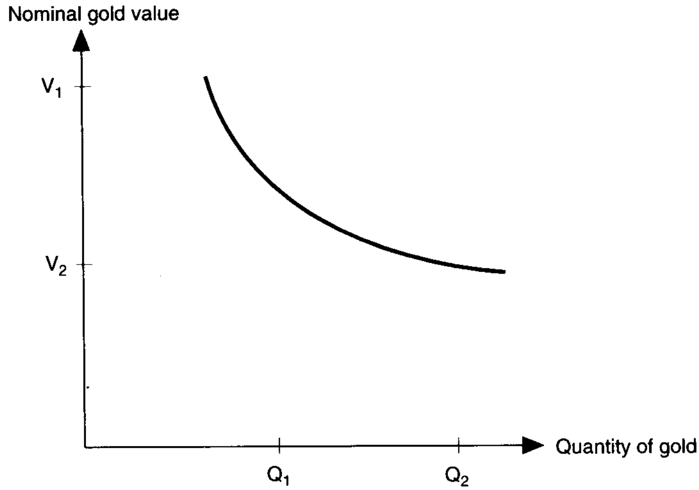

Figure 10.1 The value of gold

circumstances having caused the rise of price…instead of the same general cause acting over them all' (*ICF,* p. 157).[24] And there are further problems with the gold studies. Given Jevons's notion of deterministic laws, any observed error structure consists of unmeasured effects of (deterministic) causal influences (*PS,* p. 336; cf. pp. 175–77). There is no reason, even if the laws governing temporary influences on prices are independent, for the error term to have an expected value of zero. Since Jevons recognized that temporary influences on prices (especially those governing supply conditions) were not independent, the assumption is all the more inappropriate.[25] Finally, the measurement of an average rise in prices was not a conclusive verification of a causal relationship between the quantity of gold and the price level, since Jevons's inference concerning the cause of this depreciation was based on a single episode.

Observing that variations in price alterations across commodities were not uniform, Jevons examined the conditions of demand and supply across various product groups. Thus he did in fact recognize that his measured price change reflected some 'permanent' changes in real conditions of production that had not 'balanced' in the drawing of a mean, and in the face of this realization he attempted to employ the 'method of correction' outlined on pp. 183–86. For many goods, Jevons argued that these permanent influences resulted from variations in supply conditions in the face of ongoing population growth. While 'animal materials' are said to undergo few 'temporary fluctuations' as a result of weather variations, their production is subject to diminishing returns; the 'increase of demand' for tallow, hides, leather, and butchers' meat due to ongoing population growth is said to 'outrun a supply incapable of great increase' (presumably as a result of land constraints), and therefore these goods exhibited higher than average price increases (*ICF,* p. 47). Ongoing technological change affecting many manufactured goods, the repeal of tariff barriers to trade, and the opening of new markets are all said, in addition, to have effected a secular average decline in prices. Thus a ‘speculative conclusion’ is said to be in order: ‘The gold discoveries have had the double effect of arresting the fall of prices and then raising them. The total effect is not merely the rise that has occurred but that rise *plus* the fall that would have occurred’ (Note C, *ICF,* p. 110).[26]

Jevons did use the data skilfully in these studies; having ‘been led to observe the great rise in prices of nearly all things since 1851’, economic theory suggested this was ‘obviously’ ‘due to a fall in the value of gold’ (to Herbert Jevons, 18 January 1863, *P&C,* **iii,** p. 4). Yet multiple causation implied that prices could rise for reasons apart from monetary ones; and the quantitative impact of the gold discoveries was by no means clear cut. On the whole, Jevons produced a work which is remarkably convincing that prices had risen,[27] and fairly convincing regarding the cause of these price alterations.

THE CONDITION OF COINAGE

British currency law constituted ‘a kind of legal fiction’, Jevons argued, since the public and the banks might avoid losses due to light coins by passing them along to others, and using newer coins for transactions with banks (‘On the Condition of the Gold Coinage of the United Kingdom, with reference to the Question of International Currency’ [1868], *ICF,* p. 255).[28] Thus arose a practice of ‘sieving and picking’, which ‘is not only a source of labour and trouble, but is of questionable legality and expedience’ (p. 256).[29] Since there was a tendency for coins to collect in agricultural districts, this ‘evil and injustice’ constituted a relatively serious problem there.

In order to confirm this reasoning and to measure the extent of the problem of light currency, Jevons undertook a detailed study of the condition of coinage in the United Kingdom. He commenced by asking bankers throughout the United Kingdom to record the date of issue for gold coins in a sample of one or two hundred sovereigns and smaller samples of half-sovereigns (*ICF,* pp. 262–63). From a total of 213 distinct towns or localities, 321 bankers responded to his request, resulting in the enumeration of 90,474 sovereigns and 75,036 half-sovereigns, for a sample that Jevons estimated contained at least one out of every 600 UK coins (p. 263).

Having examined the distribution of sovereign age in various parts of the UK, and using an estimate for the total number of sovereigns in existence, Jevons next calculated the proportion of sovereigns minted in various years (*ICF,* p. 274; reproduced in Appendix 10.2). This calculation revealed that the largest proportion of old coin occurred in the Eastern counties of Norfolk, Suffolk and Essex, where 22.5 per cent of gold sovereigns were issued in 1839 or earlier (compared to 12.7 per cent for London and 9.4 per cent for Manchester, pp. 274–75). Manchester, where nearly half of the sampled sovereigns were coined since

1860, possessed the newest coinage, while that of London resembled the general average (p. 276).

Based on the assumption that the 'average rate of wear' of currency was 'approximately uniform and proportional to its age', Jevons argued that the average age of coins would indicate 'their amount of depreciation' (*ICF,* p. 282). Thus he drew a sample of 434 sovereigns and 178 half-sovereigns 'from the ordinary circulation at Manchester', and weighed them carefully. This enabled him to calculate the average deficiency of coin weights issued during various years (see Appendix 10.2), as well as the average rate of wear, and the average rate of wear per year. The average weight of sovereigns was found to be 122.71 grains, while the average date of issue was 1854.6. Since the weight at issue was 123.26 grains, this yielded an average deficiency equal to 0.55 grains, in an average of 12.9 years; average wear per year was then equal to 0.55÷12.9, or 0.043 grains of wear per year (p. 284). At this rate of wear, coins would, on the average, fall below the legal weight (122.5 grains) in about eighteen years (p. 285).[30]

Jevons was explicit in this context that his conclusion pertained to the average, while exceptions to his eighteen-year prediction would occur, due to 'accidental circumstances':

> Of course it is not meant that every sovereign will be light after eighteen years' wear, for some are coined heavier than others, or undergo less wear owing to accidental circumstances; but these will be balanced by others coined lighter, or subject to more severe wear. But it would be hard to name a subject in which reasoning by averages may be more safely trusted than the present, because the coinage consists of an immense number of pieces which are constantly circulating through every part of the country and in every kind of business.
>
> (*ICF,* p. 285)

As in the gold studies, he argued that, while any one coin might be a poor indicator of its weight, 'the age of 1,000,000 or 1000, or even 100 coins drawn from the ordinary mixture in circulation, must be a very sure criterion' (p. 285).[31] Even in a sample of 100 coins, Jevons asserted, 'it is in the highest degree unlikely' that 'accidental peculiarities of the history of any of those coins should influence appreciably the general average' (p. 285). He did not elaborate upon this statement, which might be read as an assertion regarding appropriate sample size.

Jevons's next step was to estimate the proportion of sovereigns in the United Kingdom that was below the legal weight limit. Since his estimated average rate of wear implied that coins became light in eighteen years, coins older than eighteen years would, on average, fall below the legal weight. Jevons thus calculated the proportion of coins issued earlier than 1850, as an estimate of the proportion of light coins in the UK. In the UK 31.5 per cent of sovereigns were thus estimated to be below the legal weight (*ICF,* p. 286; see Appendix 10.2).

A second detailed empirical study of this type involved a sample of 280 sovereigns drawn from Manchester banks ('On the International Monetary Convention, and the Introduction of an International Currency into this Kingdom' [1868], *P&C,* **vii,** p. 72). As a result of a meticulous process of weighing these sovereigns, Jevons found that 74 per cent were at least the legal weight, while the remaining 26 per cent were below the legal weight. The Manchester estimate is somewhat below the 31.5 per cent estimate for the entire United Kingdom, but since Jevons had remarked that the circulation at Manchester was new relative to that throughout the United Kingdom, this is not surprising.

Jevons's contribution

Stephen Stigler (1982) has paid tribute to Jevons's contribution in the gold studies, the argument that explaining all particular price changes would soon stall scientific endeavours, accompanied by the eloquent defence of the view that the economist must instead 'attack' their data by the use of 'wide averages'.[32] But the further implication—that the method employed in both the gold and the currency weight studies entailed a significant methodological departure from the procedures of Jevons's predecessors—has received less attention. Jevons's explicit suggestion that unmodelled omitted causes 'balanced' in the drawing of an average, so that the 'general variation of the price' might be attributed to the gold influx, or average age served as an indicator of sovereign wear, contrasted with Mill's insistence that specific experience afforded the economist an opportunity and an obligation actively to seek out causes unaccounted for in the model. We will see below (pp. 210–12) that this implication was appreciated and also resisted by some of Jevons's contemporaries.

THE DAVENANT LAW

Based on the King-Davenant data for corn consumption and prices,[33] Jevons 'endeavoured to ascertain the law to which Davenant's figures conform' (*TPE,* p. 157).[34] Following Davenant, Jevons's formulation presumed price to be the dependent variable, while quantity was the independent variable.[35] He placed two *a priori* restrictions upon the price-quantity relationship, arguing that the relationship would be asymptotic to the quantity axis: 'the price of corn should never sink to zero, as, if abundant, it could be used for horses, poultry or cattle, as for other purposes for which it is too costly at present'; and that price would approach infinity before the quantity fell to zero: 'when the quantity is much diminished, the price should rise rapidly, and should become infinite before the quantity is zero, because famine would then be impending' (p. 157). Based on that reasoning, he obtained a functional form: $p_c=a/(q_c-b)^n$, where *a, b,* and *n* were parameters to be estimated.[36] 'An inspection of the numerical data' apparently convinced Jevons that the exponential parameter was approximately 2, and he then claimed that 'assuming it to be exactly 2, I find that the most probable values of *a* and *b* are a=0.824 and b= 0.12' (p. 157), so that the estimated function was $p_c=0.824/(q_c-0.12)^2$.[37] Comparing his estimated prices with those of Davenant (see Appendix 10.3), Jevons concluded that his 'close approximation' enabled researchers to 'safely substitute the empirical formula for his numbers' (p. 158).[38] In line with his position in the *Principles of Science,* he maintained that the estimated demand function would reduce erroneous (casual) interpretations of the Davenant-King data and assist the theorist in the discovery of economic laws.

This latter involved the specification of a marginal utility function for corn, and the task was admittedly complex. As noted in Chapter 5, Jevons recognized that there was no *a priori* way to specify the rate of marginal utility decline for a consumer. Nor, since data were given introspectively, were utility functions directly measurable. But since he had worked out the relationship between price and the final degree of utility, price data could be used to approximate an average marginal utility function:

> To do this we need accurate statistics of the quantities of commodities purchased by the whole population at various prices. The price of a commodity is the only test we have of the utility of the commodity to the purchaser; and if we could tell exactly how much people reduce their consumption of each important article when the price rises, we could determine, at least approximately, the variation of the final degree of utility.
>
> (*TPE,* pp. 146–47; cf. *P&C,* **iii,** p. 246)

A major problem arose from the interdependence of goods in the consumption basket (cf. *P&C,* **vi,** p. 88). Initially, simplifications were in order.[39] Specifically, the 'general utility of a person's income' could be assumed constant in the exchange equation, and the economist could determine the 'general character' of the 'final degree of utility'. The 'great difficulty' is recognized—that there are 'vast differences in the condition of persons' and 'complicated ways in which one commodity replaces or serves instead of another', so that when the price of one good altered, the prices of other commodities changed (*TPE,* p. 148). Notwithstanding appreciation of these complexities, Jevons called for derivation of empirical (average) marginal utility functions, which, presumably, would assist in the specification of the theoretical relationship and also provide information on the precise operation of the behavioural axiom in specific contexts.

THE SUNSPOT CYCLE[40]

In his attempts to find empirical support for his theory of fluctuations (examined in Chapter 3), Jevons faced a number of serious difficulties. First, and perhaps most importantly, the explanation of fluctuations involved vaguely defined variables (most notably, commercial 'moods'), for which data were simply unavailable.[41] Second, neither the length of the sunspot cycle, nor the record of cyclical economic fluctuations was well established; Jevons was often forced to piece together evidence on fluctuations from various sources since an uninterrupted time series of economic variables simply did not exist. In addition, important 'disturbing causes' frequently affected the time series to which he did have access.

Jevons's first attempt to find empirical support for his theory of fluctuations, in 'The Solar Period and the Price of Corn' [1875], attempted to fit James E.Thorold Rogers's price data for the years 1259–1400 on wheat, barley, oats, beans, peas, vetches, and rye—'the most valuable and remarkable contribution to the history and statistics of a past century ever made by a single individual in a single work' (*ICF,* p. 196)—to the estimated sunspot cycle of 11.11 years. These price data, Jevons argued, appeared to be free from the influence of major interfering causes, such as 'any great revolution in the value of the precious metals', 'credit cycles', 'crises', or 'floods of paper money'.[42] Rogers's data consisted of yearly mean prices for each crop (p. 197). Jevons arrayed the data in eleven-year intervals using a technique borrowed from the physicists, known as a Buys-Ballot table (see Aldrich 1987). That technique involved arranging the one hundred and forty years of data on an eleven-year grid, and then comparing average prices for each of the eleven years of the sunspot cycle (p. 197; see Appendix 10.4).[43]

Since Jevons lacked data on the precise dates of crises for this period, his purpose was 'solely to ascertain whether in one part of the eleven years' period, as accidentally chosen, prices tended on the average to be higher or lower than at another part' (*ICF,* p. 198). Having calculated the mean price for each crop throughout the eleven-year period, he observed that 'the price of every kind of commodity, without exception, rises in the second, third, or fourth years, and afterwards falls' (p. 199); while in 'every case' the maximum price occurred 'in the third or the fourth year', a result which, he argued, 'is hardly conceivable' to be 'accidental' (p. 199).[44]

While these results 'would be altogether conclusive as to the influence of the sun-spots if each of the seven commodities varied independently of the rest', Jevons acknowledged that the dependent nature of his seven price series rendered his results 'of a merely provisional value' (*ICF,* p. 202).[45] A second problem arose because 'an intense and universal famine' had occurred during the years 1315–16, causing a sharp unusual rise in prices (p. 200).[46] The correspondence, however, reveals what was probably a more serious difficulty: 'I found, with subsequent calculations, that the same data would give other periods of variation equally well. The method of averages adopted seems delusive' (to John Mills, 3 January 1877; *P&C,* **iv,** pp. 188–89).[47]

Jevons continued working on the connection between commercial crises and sunspots, writing in 1877 that he was 'more convinced than ever that there is some connection but it is a treacherous subject, and requires much care' (to John Mills, 30 May; *P&C,* **iv,** p. 199). In August 1878, he presented 'On the Periodicity of Commercial Crises and its Physical Explanation' to the BAAS, where he attempted to establish that the length of the cycle corresponded to the sunspot cycle, newly estimated by the physicist J.A.Broun at 10.45 years (*ICF,* p. 215). He now abandoned the attempt to correlate prices with stages of the cycle, and sought instead simply to demonstrate that the average fluctuation length was approximately equal to that of the sunspot cycle.

The principle he now relied on, outlined in 'The Solar Influence on Commerce' (1879, unpublished until 1981; see *P&C,* **vii,** pp. 90–98), held that 'in the absence of disturbing causes', periodic causes produce periodic effects (pp. 92–93). Unlike the studies of gold or currency (pp. 195–205), disturbing causes were thus presumed largely to be absent, instead of balancing; Jevons attempted to put the method of avoidance to use. This presumption may explain why his sunspot papers contain no references to sampling variation. At the same time, when he did find disturbing causes, Jevons relied on the method of correction. Thus, for instance, he argued that special circumstances might cause an economic fluctuation to be precipitated early (i.e. before the decennial fluctuation would normally occur).

To discover the cause of a periodic effect such as economic fluctuations, the social scientist was directed to seek out 'that cause which if it existed would most probably lead to that effect' (*P&C,* **vii,** p. 93). Equality of period was sufficient to establish causality, although Jevons maintained that the conclusion gains 'much in probability if we can analyse and explain the precise relation of cause and effect' (p. 94):

> if we perceive a distinctly periodic effect, and can discover any cause which recurs at exactly equal intervals, and is the only discoverable cause recurring in that period, this is probably the cause of which we are in search…. But this *prima facie* probability is immensely strengthened if we can give other reasons for believing that a cause of the nature supposed, apart from the question of its period, is likely to have effects of the kind we are attributing to it.
>
> (*P&C,* **vii,** p. 94)

That explanation of the cause-effect relationship, as well as Jevons's inductive argument regarding causality, pertained to the level of the average, and not to each specific fluctuation.[48]

Jevons now turned also to more recent evidence of cyclical fluctuations, and argued that cycle maxima occurred in 1701, 1711, 1721, 1732, 1742, 1753, 1763, 1772, 1782, 1793, 1805, 1815, 1825, 1837, 1847, 1857, and 1866. This yielded an average cycle length equal to 10.3 years ('On the Periodicity of Commercial Crises' [1878], ICF, pp. 214–15). But he now maintained that the 'earlier dates, 1701 and 1711, are not well established' (p. 215). Further, the 1866 crisis was, he argued, very likely 'precipitated' a year early 'by the fall of Overends, Gurney and Co.' (p. 215). Dropping the two early observations, and presuming that the 1866 crisis would have occurred in 1867 if the financial collapse of Overends had not occurred, yielded an estimated average cycle length of 10.46 years. The 'most probable' result was obtained by using the series of cycles commencing in 1763—'a year of well-marked crisis'—to 1857, and resulted in an average period of 10.444 years 'which falls nearly between the previous results, and may be accepted as the most probable' (p. 215). 'Judging this close coincidence of results according to the theory of probabilities', Jevons concluded, 'it becomes highly probable that two periodic phenomena, varying so nearly in the same mean period, are connected as cause and effect' (p. 215).[49]

While a correspondence seemed to exist between crises and sunspot activity in England, however, Jevons was unable to establish the same relationship for Europe.[50] Somewhat disingenuously, he now argued that 'the success of the European corn harvests depends upon a conjunction of fortunate events' which presumably differed from the British situation: 'a frosty winter to prepare the ground, a good ploughing and sowing season, moisture for the growing plant, a favourable blooming-time, a warm sun to ripen the grain, and a dry period to harvest it' (p. 216).[51] He was, however, able to find 'corroborative' evidence of decennial periodicity for Indian agricultural production (pp. 216, 218–19).[52]

Jevons's 1878 *Nature* article, 'Commercial Crises and Sun-Spots', relied on similar evidence. Here he established the following series, containing several crises of a tentative nature, noted in parentheses: (1701?), 1711, 1721, 1731–32, (1742?), (1752?), 1763, 1772–73, 1783, 1793, (1804–5?), 1815, 1836–39 (1837 in the United States), 1847, 1857, 1866, 1878 (*ICF,* pp. 230–31). The elimination of tentative crisis years would have lowered his estimated cycle to 10.3 years; yet Jevons now insisted that 'A series of this sort, is not, like a chain, as weak as its weakest part': 'on the contrary, the strong parts add strength to the weak parts. In spite, therefore of the doubtful existence of some of the crises, as marked in the list, I can entertain no doubt whatever that the principal commercial crises do fall into a series having the average period of about 10.466 years (p. 231).[53] Again, Jevons speculated that the cyclical variation in England was related, in part, to trade with India and China, but he conceded that 'The complications and disturbances produced in the statistics of such a trade by various events are so considerable that I have not yet attempted to disentangle them properly' (p. 232).[54]

In the second part of 'Commercial Crises and Sun-Spots', published in an 1879 contribution to *Nature,* Jevons finally succeeded in finding the data to support his reasoning that the cycle was transmitted to England via famines in India (see Chapter 3). Here he referred to a series of prices of wheat at Delhi from 1763 to 1836 (*ICF,* pp. 237–38).[55] He arrayed the time series, and noted years in which wheat prices attained maxima, as well as commercial crisis years (pp. 238–39):

> When the above numbers are plotted out in the form of a curve, the earlier part of the series presents the appearance of a saw, with four or five high sharp-pointed teeth at almost exactly equal distances of ten years. The first maximum, that of 1763, is perhaps imperfectly represented, and were the table extended backwards, the true maximum might fall in 1762. It is remarkable that after about the year 1807 the character of the curve suddenly and entirely changes, the oscillations becoming comparatively small, irregular, and rounded, although the periodicity, as already remarked, seems to recur in a less intense degree after 1823. This change in the curve may be due to some local causes, such as the opening of new roads and markets, and it is obviously important that we should learn whether this is the case, or whether some important meteorological variation is here manifested.
>
> (*ICF,* p. 239)

The timing of these events, however, created something of a problem for Jevons, since, as he acknowledged, 'the commercial crises in England occur *simultaneously* with the high prices in Delhi, or even in anticipation of the latter', while 'the effect cannot precede its cause' (*ICF,* p. 239), and one might in fact reasonably expect a lag time of about 'a year or two' between the Indian famines and the crisis in England. Since famines in Delhi followed famines in Madras by several years, however, this did not overly concern Jevons (p. 240).

By 1882, Jevons extended his argument to suggest that evidence of a commercial crisis might be sufficient for the inference of sunspot activity: 'May we not reverse the argument and infer that the evident relation between the previous sun-spot maxima and the succeeding [corn] scarcities at Delhi, would lead us to expect a minor solar maximum about the year 1797?' (*P&C,* **vii,** p. 109). This was important to his inductive argument since it would have provided one more crisis observation in support of the correlation. Considering that he fully recognized that commercial collapses could be provoked by real events such as wars or trade legislation, Jevons's argument and his inference appear unwarranted. Yet he was not, in general, willing to make this inference unless the trade cycle had occurred at the same time that one would have expected to find sunspot activity: only if an economic crisis were observed 10.45 years before an acknowledged solar maximum, might one infer that another solar maximum had occurred then.

Correlation and causality

Does Jevons's analysis of the sunspot evidence 'serve as a prime example of the dangers of confusing correlation with causation', as Laidler and others have argued (1982, p. 340)?[56] With the advantage of hindsight one is tempted to levy this criticism. In defence of Jevons, however, one must bear in mind that his understanding of causality was equivalent to 'correlation', a 'cause' being 'the group of positive or negative conditions which, with more or less probability precede an event' (*PS,* p. 226; see pp. 175–77).[57] The common cause argument, which we have seen Jevons use repeatedly, also amounts to the notion of correlation; if two phenomena are highly correlated, he argued that it was highly probable that one phenomenon (and not many phenomena) 'caused' the other.

A more telling criticism of the work on fluctuations, perhaps, is whether—given his procedures outlined in Chapter 9 concerning induction—Jevons practised his own methodological guidelines in the sunspot papers. Here, as I have argued, he was equally willing to discard weakly established observations that did not support the correlation, and to include weakly established crisis observations that supported it. A more serious flaw in his empirical work on cycles, then, is that he was not entirely candid in the attempt to establish and estimate the correlation.[58]

SOME REACTIONS TO JEVONS'S METHODOLOGY

The foregoing has suggested that Jevons's empirical studies, which relied on 'wide averages' and attempted to establish or measure economic relationships by balancing variable causes in the drawing of a mean, constituted a significant break from the methodology of Mill, and one which considerably altered the 'theory-practice' distinction so important to Mill. It remains to assess some reactions to Jevons's methods in his applied works. Not surprisingly, these focus on the key difference between Jevons and his precursors—the application of the method of means to economic problems and the related assumption that unaccounted-for causes might be assumed to 'balance'. Not surprisingly also, given the contrast between the treatment of multiple cause by Jevons and Mill, Jevons's procedures elicited varied reactions both from late nineteenth and early twentieth century economists.

T.E.C.Leslie took issue with Jevons's procedure in *ASF,* and stressed in opposition to Jevons that the gold discoveries were not the only cause of the measured price alteration. 'The method of averages fails in several ways':

> It does not show the real movement of prices or the real depreciation of money; the tables omit some of the chief elements of the cost of living; the prices compared are wholesale prices, while the purchasing power of an income depends on retail prices; and, by ascribing the whole rise of prices

> to the new gold, this method conceals the material fact that the gold is only one of a plurality of causes lately tending to raise them.
>
> ('Prices in England in 1873' [1873]; Leslie 1879, p. 349)[59]

Leslie questioned the assumption that 'the new gold [constitutes] the sole cause of the rise in prices arrived at, on the ground that 'the average must, in all reasonable probability, represent some single influence acting on all commodities' and argued, in opposition to Jevons, 'But why not a plurality of influences?' (p. 353). His own investigation focused on this very 'plurality of causes', and how their influence differed across different goods.[60] In a study which argued strongly in favour of uniting economic science and statistics, he presented a general criticism of the assumption that errors might 'balance':

> And we have in this matter an illustration of the defective character of that kind of statistical inquiry which confines itself to the collection of a multitude of instances of facts, without reference to causes. It must be allowed that the principles laid down by the illustrious Quetelet rather tend to foster the error to which we advert. He assumed that by enlarging the number of instances, we eliminate chance and arrive at general and stable laws or conditions. But a great number of instances does not give us their law, or justify us in any positive conclusion respecting the future. New conditions, for example, have been acting on prices during the last two years, and mere tables of prices for the last twenty or ten years, confound years in which those causes were in operation with years in which they were not.
>
> ('Economic Science and Statistics' [1873]; 1879, pp. 381–82)[61]

More recently, J.M.Keynes criticized Jevons's attempts to '"average out" the chaotic but compensatory movements in individual prices due to their movements relatively to one another and to the price-level', an exercise that he termed 'a will-o'-the-wisp, a circle-squaring expedition which has given an elusive taint, difficult to touch or catch, to the treatment of the Theory of Price Index-Numbers' (1930, pp. 82, 80–81). Like Leslie, Keynes objected to the use of the method of means in this context.[62] Specifically, he took issue with Jevons's central assumption 'that the fluctuations of individual prices round the "mean" are "random"': 'in the case of prices a movement in the price of one commodity necessarily influences the movement in the prices of other commodities, whilst the magnitudes of these compensatory movements depend on the magnitude of the change in expenditure on the first commodity as compared with the importance of the expenditure on the commodities secondarily affected' (p. 86).[63]

Not all Jevons's contemporaries were critical of his empirical studies. J.E.Cairnes responded favourably to *ASF,* although he did take exception with Jevons's neglect of the influence of technical change that secularly reduced prices.[64] In a letter dated 3 June 1863, Jevons conceded to Cairnes that his calculation failed to take account of this influence. But Jevons was not overly concerned with this criticism, since any disturbing cause serving to reduce prices, such as technological change, actually strengthened his case: the effects of the gold discoveries, he maintained, 'are not limited to the rise of price but comprise a fall of price prevented' (*P&C,* **iii,** p. 22).

At the same time, however, Cairnes was reluctant to endorse the possibility of establishing exact laws using empirical methods.[65] Thus he argued in the *Character and Logical Method of Political Economy* that an exact law revealing the relationship between the price and quantity of corn was unattainable (1875, pp. 121–27). He insisted, moreover, that little reliance be placed on the King-Davenant price-quantity schedule (p. 126).

Henry Fawcett's *Manual of Political Economy* [1883] also contained high praise for Jevons's procedures: 'Prof. Jevons compared the average prices of many hundreds of commodities after the gold discoveries, with their prices previous to 1848. He also, with the utmost care, made allowance for the influence which might have been exerted upon the price of any particular commodity by causes independent of a change in the value of gold. The result of his investigations proves that there was a rise in general prices amounting to 10 or 15 per cent' (1883, p. 481).[66] Philip Wicksteed, also, praised not only Jevons's procedures in the studies of currency and finance—his 'elaborate logical and other tabulations' being 'models of sound method and laborious research illuminated by theory'—but also his 'brilliant attempt' to relate commercial fluctuations with sunspots (1935, p. 805; cf. p. 804).

CONCLUSIONS

Not surprisingly, given our investigation in Chapter 9, the empirical studies examined above all yield a prominent place to the procedures for inductive quantification that were so important to Jevons's *Principles of Science*. Thus, as we have seen (pp. 195–205), in his measurements of the effects of the gold discoveries as well as the extent of currency wear in the United Kingdom, Jevons relied on a method of gathering observations and obtaining 'wide averages', accompanied by the presumption that unobserved or unaccounted-for causes influencing the data 'balanced' so that his measurements could be attributed to the cause of interest. In this endeavour he stressed the importance of obtaining data as free as possible from disturbing causes, and, second, that as the size of the sample increased, so did his confidence that temporary or 'noxious' causes would 'balance', and that the estimate was reliable. In 1869 Jevons estimated an average price change, calculated the probable error of his estimate, and calculated a confidence error for his estimate, thus putting the recommendations outlined subsequently in his *Principles of Science* to direct use.

The 'proof of the explanation for the average price increase, relied on the 'common cause' argument, that it was more likely that one and not many causes influenced the prices of goods after 1851. In order to establish probable causality, Jevons relied, in addition, on the principle that the effect (the average price increase) followed the hypothesized cause (the influx of gold). Both of these principles implicitly also underscore the currency wear studies, where sovereigns are presumed to wear for one reason (circulation time), rather than many unconnected reasons, and where, by definition, the cause (circulation time) precedes the effect (wear).

In the estimation of the Davenant price-quantity relationship, Jevons fit a series of observations to a function obtained using *a priori* reasoning to establish the dependent and the independent variables, and to choose the functional form. Here the causal relationship was known from economic theory, but while theory led Jevons to restrict the shape of the function, there was no way of knowing *a priori* the precise price-quantity relation. Although the function involved only two variables, Jevons's *a priori* restrictions led him to choose a function that did not lend itself to least squares estimation (as recommended in *The Principles of Science;* pp. 187–88), in a straightforward way. While it is possible that he used least squares on a transformed equation, his only description of how he obtained his estimates consists of the phrase, 'inspection of the data', which is said to have led him to specify probable parameter values for this functional relationship. In line with his reasoning in the *PS,* he placed great faith in this type of exercise both for the eventual advancement of theory, as more and more formulae that were initially established empirically fed into the body of theoretical research in the discipline, and, second and more immediately, as empirical estimates served to guide policy-makers in their decisions regarding taxation and other matters of public finance.

Finally, the sunspot papers constitute an attempt to establish a causal relationship between periodic variations in solar activity and a periodic effect, fluctuations in economic activity. Here, Jevons again relied on averaging, arguing that if he could establish that the average length of economic fluctuations was equivalent to the average sunspot cycle, and he could, moreover, provide a rationale for why the variation in solar activity might cause economic fluctuations, then he had established a probable causal relationship between solar and economic fluctuations using inductive methods. The notion of an average measurement, an 'average' fluctuation, with regular features that characterized each episode as well as variations specific to each fluctuation, gained prominence. These variations might influence both the features of specific cycles, as well as the timing of cycles; variations in the features of the cycle, however, might be safely ignored given his overriding concern with establishing a cause for the timing of 'average' fluctuations. Instead of presuming that he might 'balance' causes that influenced the timing of fluctuations one against the other, Jevons attempted to find data free of the influence of these causes—as in the case of the Rogers data—and, failing this, to posit the existence of major causes other than sunspots—as in the case of the 1866 fluctuation that, he argued, was precipitated early by the collapse of the great financial concern. Thus, his procedure in this respect consisted of a combination of the method of avoidance and the method of reversal, outlined in the *Principles of Science*.

APPENDIX 10.1
JEVONS'S COMMODITY GROUPS, ENLARGED SAMPLE

1 Silver*
2 Tin*
3 Copper*
4 Lead

Red lead

White lead

Foreign spelter

Swedish steel

5 Bar iron*
6 Pig iron*
7 Tin plates*
8 Palm oil*
9 Linseed oil*

Sperm oil

Olive oil, Gallipoli

Cocoa-nut oil

Rapeseed oil, pale

Linseed cake, foreign

10 Tallow*
11 Hides*

Hides, Australian

12 Leather*

Calf skins, 28–35 Ib.

Tar, Stockholm

Turpentine, American

Turpentine, English spirits

Turpentine, foreign spirits

Nitrate of soda

13 Timber*

Quebec oak

Baltic oak

African oak

Indian teak

Deals, Canada, 1st pine

14 Hemp*

Hemp, Russia

Manilla hemp

East Indian Sunn

Jute

15 Upland cotton*
16 Pernam. cotton*
17 Surat cotton*
18 Wool

Wool, Southdown*

Wool, German, 1st and 2nd

Wool, German, tertia

Wool, Sydney lambs

Wool, V.D.L., locks and pieces

19 Silk

Silk, Cossimbuzar*

Silk, China, Tsatlee

Silk, raw, White Novi

Silk, organzine, Piedm, 22–24

20 Flax

Flax, Riga*

21 Logwood*
22 Indigo

Cochineal, Teneriffe

Turmeric, Bengal*

Terra Japonica, Cutch

Brazil wood

Fustic, Cuba

Sapan wood

23 Wheat*
24 Barley*
25 Oats*
26 Rye*
27 Beans*
28 Peas*

Rice, Bengal

Sago, pearl

29 Hay*
30 Clover*
31 Straw*
32 Beef*

Beef, salt, American

33 Mutton*
34 Pork*

Pork, salt, American

35 Butter*

Cheese, American

Lard, American

36 Sugar

Sugar, Gazzete average

Sugar, Mauritius, yellow*

Sugar, Havana, white

Sugar, Java, grey and white

Sugar, refined, 8–10 1b.

Sugar, bastards

37 Tea

Tea, Congou*

Tea, Souchong

Tea, Orange Pekoe

Tea, Hyson

Tea, Gunpowder

Coffee, Ceylon, ordinary

Cocoa, Guayaquil

38 Spirits

Jamaica rum*

East India rum

Spirits, Geneva

39 Pepper

Pepper, black*

Pepper, white

Cinnamon, Ceylon

Cassia Lignea

Cloves, Amboyna

Cloves, Bourbon

Ginger, East Indian, common

Mace

Nutmegs

Tobacco, Maryland

Seeds, Caraway

Seeds, Canary

Seeds, Clover, red

Seeds, Coriander

Seeds, Mustard

Almonds, Sweet Barbary

Currants, Patras, new

Figs, Turkey

Prunes

Raisons, Valentia, new

Port wine

Claret wine

Sherry wine

Madeira wine

Source: A Serious Fall in the Value of Gold ascertained, and its Social Effects set forth [1863], in *ICF,* pp. 38–42, 51–52
* Included in Jevons's smaller sample consisting of 39 goods

APPENDIX 10.2
THE CURRENCY WEAR CALCULATIONS

1
Distribution of sovereign age, major UK towns or districts

Name of town or district	*Proportion of current sovereigns coined in the period*						
	1817 –19	*1820 –29*	*1830 –39*	*1840 –49*	*1850 –59*	*1860 –67*	*Australian*
London	0.1	6.5	5.6	17.1	28.7	40.0	2.0
London further returns	0.1	6.2	6.4	16.9	28.3	40.1	2.0
Manchester	0.1	4.4	4.9	13.1	29.4	46.8	1.3
Manchester (Mr Ross)	0.2	4.3	4.6	11.8	27.7	49.7	1.7
Birmingham	0.2	6.9	6.4	17.1	28.6	39.6	1.2
Swansea	0.2	8.4	7.4	15.7	28.4	37.0	2.9
Hull and Bridlington	0.4	9.3	8.1	20.3	30.8	30.4	0.7
Ormskirk	0.1	6.8	5.7	17.2	31.1	38.2	0.9
Glasgow	0.3	10.6	8.0	12.1	28.3	38.0	2.7
Edinburgh	1.1	8.6	5.5	18.9	25.8	39.0	1.1
Eastern counties	0.2	10.5	11.5	22.0	28.5	25.7	1.6
South-Eastern counties	0.2	7.0	7.8	17.7	29.9	35.7	1.7
South-Western counties	0.4	7.8	8.2	17.2	32.1	32.9	1.4
South Midland counties	0.1	7.8	8.1	19.6	27.6	35.6	1.2
West Midland counties	0.4	9.2	8.2	15.9	27.1	38.3	0.9
North Midland counties	0.4	9.2	7.9	16.6	26.6	38.2	1.1
Lancashire and Cheshire	0.2	7.1	6.3	16.1	26.6	42.5	1.2
Yorkshire	0.3	7.3	6.9	14.9	27.0	42.6	1.0
Northern counties	0.2	6.4	6.6	16.5	26.6	42.7	1.0
North Wales	0.2	8.5	7.5	17.4	27.5	38.1	0.8
South Wales	0.3	7.7	9.5	18.9	26.9	35.6	1.1
Northern Ireland	0.2	5.9	6.6	17.5	31.8	36.8	1.2
Southern Ireland	0.2	9.3	7.3	19.9	29.8	32.2	1.3
Scottish Highlands	0.2	6.6	6.9	17.2	27.5	40.7	0.9
Scottish Lowlands, Bank of Scotland	0.1	7.3	6.2	14.8	28.7	40.6	2.3
General average	0.2	7.4	7.0	16.9	28.6	38.3	1.6

Source: 'On the Condition of the Gold Coinage of the United Kingdom, with reference to the Question of International Currency' [1868], in *ICF,* p. 274

2

Average wear per year, UK sovereigns

Years of issue	*Number of sovereigns weighed*	*Avg weight of the sovereigns (grains)*	*Deficiency from mint weight (grains)*	*Avg date of coinage*	*Avg annual loss of weight (grains)*
1817–29	31	121.40	1.86	1824.7	0.043
1830–39	22	121.92	1.34	1834.3	0.040
1840–49	44	122.16	1.10	1845.8	0.051
1850–59	129	122.72	0.54	1854.6	0.042
1860–67	208	123.04	0.22	1863.1	0.050
Mint weight	—	123.26	—	(1867.5)	—

Source: 'On the Condition of the Gold Coinage of the United Kingdom, with reference to the Question of International Currency' [1868], in *ICF,* p. 284

APPENDIX 10.3
THE DAVENANT CORN LAW

1

The Davenant Corn Law and Jevons's estimates compared

Harvest	1.0	0.9	0.8	0.7	0.6	0.5
Price (Davenant)	1.0	1.3	1.8	2.6	3.8	5.5
Price calculated (Jevons)*	1.06	1.36	1.78	2.45	3.58	5.71

Source: TPE, p. 158

* Using Jevons's estimated equation: p=0.824/(q–0.12)2

2

Stigler's numerical solution to the Davenant Law

Stigler begins by transforming Jevons's equation, and accepting the presumption that the value for the exponent is 2:

$$p = a/(x - b)^2, \text{ then becomes } p(x - b)^2 = a.$$

To solve for *b,* use the two extreme values for *x* and *p* (1.0, 1.0) and (0.5, 5.5):

$$1.0(1.0 - b)^2 = 5.5(0.5 - b)^2.$$

This yields *b*=0.12 as the solution for *b,* which agrees with Jevons's estimate.

To find *a,* compute the value of:

$$p(x - 0.12)^2 = a$$

This yields *a*=0.824, which equals Jevons's estimate precisely.

Source: S.Stigler (1994, pp. 187–88)

APPENDIX 10.4
JEVONS'S 1875 BUYS-BALLOT TABLE

	Years										
	1st 1259 etc.	*2nd 1260 etc.*	*3rd 1261 etc.*	*4th 1262 etc.*	*5th 1263 etc.*	*6th 1264 etc.*	*7th 1265 etc.*	*8th 1266 etc.*	*9th 1267 etc.*	*10th 1268 etc.*	*11th 1269 etc.*
Wheat	1490	1490	1570 (*mx*)	1570 (*mx*)	1460	1490	1410	1370	1290 (*mn*)	1320	1540
Barley	1058	1021	1026	1111 (*mx*)	979	1017	1010	1027	965	902 (*mn*)	1036
Oats	598	596	619	699 (*mx*)	593	625	592	575	581	555 (*mn*)	626
Beans	993	1064	1243	1424 (*mx*)	1111	1116	980	1095	983	843 (*mn*)	1049
Peas	928	818	1019	1231 (*mx*)	1016	891	870	880	757 (*mn*)	767	929
Vetches	900	848	1139	1228 (*mx*)	1016	953	916	824	850	920	808 (*mn*)
Rye	1047	1025	1245 (*mx*)	1161	1011	1142	1065	1139	1027	968 (*mn*)	1094
Sums	7014	6862	7861	8424	7186	7234	6843	6910	6453	6275	7082

Source: 'The Solar Period and the Price of Corn' [1875], in *ICF*, p. 198

11
CONCLUSION

There can be no doubt as to the broad range of Jevons's preoccupations and talents. This investigation has shown him to be intensely interested in theoretical matters —microeconomic decision-making—and at the same time very much concerned with how an economy develops through time. In addition, he devoted his attention to philosophical issues important to economics, the utilitarian conception of 'welfare' that remains the underpinning for much economic policy-making today. His writings on policy—on the establishment of museums and libraries; on taxation; on the regulation of workers in an early capitalist setting; on the benefits associated with concert halls; on working women and child care issues; on co-operation; on how to alleviate poverty—reveal a mind willing to tackle social and economic problems using an extraordinarily broad range of policy instruments and recommendations. In his methodological investigation, Jevons made some of his most significant contributions to economics, recommending the systematic appropriation and use of statistical techniques for measurement and approximation in economics. His own forays into measurement and quantification—the attempt to measure the influence of the gold discovery and to convince his audience that the alteration in prices was due to a change in the value of gold; his work with the Davenant corn data; his careful estimates of currency wear in the United Kingdom; and his analysis of economic data regarding fluctuations—demonstrate an ability to undertake a wide range of economic problems with resolve, and imagination.

In fact, this investigation has focused on Jevons's research into economic questions, leaving a substantial body of work on meteorological and other scientific concerns largely untouched: he was even more the polymath than the foregoing suggests. One specifically striking essay that we have neglected, 'Cram' [1877], highlights a keen interest in pedagogical matters, as well as a serious commitment to teaching. I frequently share the colourful description of learning contained there with my own students, who appreciate that technological change has enabled them to escape the fate of the 'lecture-room benches' for the relative comfort of desks, and chairs.[1]

Even so, in some sense the Jevons who emerges from the investigation of 'Jevonian economics' is a polymath with few connections: the feature that, perhaps, separates him most strikingly from John Stuart Mill, is Jevons's unwillingness or inability to relate his research projects one to another in a systematic fashion.[2] Perhaps as a result of this failure to spell out the connections among his own research projects, a number of conflicting positions or tensions within his economics have emerged above. This may also explain why Jevons's economics has been investigated, to date, mainly in a piecemeal fashion;[3] and why interpretive disputes exist concerning his position on various issues.[4]

We have seen that, in contrast with the Classical synthetical approach to Political Economy, the Jevonian economist was encouraged to specialize, along the lines of methodology or subject matter, within a subset of the discipline (Chapter 4). Instead of advising that the political economist master economic theory and, in addition, the 'art' of policy evaluation, as Mill did, Jevons recommended that the profession be separated into those who specialized in, for instance, matters of taxation, and those who gathered and analysed statistics. As a consequence, at the same time that his *TPE* and related work generated new research questions and methods for political economists, the scope of any individual economist's research programme who followed Jevons's advice was appreciably narrowed.[5]

The economics profession has clearly evolved along Jevonian, rather than Millian, lines: it consists of specialists who investigate research questions that generally constitute a subset of Jevons's suggested topics. While Jevons called for subdivision into historical and statistical categories, one specializes today in increasingly more narrow fields, as, for example, in 'US ante bellum economic history'; or in 'Bayesian statistical analysis'.[6] Related to this, the training of economists has considerably narrowed, so that, however broad one might hope, at the outset of graduate school, one's research will be, eventually one is encouraged to become more narrow (some might, of course, say more 'focused'), in order to succeed in the graduate programme and beyond.[7]

A major theme of this investigation is that Jevons's call for subdivision along both methodological and subject matter lines also, importantly, opened the way for the development of a particular specialization within economics, known broadly as 'Welfare Economics' and characterized since late in the nineteenth century by ongoing debates over the nature and measurability of Social Utility. For while the theory of exchange was said to rest on immeasurable utility principles and to require no interpersonal comparisons of utility, Jevons recognized that some types of welfare measures might prove useful to the assessment of tax incidence, or, indeed, to assessments of the effects of any policy measures, and he suggested that utility might be measured indirectly, from the actions that utility imbalances prompt. He called for the collection of data to facilitate this measurement (Chapters 4 and 10). Further, he was intensely critical of Mill's characterization of pleasures differing both in 'kind' as well as in 'amount' (Chapter 7). In opposition to Mill, Jevons insisted that pleasures differed only in terms of their Benthamite attributes, attributes that were, at least in principle, quantifiable. Coupled with his calls for the appropriation of empirical methods in economics (Chapters 9 and 10), and his calls for the collection and analysis of economic statistics, this position concerning the nature of 'pleasure' or utility led directly to the rise of cardinalism within economics. That tradition, we have seen, has a history that starts late in the nineteenth century and continues to contemporary analysis: it is no coincidence that it was one of Jevons's followers, F.Y.Edgeworth, who called for the direct measurement of utility increments using the 'hedonemeter' (Chapter 8).

While the potential scope of the political economist's research programme was narrowed by Jevons's insistence on subdivision within the discipline, the applicability of his economic principles was by no means said to be limited. Instead, he granted the basic axioms of economics, including self-interested maximizing behaviour and the all-important law of diminishing marginal utility, universal status. Thus, he held that all branches of the science of economics have as their basis 'certain general principles' that explain decisions made by all humans and even, it will be recalled, by the more intelligent members of the animal kingdom! Consequently, at the same time that Jevons urged a narrowing of focus (specialization), he intended to broaden the applicability of economic analysis. Coupled with his insistence on universal applicability, he maintained—in opposition to Mill—that economics, as a social science, relies on methods appropriate to any science (i.e. that there is no special method required for economics qua science). Perhaps because his career was suddenly cut short in 1882, his own research did little to further the attempt to draft what he called the 'superstructure' of the aggregate science of economics, or to explain how 'general principles' underpin his analysis outside of the *Theory of Political Economy*.[8] What he did do, however, was extend economic analysis to the investigation of a wide range of new topics and concerns, such as the 'use and abuse' of museums, and the issue of married women working in factories. At the same time, he applied the methods outlined in his *Principles of Science,* without modification for any special features of economic analysis, to a wide range of economic issues. Of course, he also called for increasing the mathematical rigour of economics, and provided a model of such rigour in his *Theory of Political Economy*.

In the twentieth century, the development of neoclassical microeconomics as a discipline has been characterized by the continuous application of fundamental economic principles to an increasingly wide range of topics—such as the economics of the family, crime, and addiction—all in increasingly technical work. Jevons's methodological stance, his use of the calculus, as well as the example set by his own research agenda, constitute an important forerunner of that development. Again, the profession clearly developed along Jevonian, as opposed to Millian, lines.

What major conflicts characterize Jevons's economics? Since these sometimes consist of his espoused new position and vestiges of Classical concerns, they reveal the transitional nature of Jevonian economics, and it may, in sum, be helpful to reiterate the main tensions that have emerged in the investigation above. First and foremost, is his adherence to Classical style growth analysis (Chapter 2), and his repeated criticism of the wage fund theory and a cost of production theory of value at the same time that he allowed the analysis in *TPE* was fully in line with a cost of production theory of value, and that the wage fund theory had a ‘certain limited’ application. We have seen (Chapters 4 and 5) that Jevons’s focus on exchange (as opposed to production), his speculation concerning the nature of the individual’s utility function, and his (marginal utility) explanation of exchange between price-taking parties, constituted departures from the Classical preoccupation with production and costs of production as explanations of economic activity. But while he was considerably preoccupied with characterizing the formal conditions for price-taking exchange at a point in time, and he was anxious to demonstrate the novelty of his approach to exchange, he insisted that the analysis was consistent with the derivation of long period values determined by costs of production. He made no attempt, however, to explain how long-run equilibrium and short-term prices are linked and that failure, coupled with his emphasis in *TPE* on the marginal utility explanation of short-term prices, has led to evaluations that rule out any continuity with Classical economics.

When Jevons did turn to the matter of production, his treatment had much in common with the Classics, including the nature of the production process which he frequently used for the purpose of illustrating his theory - agriculture. His examples of how agricultural production adjusts to alterations in relative prices (Chapter 6) reveal that his treatment of labour often presupposed physical exertion in the context of simple (one factor) production processes. They serve to reinforce the fact, in addition, that Jevons’s formal presentation of the theory of labour did not entail new implications for the analysis of production and consumption: his examples and his analysis thereof are strikingly similar to those used by Classical economists to illustrate cost of production theory. While Jevons allowed that a ‘complicated double adjustment’ occurs in the production and consumption of various goods, he did not proceed much farther in his *TPE* to relate the utility analysis to a cost of production theory. Nor, apparently, was he able to relate his analysis of growth relying on a Malthusian conception of the relationship between labour supply and per capita income, as well as diminishing returns in the production of coal, to the microeconomic analysis in the *Theory of Political Economy*.

The second tension in Jevons’s work is one that also characterizes Classical economics, and concerns the rationality of economic agents. The foregoing has revealed that he presumed that decisions at a point in time are, at least on average, correct. Thus, we have seen (Chapter 5) that price-taking individuals are generally presumed to be able correctly to decide how to allocate income (i.e. they make only unsystematic mistakes at a point in time). It is important, however, to bear in mind that individuals do make mistakes in this context. For pragmatic reasons, Jevons maintained that economic choices be analysed in terms of the main cause(s) of interest, (private self-interest, greater gain is preferred to lesser gain), while acknowledging the existence of ‘extraneous’ or ‘noxious’ influences on consumer choice. These ‘extraneous’ causes, we have seen, included imperfect information, and lack of competition, as well as ‘caprice’ and the inability to evaluate correctly the amount of pleasure associated with particular actions. Jevons was aware that prevalence of these extraneous causes over pure self-interest would lead consumers to stray from his theoretical conditions for utility maximization. And since what the economist actually observes consists of choices made by individuals that are the result of all—and not simply the main—causal factors operating at once, observed behaviour rarely, if ever, conforms to the economist’s necessarily abstract and simplified theory. Such a situation, however, was not seen to violate any notion of ‘average’ utility maximization: Jevons always maintained that the interference of ‘caprice’ and other extraneous causes would lead to only non-systematic violations of utility maximization so that, among a wide sample of individuals at a point in time, aggregate utility maximization occurs, or, for an individual making a choice repeatedly (as in the case of weekly purchases of sugar), average utility maximization occurs.

But Jevons also insisted, and here his views are very much in line with those of Classical economists, that, in some important sense it is more difficult to get intertemporal decision-making ‘right’; without education, he maintained, individuals systematically undersave; because they are impatient and discount the future relative to the present, they fail, on average, to maximize utility (Chapters 2 and 5). This is especially true, he maintained, for the labouring classes, although Chapter 3 reveals his conviction that entrepreneurs and merchants also have difficulty with intertemporal decisions throughout the course of economic fluctuations. More specifically, he held that, without education, labourers cannot correctly decide how much to save throughout the cycle or how to make the family size choice, a pervasive problem for Jevons, who described the ‘great defect’ of the labouring classes, ‘their want of thrift and providence’ (Chapters 2, 5 and 8). Without education to correct this defect in character, he insisted throughout his career that individuals will marry ‘improvidently’ and have families that are ‘too large’ (Chapters 2, 7 and 8).

Nor is this position limited to his non-theoretical work. In his discussion of intertemporal consumption decisions in the *TPE,* Jevons’s disapproval of consumption choices by, especially, the labouring classes, is particularly evident. In fact, he maintained in this context that (uneducated) consumers are imperfect (as opposed to the ‘perfectly wise beings’ who maximize utility in static contexts); it was non-maximizing behaviour to discount future pleasures relative to present ones, a purported character flaw which implied that, without intervention, individuals do not save enough for the future (Chapter 5). He also held that decisions concerning working hours depend upon the character of the labourers involved, with the clear implication that certain types of character are relatively hard working and in some sense ‘better’ than others. The policy implication that followed from this position was also embraced by Jevons when he endorsed the suggestion that, to improve the work hours decisions of the Irish, one might encourage altered consumption patterns, an increased taste for 'luxury goods' such as shoes and beef (Chapter 6).

It is sometimes held that Jevons commenced a line of reasoning that removed from economics any role for institutions, for history, for learning, or for time.[9] It may be that the lack of connections across Jevons's works explains such a perception. For there are certainly strong case statements in *TPE* concerning the efficacy of markets and unregulated decision-making in ensuring optimal outcomes (Chapter 5). There is, further, cautionary evidence concerning the ability of policy-makers to influence character and effect reforms (Chapters 7 and 8). Finally and obviously, there is no role for institutions in the simple exchange equations.

While Jevons proclaimed the efficacy of unregulated markets for ensuring the 'best' allocation of goods in the context of his analysis of decisions made at a point in time (Chapter 5), however, there is also much textual evidence that in the case of intertemporal decision-making he urged intervention in order to alter (and 'improve') the nature of decision-making among both consumers and producers. Indeed, an important theme of the foregoing investigation is that history and institutions do 'matter' in Jevons's work. Clearly, if behaviour varies across cultural lines, and certain forms of 'unwanted' behaviour can be discouraged by education, then there is a role for institutions to influence behaviour. Jevons appreciated this implication, and as we have seen (Chapters 2, 7 and 8), in many of his written works he called for various policy reforms designed specifically to alter the behaviour of, especially, the labouring classes.

Thus, the foregoing contends that the most persistent message of Jevons's major works that deal with economic policy is that poverty results in large part from 'bad' (ignorant) intertemporal decision-making, and thus might be mitigated by education. For Jevons, pauperism is an institutional failing, 'the general resultant of all that is wrong in our social arrangements'. The solution to such an institutional failing is clear: 'it can only be reduced by such exertions as raise the intelligence and provident habits of the people'. The 'solution' to 'over-population' (to a subsistence wage or to 'the deep and almost hopeless poverty in the mass of people'), we have seen, lay in the cultivation of a desire 'to appreciate or accumulate the wealth which science brings'. That education, interpreted broadly, to include a cultural dimension and the encouragement of habits of self-reliance, would enable labourers to gain the requisite 'habits of providence and foresight' is spelled out time and again in Jevons's writings (Chapters 2, 7 and 8). These calls for education and economic reforms designed specifically to 'improve' the nature of decision-making were directly in line with —though not the central focus of—his *Theory of Political Economy*. A consequence of this examination is that what Jevons left out of the exchange equations in the *Theory* is as important as what he formalized. His policy recommendations do not flow from that formal analysis. Instead, the general principle guiding policy, is to encourage people (or markets) to behave in a way that more closely mirrors the behaviour described by the 'perfect' model, and to make the choices that would be made by those whom Jevons called 'perfectly wise beings'.

Jevons provided no rationale for why static decision-making, at least on the average, leads to utility maximization, while intertemporal decisions are presumed to be systematically non-maximizing without such education. He never explicitly considered what, if anything, renders decision-making over time more difficult than decisions made at a point in time. Increased difficulty, of course, might simply entail larger errors associated with bad decisions, and would not necessarily render decisions systematically incorrect. But Jevons had persistent mistakes in mind in this context. What he failed to provide, in addition, was a detailed rationale for why workers were, apparently, persistently myopic, why they were unable to learn from their mistakes throughout the course of a lifetime or cyclical fluctuations; and why they were unable to learn that discounting the future apparently led to non-maximizing savings rates or overly large family sizes.

Jevons's conflicting positions concerning the decision-making skills of individuals at a point in time and across time serve to emphasize the lack of connections throughout his economic analysis. But they are also consistent with a long line of economic reasoning which held that education was required to ensure that family size and savings decisions among workers were 'prudent', that is, served the individual as well as the social good, while maintaining that, at any point in time, economic freedom promoted the welfare of individuals and society at large.

The third tension running through Jevons's work is related to his unfortunate position regarding the measurability of utility, unfortunate in the sense that it has earned him criticism from investigators such as George Stigler, who find Jevons to be, albeit 'gallantly', confused on the issue. Here, as we have seen, Jevons sometimes maintained unequivocally that utility was unmeasurable; but he allowed that it might be measured indirectly in the future, provided that more complete data be collected and analysed. In addition, he insisted that interpersonal comparisons of utility were a pipedream, and yet he went some distance towards encouraging attempts to quantify Social Welfare, attempts which he called for in the analysis of policy. In short, he held several positions concerning utility which he never ultimately resolved: that utility was unmeasurable; that it was, given the statistical data and techniques available to researchers, currently unmeasurable; and that utility was measurable indirectly.

Further, while Jevons recognized the great difficulties associated with estimating the total utility of a commodity, he nevertheless urged that we attempt 'to measure the benefit from any trade' (*TPE,* p. 145). Specifically, he argued that interferences with trade such as tariffs, reduced the gains from trade, a welfare reduction which might eventually be measured. In fact, he urged that work in this direction proceed apace, and this constitutes an important implication of the *TPE*. As noted above, he lent his weight there and elsewhere to a specific direction for specialization within economics—empirical economics—proclaiming its ultimate usefulness: 'We cannot really tell the effect of any change in trade or manufacture until we can with some approach to truth express the laws of the variation of utility numerically' (p. 146). To proceed along these lines, Jevons urged that reliable data be collected, data which would reveal 'exactly' how consumers react to price increases, and thereby enable the empirical discovery of the variation of utility.

An additional major conflict within Jevons's work, one related to his conflicting views on the rationality of economic actors, arises from his conviction that, in the main, individuals can find the best paths in life on their own, coupled with his utilitarian position that the greatest good should be the defining rule for intervention. Throughout his career Jevons trod a fine line between the presumption in favour of liberty, and the conviction that intervention was warranted in some situations when unregulated markets yield 'undesirable' outcomes. For instance, he allowed that mothers who placed their infant children in unsanitary or unsafe day care arrangements while they worked in factories, should be prohibited from working—a policy that purportedly constituted a justifiable restriction of individual choice, when the welfare of children was weighed against the liberty of the parent. Related to this, we have a final tension between Jevons's clearly defined position in favour of a wide-ranging reform programme to help the labouring classes become self-reliant (Chapters 7 and 8), while at the same time he likened human beings to 'granite', unresponsive to policy interventions designed to influence their character.[10] Nor is it the case that this tension may be resolved by arguing that the 'young' Jevons opposed intervention, while the 'older' Jevons became more willing to endorse reform measures: instead, he sometimes endorsed intervention early on in his career and sometimes opposed it then; while the same may be said of the more mature Jevons. Throughout his career, he danced between maintaining that reform—especially in the form of education, broadly interpreted—might serve to teach the labouring classes the errors of their ways and help them acquire habits of self-reliance, and recognizing the enormous difficulties associated with any attempt to 'improve' behaviour using institutional reform.

We have seen, finally, a number of key differences between Mill and Jevons, and it is important to bear these in mind in our summary evaluation. First, Jevons followed Mill in his conception of (deterministic) causality, but on occasion a hint of non-determinism entered into his thinking on this matter (Chapter 9). Second, while he followed many of Mill's policy recommendations, and shared Mill's conception of the reformed society, in a number of instances he distanced himself from Mill's reform programme, being somewhat less willing than Mill to endorse wideranging reforms or to trust that the alteration in behaviour which he wanted to see forthcoming could be effected by institutional reform (Chapters 7 and 8). Thus, Jevons objected to what he termed Mill's 'lumps of soft clay' conception of humanity, and maintained, in opposition to Mill, that policy-makers possessed only limited means to alter the behaviour of individuals. He advocated that reform measures be tested on a small scale, objecting to Mill's scheme for peasant proprietorship in Ireland on the grounds that this was too revolutionary a policy to attempt on such a wide scale (Chapter 8). In addition, his insistence that utility might be measured from its effects (choices made), his claim that pleasures differed only in amount, as well as his calls for increased precision in economics and for the development of the specialization, empirical economics, went some distance beyond Mill and earlier utilitarians towards establishing a tradition of cardinalism within economics.

Jevons's methodological procedure in the *Theory* consisted of analysing economic phenomena on the basis of a few main causes (such as private self-interest), that could be identified as primary influences on economic decisions, while acknowledging the existence and even the importance of a multitude of additional influences. Specialization—focusing on narrow sets of economic behaviour, while acknowledging that more complex situations were the norm—was regarded as a means to overcoming the conceptual difficulties created by the fact that economics presumes to investigate the very complex 'conditions of a mind'. In social science, Jevons argued, the 'complexity' of economic relationships hindered the precise theoretical specification of laws. As a consequence of such pronounced multiplicity of cause, he endorsed the use of empirical methods in economics.

Indeed, the theme of Part IV has been that Jevons's calls for subdivision, coupled with his calls for the development of empirical economics, constituted a significant departure from the methodology of J.S.Mill. The method that Jevons described for applied economics in his *Principles of Science* had little in common with that of Mill. He called for the use of new techniques of data manipulation and combination that the Classical economists, most notably Mill, had repudiated. Such procedures entailed a break with Classical methods that opened the door for the systematic use of data and measurement in economics.

The foregoing has suggested, in fact, that Mill's method erected a roadblock between economists and such elementary statistical procedures. For Mill's insistence that the economist, in application, turn attention to 'disturbing causes', and treat each observed outcome as a case study, precluded a role for combining observations, for measurement in economics, or for the use of 'wide averages'. While Jevons, like Mill, allowed that abstraction from causal influences was the procedure for theoretical analyses, he recommended what effectively amounted to abstraction from disturbing causes in application also. In practice, the social scientist was to ensure that disturbing causes 'balanced'; only failing that might the scientist adjust for disturbing causes. Thus Jevons's methodology downplayed the importance of 'disturbing causes', which no longer needed to be explained or accounted for, but might instead be ignored. The foregoing has also examined examples of Jevons's measurements of economic phenomena, including his attempts to establish the fact of a depreciation of gold, to measure the extent of the depreciation, and to explain the depreciation using a spectacular array of data on prices; his measurement of currency wear in the United Kingdom which relied on the argument that influences on currency wear other than age would balance, so that average age could serve as a measure of average currency wear; his attempt to fit estimates of corn prices and quantities to a functional form; and his less than fully successful attempts to relate economic variables indicating the average fluctuation length to the estimated sunspot cycle (Chapter 10).

Jevons's calls for the use of approximation techniques, coupled with his own use of such techniques, carried wide-ranging implications for the subsequent course of economics. Mill's method implied an important role for specific observations, which were to be used to assess the reliability of the theoretical analysis and, more importantly, might feed into the theory by uncovering causes ill-advisedly omitted from the axiomatic framework. But his recommendations ruled out the development of empirical techniques in economics. Jevons broke with the presumption that the social scientist must treat specific observations separately, as case studies. Instead of following Mill in the attempt to explain all the varied influences on each specific observed economic outcome, he argued that one might proceed in terms of averages, finding overall regularities and patterns. Thus, importantly, Jevons removed a major obstacle to the development and appropriation of statistical methods in economics.

Just as the profession has followed Jevons, and not Mill, in the matters of specialization and increasingly technical applications of microeconomic principles to an increasingly wide range of topics, so, too, it has been Jevons's and not Mill's methodological stance that gained prominence within the discipline in this century. Following the pragmatism of Jevons, economists have largely accepted that not every particular observation requires explanation, and that, instead, we might 'attack' our data by way of 'wide averages' in order to ascertain underlying regularities. While debates are still waged over, among other things, the role of hypothesis testing, or the perils of 'data mining',[11] the suggestion rarely, if ever, emerges, that economists must revert to the recommendations of Mill—explaining specific experience on a case-by-case basis. Instead, the profession has on the whole attempted to improve its measurement techniques and approximations and to justify those procedures by specifying the methodological assumptions necessary for their use, thereby following the spirit of Jevons's—as opposed to Mill's—methodological recommendations.

NOTES

1
INTRODUCTION

1 See the review of 21 October 1886, in the *Daily News* (JA6/50/15); the 25 June review in *The Literary World* (JA6/50/24); and the 14 June review (JA6/50/29).

2 'It is arguable that William Stanley Jevons has a better claim to the title "pioneer of modern economics" than any of his British contemporaries' (Black 1981, p. 1).

3 See Walras' remarks to Jevons, (*P&C,* **iv,** p. 45), cited in full in Chapter 9.

4 17 November 1857; *P&C,* **ii,** p. 307.

5 Thomas Kuhn characterizes 'scientific revolutions' as 'those non-cumulative developmental episodes in which an older paradigm is replaced in whole or in part by an incompatible new one' (1962, p. 92). Following recent scholar-ship, we may distinguish between paradigms as 'world views' and 'paradigmas-exemplar' (Argyrous 1992, p. 232). The latter notion consists of a 'concrete piece of research or standard illustration that becomes a classic example of how 'good' science is conducted and that suggests further research' (ibid., p. 232). As such, it is related to, but more narrow than, 'world view': exemplars constitute components of world views which provide guidance for conducting further research within a specific world view. In this sense, Jevons's methodology constitutes a 'revolutionary' development.

6 Backhouse (1994) has argued that the 'standard approach' to the history of economic thought, which places the history of value theory at its centre, has minimized the importance of examining 'problems of empirical evidence and the testing of economic theories' (pp. 8–9; cf. Georgescu-Roegen 1968, p. 236). Schabas has suggested that Jevons's contribution to economics was methodological, as opposed to theoretical; her focus has been on the introduction of mathematical techniques into the discipline (1989, p. 62; see Peart 1992 and 1993b).

7 The following biographical material is drawn largely from Rosamund Könekamp's 'Biographical Introduction' to the *Papers and Correspondence [P&C],* **i,** pp. 1–52, as well as Margaret Schabas (1990, pp. 12–30). See also, Black (1981). Appendix 1.1 contains a chronology of major events in Jevons's life.

8 In 1815, Thomas Jevons launched a small iron pleasure boat built according to his design; he also designed an iron lifeboat that was built in 1822 (*P&C,* **i,** pp. 3–4). For correspondence and newsclippings relating to these inventions, see JA3/3/6–9.

9 The pamphlet was entitled *Prosperity of the landholders not dependant on the Corn-laws*. See JA3/3/10 for printed reviews.

10 Thomas Graham [1805–1869] was Master of the Royal Mint from 1855–69, and helped procure the offer for Jevons at the Sydney Mint. Augustus De Morgan [1806–71], was Professor of Mathematics from 1828 (at the age of 21), until 1831, and from 1836–66. Jevons studied under De Morgan from 1851–53 and, when he returned from Australia, between 1859 and 1861. For his influence on Jevons, see Black (1972a).

11 The position was offered to Jevons through the help of Thomas Graham, who had initially recommended Jevons's cousin, Henry (Harry) Enfield Roscoe [1833–1915]. Roscoe declined in order to pursue a PhD under Robert Bunsen at Heidelberg.

12 In a letter to his sister, Henrietta, dated 30 January 1859, Jevons wrote: 'within the last few years I have become convinced that more is really to be done in the scientific investigation of *Man*.… But does it not strike you that just as in Physical Science there are general & profound principles deducible from a great number of apparent phenomena, so in treating of Man or Society there must also be general principles and laws which underlie all the present discussions & partial arguments? Is it not worth years of labour to dive into these inmost & obscurest principles, and after obtaining some good clue to follow it out with all the intense pleasure of mental success into a multitude of useful conclusions?' (*P&C,* **ii,** p. 361; cf. letter to Henrietta Jevons, dated 8 August 1858, pp. 333–39).

13 The statistical atlas was never published, although Jevons did publish two diagrams that were intended to be part of it, at his own expense. See Chapter 2 for details.

14 Owens College was one of only two colleges (the other being University College) at the time, that employed nonconformists. In 1879, Owens College became the Victoria University of Manchester.

15 See Joseph Schumpeter (1954, pp. 886f). The dichotomy between a preoccupation with growth and static allocative problems is stressed by Vivian Walsh and Harvey Gram (1980, p. 131), Maurice Dobb (1973, p. 194) and Mark Blaug (1962, pp. 294, 306). The 'Marginal Revolution' is generally associated with the nearly simultaneous publication of Jevons's *Theory of Political Economy* [1871], Léon Walras' *Eléments d'économie politique pure* [1874], and Carl Menger's *Grundsätze* [1871].

16 See the papers presented at a conference in Bellagio, Italy, and reprinted in the Fall, 1972, issue of *HOPE,* edited by R.D.Collison Black, Craufurd Goodwin, and A.W.Coats. In addition, see Bronfenbrenner (1971), and Hollander (1979). Bronfenbrenner maintains that neither 'conventional incrementalism or "uniformitarianism" on the one hand, nor Thomas Kuhn's "catastrophic" theory of scientific revolution on the other, fits the broad sweep of economic doctrinal history' (1971, p. 136).

17 As Bowley (1972) has demonstrated, most elements of Jevons's theory were present in Classical thought: the distinction between total and marginal utility; the ranking of wants; and the diminishing marginal utility formulation. Cf. Georgescu-Roegen (1968, pp. 236–37, 263), and G.Stigler (1972). Hollander (1985, 1989a)

maintains also that John Stuart Mill accepted the notion of a budget constraint, the ranking of alternatives in a stable preference ordering, maximization, the law of one price, and traded goods as equivalents in equilibrium.

18 For the earlier, contrasting, view, see Schumpeter (1954, p. 952): 'Nobody denies that, numerous differences in detail notwithstanding, Jevons, Menger, and Walras taught essentially the same doctrine.'

19 Thus, the noun was also important in the phrase 'Marginal Utility Revolution'. In Hutchison's evaluation, by contrast, 'the marginal utility theory of value provided the archetype of a 'microeconomic' maximizing allocation problem, capable of a pure and simple mathematical formulation, and using the concept of the marginal unit to formulate a precise maximizing solution…what was important in marginal utility was the adjective rather than the noun' (1953, p. 16; cf. Walsh and Gram 1980, p. 131; Dobb 1973, p. 194; and Black 1972c, p. 372).

20 Maloney (1985) has contrasted the synthetical approach to economics by J.S. Mill, with that by Jevons, who 'almost made a virtue of disconnectedness' (p. 10; cf. p. 53). Jevons's call for the subdivision of economics, Maloney argues, was contrary to Mill's vision of economic science, and to the spirit of Section F of the British Association for the Advancement of Science. The President of Section F in 1878, J.K.Ingram, opposed the separation of various specializations within economics; see Ingram (1878, pp. 608–12).

21 See the recent evaluation by Warren Samuels: 'I do not find it remarkable that Jevons pursued one mode of analysis in *CQ [The Coal Question],* and another in *TPE [Theory of Political Economy].* I find [Jevons to be] a person who is capable of pursuing different problems, of doing different intellectual tasks, in ways which, in his view, are respectively best suited to those tasks' (1991, p. 237).

22 Much of this material appears in *P&C,* **vii,** pp. 241f, and **i,** pp. 1–52.

2
JEVONS'S THEORY OF ECONOMIC GROWTH

1 This section relies upon the correspondence, as well as the excellent notes accompanying the correspondence in the *Papers & Correspondence* [1972–81; *P&C],* edited by Black. For an indication of Jevons's determination at an early age, see 'Recollections of my brother', by Lucy Ann Mutton [1882]: 'he had a good deal of impatience at interference with his own plans of action even as a very small child, and if at all rudely thwarted would shew evident signs of displeasure' (JA4/2/1).

2 Jevons placed third in a tie with Marcus Nathan Adler. See *P&C,* **ii,** p. 416, note 4.

3 Jevons 'struck out' the '*true* Theory of Economy' early in 1860. See his 1 June letter to Herbert Jevons, *P&C,* **ii,** p. 410, as well as LaNauze, who dates the discovery on 19 February 1860 (1953, p. 357).

4 See the 8 December 1861 Journal entry, *P&C,* **i,** pp. 180–81. Both diagrams were reprinted in *Investigations in Currency and Finance* [1884; *ICF*].

5 '[That year]', Jevons wrote in the same entry, 'has convinced me that success in my line of endeavour is even a slower achievement than I thought. This year has taken much youthfulness out of me' (*P&C,* **i,** p. 188). For a comment on the lack of

interest in Jevons's MT, see Black (1962, pp. 205–206), and for a more favourable evaluation of the reception of Jevons's theory, see Schabas (1985).

6 See Jevons's letter to Herbert Jevons, of 24 July 1863 (*P&C,* **iii,** p. 33).

7 On 25 April 1863, Jevons remarked: 'Now I suppose I am low because my Essay on Gold is out, & as yet no one has said a word in its favour except my sister who of course does it as a sister' (*P&C,* **i,** p. 191). *ASF* was published on the 16 April by Edward Stanford of Charing Cross, London. But see Jevons's letter of 15 May to T.E.Jevons, acknowledging some amount of recognition: 'I understand from Richard Hutton that there will be an article in the *Spectator* tomorrow on my Gold pamphlet—He considers that the fall is conclusively proved. There begin to be some slight signs that the thing is noticed, but very slight' (*P&C,* **iii,** p. 13). ASF sparked a correspondence with and the favourable evaluation by J.E.Cairnes (cf. Cairnes to Jevons, 28 May 1863; Jevons to Cairnes, 2 June 1863; Jevons to Cairnes, 3 June 1863; Cairnes to Jevons, 4 June 1863; **iii,** pp. 16–25).

8 In his accompanying letter dated 3 March 1866, Macmillan predicted that 'the book must attract more notice by and by' (*P&C,* **iii,** p. 84).

9 Jevons copied this letter, dated 24 February 1866, into his Journal (see *P&C,* **i,** p. 203).

10 This favourable letter was very important to Jevons. See his remark to Herbert Jevons in a 24 March 1866 letter (*P&C,* **iii,** pp. 88–89), as well as the three drafted responses to Gladstone (pp. 90–93). A key to Gladstone's favourable reaction to *TCQ,* was Jevons's call for reduction of the National Debt. On this matter, see White (1991a).

11 Hansard Parliamentary Debates, p. 1525. The exhaustion of coal supplies was discussed in the House of Commons during debates on the Cobden-Chevalier Treaty, when estimates of the size of Britain's reserves varied widely; see Black (1981).

12 This is published in Volume **vii** of the *Papers and Correspondence,* pp. 11–18. See also, 'On Coal', a Lecture delivered in the Carpenters' Hall, Manchester, 16 January 1867 (*P&C,* **vii,** pp. 18–28), and 'On the Probable Exhaustion of Our Coal Mines', a Lecture delivered at the Royal Institution, 13 March 1868 (*P&C,* **vii,** pp. 28–35).

13 *P&C,* **iii,** p. 101. The Royal Commission was named late in June 1866.

14 The figures Jevons used (*TCQ,* p. 265) were:

Year	*Tons*
1854	64,661,401
1855	61,453,079
1856	66,645,450
1857	65,394,707
1858	65,008,649
1859	71,979,765
1860	80,042,698
1861	83,635,214
1862	81,638,338
1863	86,292,215

Jevons claimed that a more accurate figure for 1863 was 88,292,515 tons, but he used the conservative estimate of consumption in order to ensure a lower bound on his estimated growth rate (*TCQ,* p. 266). See Appendix 2.1 for a full description of Jevons's calculation of the geometrical growth rate.

15 'The total aggregate consumption of the period of 110 years, 1861–1970, would be 102,704,000,000 tons' (*TCQ,* p. 273). See Appendix 2.1 for the details of this calculation.

16 This and *The Coal Question* example, pertain to situations where a reallocation of factors yields a static efficiency gain, and increased real wages; the rate of growth of output does not rise. One should not be overly critical of the analysis in the Lectures, since, as Professor Black has reminded me in correspondence, they were not designed for publication, and, further, may contain the errors of Jevons's student, Harold Rylett, who took down the lecture notes.

17 Labourers are presumed to be myopic, and the resultant consumption pattern, which entailed zero or low savings rates, could lead to short-term 'pauperism' if cyclical fluctuations in labour demand occurred: 'There are comparatively few signs that the wages of the working-classes, even when sufficient, are saved and applied really to advance the condition of the recipients. All is expended in a higher [short-term] scale of living, so that little permanent benefit results; and when bad trade comes again, there is as much distress as ever' ('Opening Address as President of Section F (Economic Science and Statistics) of the BAAS' [1870], *Methods of Social Reform, and other Papers* [1883; *MSR,* p. 205]). As a consequence education is all-important for cultivating prudential habits and the desire to save. A similar argument appears in the *TPE;* see below, pp. 96–98.

18 In his *TPE,* Jevons was critical of the subsistence wage theory. See pp. 76; 133–34.

19 If this is Jevons's representation of Malthus's position, there is evidence that it is incorrect; see Malthus's correspondence with Nassau W.Senior concerning the increase in real wages which 'may sometimes operate in giving the labouring classes a taste for such a mode of living as will tend to increase their prudential habits'; 'the final condition of the labouring classes would not depend on this change which had taken place in the law, but upon the greater or less prevalence of the moral checks to population after the peculiar stimulus to its increase had subsided' (Senior 1829, pp. 84–86; cf. pp. 56–57, 77; and Hollander 1987, especially pp. 200–202).

20 In the Jevons Archives, these phrases are attributed to Thomas Chalmers, as 'quoted by Scrope'. Jevons continues:

> No doubt this is true where there is no foresight, no providence, nothing but blind obedience to the impulse of nature. Case of the Irish or living on potatoes. If we like to live like animals we become subject to their laws.
>
> But we have many alternatives.
>
> 1. Prudence & deferment of marriage.
> 2. Careful provision for children & energy in getting wealth.
> 3. Emigration.

(JA6/42/32)

Apparently, subsistence wages prevailed only in exceptional cases (see pp. 30; 33–34 for further discussion). I am grateful to Mike White for alluding to the importance of the Archive material in this context. See White (1994a) and Peart (1994a).

21 The subsistence wage 'theory' is elsewhere said to have caused an incorrect analysis of the falling profit rate: 'It is the accepted opinion of writers of the present day, that the rate of interest tends to fall because the soil does not yield proportionate returns as its cultivation is pushed. But I must hold that this decrease in the proportionate returns would chiefly fall upon the wages of the labourer' (MT, p. 287).

22 There is some ambiguity in Jevons's writings on this issue. For while the passages cited above oppose a subsistence wage theory, Jevons on occasion wrote of a wage rate being driven back down to a subsistence level; this occurs in the context of policy recommendations, and the comments may have been designed to inspire action in the face of 'pressing' impoverishment (cf. pp. 30; 33–34). For an overview of interpretations of the wage rate in Classical growth theory, see Peach (1988, pp. 109–11).

23 The 1875 Lecture also contains this argument (cf. *P&C,* **vi,** p. 59). This is a point much emphasized by Karl Marx in *Capital* (1887): 'the high death-rates [of children] are, apart from local causes, principally due to the employment of the mothers away from their homes, and to the neglect and maltreatment, consequent on her absence, such as, amongst others, insufficient nourishment, unsuitable food, and dosing with opiates; besides this, there arises an unnatural estrangement between mother and child, and as a consequence intentional starving and poisoning of the children' ('Machinery and Modern Industry', p. 375; cf. pp. 372–79).

24 J.S.Mill argued that 'the opening of industrial occupations freely to both sexes' would 'accelerate' the tendency 'that population…will bear a gradually diminishing ratio to capital and employment'. Thus 'among the probable consequences of the industrial and social independence of women', Mill included 'a great diminution of the evil of over-population' (*Collected Works of John Stuart Mill* [1962–; *CW*], **iii,** pp. 765–66).

25 There is no outline here of the circumstances that might 'disguise' a geometric growth rate. Jevons's empirical analysis in *TCQ* commences with population growth statistics, and then turns to emigration in order to establish that high emigration rates in the face of relatively high colonial wages were responsible for the 'appearance' of low British population growth rates. He may therefore have had emigration in mind in this discussion. The a posteriori proof 'consists in furnishing statistics. Taking experience on a large scale and showing that where the hypothetical conditions remain somewhat the same, there is multiplication in this manner, and that where it does not occur it can be accounted for by the operation of other causes. Malthus used the a posteriori principle to a great extent' (*P&C,* **vi,** p. 57).

26 A similar interpretation is given by Eckard, who argues regarding Jevons's position that population growth is constant when the 'relation of population to environment' is constant (1940, p. 58).

27 For a recent evaluation of these issues, see Engerman (1993, pp. 162–63). Engerman compares Malthus's predictions, which were revised based on new data between 1803 and 1821, with those of Jevons. As Engerman rightly points out, many predictions of mineral and resource exhaustion, based on the assumption of no changes in key parameters, have proven inaccurate with respect to timing, a problem faced by 'all disciplines of the study of human beliefs' (p. 163).

28 Robbins has argued that the particular progressions which Malthus chose in his examples were only 'illustrative' of 'what he conceived, rightly or wrongly, to be realistic tendencies' (1970, p. 87). Mill, also, made this point: 'every candid reader knows that Mr.Malthus laid no stress on this unlucky attempt to give numerical precision to things which do not admit of it' (*CW,* **ii,** p. 353). A note in the Jevons Archives objects to the argument that scale economies ('by means of comb organization') will allow for output growth to keep pace with population: 'But the above evidently applies to manufactures not to natural agents—We draw our food from a vastly extended area' (JA6/42/33).

29 Jevons outlined a similar position in his 1875 Lecture: 'we can easily see that there is some rude approximation to truth in the matter by considering that all physical agents, all natural materials are limited in quantity ultimately' (*P&C,* **vi,** p. 57).

30 This is one of the few references to stationariness in *The Coal Question;* analytically, it is incorrect, if the model entails the extraction of an exhaustible resource and the absence of technological change (cf. Note 34).

31 White (1994a) objects to this characterization of Jevons. Damaging to this contention, he maintains, is the fact that Jevons foresaw expansion of manufacturing employment. But Jevons's pessimism pertained to the emergence of land and natural resource scarcity (Peart 1990, p. 43; cf. Peart 1994a). He believed that land scarcity checks would soon emerge in America (*TCQ,* p. 426; cf. p. 427). While agricultural opportunities in the United States removed Malthusian scarcity checks to population, this was but a temporary respite (cf. *TCQ,* pp. 201, 220, 231).

32 Cf. 'The longer our prosperity continues unslackened, the more necessary a free outlet will become. But the moment to be apprehended is when the first general check to our prosperity and growth at home is encountered. Then the larger part of the rising generation will find themselves superfluous, and must either leave the country in a vast body, or remain here to create painful pressure and poverty' (*TCQ,* p. 422).

33 Those who do not emigrate in time suffer reduced living standards: 'From established habits of prosperity and early marriage we shall continue to grow with a certain inertia, but the rising generation will not find the comfort and early independence they were brought up to expect' (*TCQ,* p. 420).

34 I avoid the suggestion that the real wage falls to some 'subsistence' level corresponding to zero population growth, since Jevons recognized that stationariness could not be achieved in the absence of technological change, because resource scarcity entailed exhaustibility and thus growth must eventually attain negative rates. If this is the case, it becomes difficult to conceive of a 'subsistence' wage at which population growth is zero, for the analysis entails in

the limit, negative growth rates of population. This was not a point which Jevons discussed in any detail, but may explain his intense pessimism.

35 Hollander (1987, pp. 202–207 and 1985, pp. 444–51), discusses these two analytical approaches in the Classical economists; Peart (1990a) contains a discussion relating to Jevons.

36 A further remark does suggest that in the course of growth, emigration and population growth might result in equalized marginal products abroad and at home. Jevons described a recent wave of emigration to America, induced by relatively high wages there (*TCQ,* p. 221). The outcome of the resulting population growth and emigration, is then said to entail 'the same addition of useful labour' by the population at home and abroad (p. 222). From Jevons's emphasis on wage rate differentials, however, one must presume that, while there is a 'tendency' for real wages to equalize across sectors and countries through population growth rate responses to differentials, the achievement of wage rate equality rarely occurs in practice.

37 For a detailed examination of Jevons's policy analysis dealing with poverty and education, see Part III, especially pp. 160–63.

38 Here Jevons appears to have neglected his analysis, which implies that as incomes rise, the population response is dampened over time. For a statement which pertains to a movement from one rate of growth to another (higher) rate, see his suggestion that emigration, capital accumulation, output growth, and rising profits, implied that 'population becomes accustomed to early marriage' (*TCQ,* p. 231).

39 The relationship between British exports and secular growth has been the subject of much debate among economic historians. A recent contribution uses causality tests to demonstrate that for the late eighteenth century export variation preceded import variation (Hatton *et al.* 1983 p. 163). Jevons relied on a similar argument to explain the cyclical variation of output, arguing that export variation led to economic fluctuations. See Chapter 3.

40 Migration from low to high growth areas was allowed for by Jevons in *TCQ,* although it is not discussed in this context. See p. 32.

41 Marx, also, maintained that absolute labour requirements in agriculture fell secularly during the nineteenth century: 'in the same period [up to 1868] the rural population has diminished, not only relatively, but absolutely' (1887, p. 473); 'as soon as capitalist production takes possession of agriculture, and in proportion to the extent to which it does so, the demand for an agricultural labouring population falls absolutely' (p. 601; cf. pp. 473–75, 601–602, 633–34).

42 Cf. Jevons's remarks concerning this pauperism, which was regarded as 'precisely what Malthus would have predicted of a population which, while supplied with easily earned wealth, is deprived of education and bribed by the mistaken benevolence of the richer classes into a neglect of the future' (*MSR,* p. 197). The labouring poor are represented here as myopic, and lacking in the desire or capability for saving. This theme is taken up in detail in Chapters 5 and 8. In addition, we shall see in Chapter 3 that investors are represented as myopic throughout the cycle.

43 This policy was said to entail long-term efficiency gains, the 'increased efficiency of labour in the next generation' (*TCQ,* p. xlix). Marx, also, had much to say concerning the employment of children in factories (cf. *Capital,* pp. 372–75). While I am convinced that both Marx and Jevons were genuinely concerned about

the plight of children in factories, efforts to resist the employment of children may not have always been motivated by altruism. See Anderson and Tollison (1984, pp. 187–201).

44 Cf. 'It is only with the increase of education and temperance that the increase of wages will prove a solid advantage' (*MSR,* p. 209). Both Malthus and Mill were very concerned with the possibility of shifting the labour growth rate-real wage correspondence. They argued that educational programmes could generate increased 'prudential' behaviour by labourers, and result in constant real wages despite diminishing returns. See Hollander (1985 and 1987, pp. 202–207), for textual evidence concerning their position. Jevons's emphasis, by way of contrast, appears to suggest that labourers should restrict population growth to prevent a fall to 'deep' poverty levels. But he, like Malthus and Mill, is very much concerned with cultivating prudential behaviour, entailing improved decisions concerning marriage, family size, and savings.

45 Pauperism 'is the general resultant of all that is wrong in our social arrangements'; 'it can only be reduced by such exertions as raise the intelligence and provident habits of the people' (*MSR,* p. 186). The analysis again emphasized the inconstancy of labourers' incomes, pauperism being 'fully accounted for by the temporary state of industry' which necessitated an intertemporal smoothing of consumption.

46 Jevons hypothesized in the 1870 'Opening Address' that Ireland was characterized by higher mortality rates than England. Some statistical evidence was presented on the issue in Appendix B to the Address (*MSR,* pp. 213–16). The hypothesis was reiterated in Jevons's Owens College Lecture on population (*P&C,* **vi,** p. 59). See White (1993, 1994c) for a criticism of Jevons's use of data in this context. White (1994a) contends that private charities are the cause of pauperism since these foster a lack of self-reliance among poor people. I agree that lack of self-reliance is at fault, in Jevons's mind, but find over-population to be an additional manifestation of this character flaw. See Peart (1994a) and Chapter 8.

47 Like Malthus, Jevons associates poverty with fallen morality. Thus, he frequently writes of 'misery and vice'. We will see in Chapter 3 that John Mills maintained a similar position concerning the behaviour of 'immoral' and 'ignorant' traders throughout the cycle (see pp. 62–63 and Note 58).

48 Mill also recommended the taxation of inheritance income, but justified this on distributional grounds, since inheritances constituted unearned income (cf. *CW,* **iii,** p. 811). On the matter of the National Debt I concur with Black, that Jevons hit upon a policy 'enshrining typically Victorian values on private and public finance'. Thus 'even for a very original mind it is not easy to transcend the paradigms of the age' (1981, p. 16). See also White (1991a).

49 Mill, *CW,* **iii,** pp. 758–96, and **iv,** 'The Claims of Labour' [1845, pp. 376f]. See Robson (1968); Hollander (1985, pp. 823–912); and the detailed discussion in Part III.

50 See Schumpeter (1954, p. 889), G.Stigler (1950, p. 172), Hutchison (1978, pp. 73–74), and Mirowski (1988, p. 13 and 1984, p. 363).

51 Carl Menger is regarded here and elsewhere as the 'odd man out': 'he was not self-consciously aware, as Jevons and Walras were, of being a revolutionary; he eschewed mathematical formulations and hence the pure logic of extremum problems; he only formulated "Gossen's second law" in words and certainly did not emphasize it;…he rejected cost theories of value, but on the other hand, was deeply suspicious

of all determinate theories of pricing and underlined discontinuities, uncertainties, and bargaining around the market price' (Blaug 1962, p. 306).

52 This phrase is cited by Hutchison as evidence that Jevons dismissed 'soft-line' Malthusianism; Blaug cites the sentence directly following, which defines 'the problem' of economics. The full passage reads:

> The doctrine of population has been conspicuously absent, not because I doubt in the least its truth and vast importance, but because it forms no part of the direct problem of Economics. I do not remember to have seen it remarked that it is an inversion of the problem to treat labour as a varying quantity, when we originally start with labour as the first element of production, and aim at the most economical employment of that labour. The problem of Economics may, as it seems to me, be stated thus:—*Given, a certain population, with various needs and powers of production, in possession of certain lands and other sources of material: required, the mode of employing their labour which will maximize the utility of the produce*.
>
> (*TPE,* pp. 266–67)

53 See Hollander (1987, pp. 351–52), Peart (1993a), and Chapter 9, for a detailed examination of this method.

54 More specifically, Black's position is that the rest of Jevons's applied works deal with two broad themes: the treatment of time series data; and the classification of trades (1981, p. 12).

55 See the account in Keynes (1933, pp. 262–63), as well as Walsh and Gram (1980, p. 128) and, most recently, White (1991b, p. 230).

56 Before Armstrong's BAAS Address, Edward Hull had investigated the question 'How long will Britain's coal fields last?'. Armstrong, by contrast, argued that the question was not exhaustion, but increasing cost of extraction, and the corresponding threat to British manufacturing. Thus, White concludes, 'it is unnecessary to attribute to Jevons any particular perceptiveness on the coal question', and 'incorrect' to suggest—as did E.W.Eckard (1940, p. 53)—that it was Jevons who shifted the debate from the issue of exhaustion to that of increasing cost.

57 Jevons's admiration of Malthus is further evident in 'The Future of Political Economy' [1876], where he suggested that Malthus's essay 'is a model of inductive inquiry so far as information was available in his day' (*Principles of Economics* [1905; *PE,* p. 193]).

58 Jevons's brother, Herbert Jevons, observed that the pressure of population was manifest, since settlers had reached 'the limits of the great desert of North America' (6 November 1860; **ii,** p. 419).

59 Mirowski maintains that Jevons's 'prediction that England was exhausting energy stocks' was a direct extrapolation 'from the mid-nineteenth century energetic movement' (1984, p. 370; cf. 1989, pp. 258–59). The foregoing demon-strates, however, that Jevons's message in *TCQ* was not exhaustion but rather increasing costs.

60 See also the passage cited on p. 24. White (1991c) considers changes to the third edition of *TCQ,* (edited by A.W.Flux, based on Jevons's notes), that involve

references to 'energy'. In the passage cited on p. 24, for instance, the phrase *'constant whole of force'* was altered to *'constant aggregate of energy'* (ibid., p. 66).

61 Kern (1990, p. 101), as well as Hollander (1989a), has reiterated that Jevons as well as earlier (Classical) economists understood the message of energy conservation in this sense.

62 For an elaboration of this argument, see Part III.

63 Actual coal consumption in 1961 was 192 million tons (Black 1981, p. 16); Jevons clearly underestimated the increasing importance of substitute energy supplies.

3
SUNSPOTS AND EXPECTATIONS

1 For a discussion of Jevons's contribution to the study of periodicity, see Part III. Jevons's studies of periodicity have received much scrutiny (Aldrich 1987; Morgan 1990; S.Stigler 1982), but less attention has been given to his theoretical position on economic fluctuations, a circumstance which Hutchison justly finds surprising considering that 'Jevons maintained that aggregate instability, and the distress it caused, presented profoundly serious problems, and devoted some of his most strenuous economic research to their explanation' (1988, p. 6).

2 A similar tension has been posed in Marshall: 'between the substantive rationality largely used for the microeconomic analysis and the procedurally rational approach that tended to be used when considering macroeconomic questions' (Biggs 1990, p. 37). See Chapters 4, 5 and 6 for further discussion of the tension between systematically correct and systematically incorrect decision-making in Jevons.

3 William Langton maintained that the long periodicity of 'excesses' prevented traders from learning restraint on their own, (without education), after an episode occurred: 'The commercial excesses which cripple our financial resources are of no infrequent occurrence, yet the intervals between them are sufficiently distant to weaken the practical value that should be derived from the experience of their disastrous effects' (1857, p. 16).

4 Langton (1803–1881) was a Manchester banker, and a founder of the Manchester Statistical Society, to which he presented 'On the Balance of Account between the Mercantile Public and the Bank of England' in 1857. Chaloner (1972) argues that Jevons's work on crises was stimulated by this presentation (pp. 79–80). Both Mills and Jevons referred to Langton's paper, which Jevons termed 'one of the most luminous inquiries concerning commercial fluctuations anywhere to be found' (*Investigations in Currency and Finance* [1884; *ICF,* p. 224]). For correspondence between Langton and Jevons, see *P&C,* **iv,** pp. 165, 209–11, 214–15, 216–17 and 220.

5 John Mills presented 'The Bank Charter Act and the Late Panic' to the National Association for the Promotion of Social Science at Manchester in 1866. Jevons corresponded frequently with Mills, used Mills's diagrams (drawn by Jevons) in his lectures at Owens College, and referred students to Mills's article, 'On Credit Cycles, and the Origin of Commercial Panics'. For correspondence between Mills and Jevons, see *P&C,* **iv,** pp. 29, 188–89, 199, 202– 203, 228, 229, 231–32, 240–41, 273–74, and 281.

6 Jevons distinguished between periodic and 'irregular' fluctuations, the latter provoked by 'disturbing' causes. 'Commercial moods' figured in both instances.

7 I do not intend to suggest, however, that Jevons relied upon the argument now frequently used by business cycle analysts, that agents cannot distinguish between nominal and real price or wage rate changes.

8 Marshall cites this passage (1923, p. 247).

9 See 'A Second Letter to J.B.Smith' (1840), where Overstone attributed the 1837 slump to (a) previous speculation having led to the negotiation of increased foreign securities; (b) monetary policy in the United States; (c) the large increase in country bank issues in 1835 and 1836. The Bank of England, he insisted, 'is in no respect answerable for these occurrences' (p. 197). See also 'Extracts from the Evidence of Samuel Jones Lloyd, Esq., before the Secret Committee of the House of Lords of 1848, on Commercial Distress' (P. 519).

10 The terms of the Act were outlined by J.S.Mill:

> the issue of promissory notes for circulation was to be confined to one body…all existing issuers were permitted to retain this privilege, but none were to be hereafter admitted to it…and for all except the Bank of England, a maximum of issues was prescribed, on a scale intentionally low. To the Bank of England no maximum was fixed for the aggregate amount of its notes, but only for the portion issued on securities, or in other words, on loan. These were never to exceed a certain limit.… All issues beyond that amount must be in exchange for bullion.
>
> (*CW,* **iii,** pp. 665–66)

11 Mill linked this variation to economic growth: when the profit rate falls secularly, risky projects are said to be taken on, and speculation begins. See Link (1968, p. 167). On the role of 'professional traders' and 'rash speculators' in the cycle, see Forget (1990). Spotton emphasizes the role of 'ignorant traders' in Classical and contemporary explanations of 'over-trading' as well (1994, p. 4).

12 Hyde Clarke, (1815–1895), was a member of the British Association for the Advancement of Science as well as Vice-President of the London (later the Royal) Statistical Society. His interest in railways prompted him to found and edit the *Railway Register* from 1844-47. See Black (1992) for detailed biographical information about Clarke; for a discussion of Clarke's attempts to date cycles, see Henderson (1992). For correspondence from Jevons to Clarke, see *P&C,* **iii,** pp. 243–44; from Clarke to Jevons, see *P&C,* **iv,** pp. 274–76 and 295–96. Jevons referred at length favourably to Clarke's 1847 paper in his 1878 *Nature* publication, 'Commercial Crises and Sun-Spots'; see *ICF,* pp. 222–24. In particular, Jevons was struck by Clarke's 'highly scientific' common cause argument (p. 222).

13 This was not an uncommon means of entry into economic analysis. Dionysius Lardner and A.J.Etienne Juvenel Dupuit were also pioneers in economics whose research focused on railways. See *TPE,* pp. xviii, xxviii–xxix.

14 Significantly for Jevons's later work, Clarke related cycles to physical phenomena; he did not, however, rely on the sunspot explanation (*P&C,* **iv,** p. 275; see p. 274).

15 Langton's use of medical metaphors as well as the focus on credit were followed by John Mills. Jevons, however, distanced himself from these phrases, in part, perhaps, because he did not believe that it was a sufficient explanation of fluctuations to posit that beliefs followed a natural cycle from 'healthy confidence' through 'diseased morbidity'; see pp. 55–57.
16 A detailed demonstration of the argument in the following section is found in Peart (1996).
17 Mills makes a similar argument in 'The Bank Charter Act and the Late Panic', in order to support his claim that the Bank Act should not be held responsible for recent panics (1866, p. 4).
18 Like Overstone, however, Mills insisted that although currency was not the cause of fluctuations, poor currency laws might aggravate fluctuations (1867, p. 16).
19 Mills did not frame this in probabilistic terms. But it seems clear that in the first case borrowers and lenders correctly estimate the distribution of returns to investments; while in the case of faulty credit they make incorrect evaluations of the distribution of returns.
20 Mills cited J.S.Mill's *PPE* in support of his argument that the expansionary period was characterized by rising prices and profits, while the contraction was characterized by falling prices and profits (1867, p. 21).
21 Mills emphasized the importance of 'this idea of the normalism of the successive phases' (1867, p. 22; cf. p. 23).
22 See 1866, pp. 4–5. Mills maintained that the speculative phase was partially checked by convertibility, although (like J.S.Mill) he admitted that suspension of convertibility had on several occasions mitigated the worst features of the panic (pp. 10f; cf. 1867, pp. 36–37). See p. 62.
23 'It is the student who watches for movements and changes; the great majority of men habitually assume that what *is* is what *will be*' (1867, p. 25). Mills's distinction between the well-educated and the less well-educated traders, resembles that by J.S.Mill between the professional traders and the public. See Note 11. Elsewhere, also, Mills assigns blame for speculative manias to a deficiency among traders (1866, p. 4).
24 Here and elsewhere, Mills allowed that some highly skilled or educated traders might perceive the instability of the speculative phase (see 1866, p. 5). The less shrewd realize that credit has become 'diseased' only after observing some striking failures, as in the case of the Grand Trunk, or the Iron works.
25 This phrase was borrowed by Jevons in his sunspot papers; see p. 57.
26 Since the Bank Act ensured that Bank notes were convertible to gold, however, the collapse into pessimism did not extend to them. This is the reason for Mills's staunch support of convertibility: without convertibility, he argued, panics would extend to money (see 1866, pp. 7f). The collapse occurs with the recognition of the gap between expected and actual returns; panic followed the destruction of 'a bundle of beliefs' concerning these engagements. It is a defect of his argument that there is no analysis of precisely how or why this gap is recognized and why, therefore, the collapse of beliefs occurs.
27 'On the Study of Periodic Commercial Fluctuations', presented to the British Association for the Advancement of Science in 1862, touches briefly on the issue of fluctuations (*ICF,* p. 4). 'The Variation of Prices and the Value of the Currency since 1782' [1865] and 'The Depreciation of Gold' [1869], followed up on the

research in *ASF*. Because of their importance for the subsequent development of empirical techniques in economics, these are discussed in Chapter 10. A third paper, 'On the Frequent Autumnal Pressure in the Money Market, and the Action of the Bank of England' [1866], followed Langton in examining seasonal fluctuations in currency, and monetary policy. See pp. 61–62 and Chapter 10. All of these have been published in *Investigations of Currency and Finance*.

28 In *ASF* he conceded that the 'remote cause' of ongoing fluctuations—the force generating observed regular cycles—remained unknown (*ICF,* p. 27).

29 Jevons originally intended this to be part of the extensive collection of diagrams in his proposed 'Statistical Atlas' (see Chapter 1). For a complete description of the intended contents of the Atlas, see *P&C,* **ii,** pp. 425–27, and 461. The 'chief interest' of the Atlas would be 'in the light thrown on Commercial storms' (to Herbert Jevons, 7 April 1861; **ii,** p. 427).

30 In addition, 'On the Study of Periodic Commercial Fluctuations' recommended that the procedures used in meteorological studies be adopted by political economists:

> It seems necessary, then, that all commercial fluctuations should be investigated according to the same scientific methods with which we are familiar in other complicated sciences, such especially as meteorology and terrestrial magnetism. Every kind of periodic fluctuation, whether daily, weekly, monthly, quarterly, or yearly, must be detected and exhibited, not only as a subject of study in itself, but because we must ascertain and eliminate such periodic variations before we can correctly exhibit those which are irregular or non-periodic, and probably of more interest and importance.
>
> (*ICF,* p. 4)

Jevons of course showed great interest in meteorological investigations. See, for instance, 'On the Cirrous Forms of Clouds' (1857), 'On the Forms of Clouds' (1858), and 'On the Semidiurnal Oscillation of the Barometer' (1859).

31 Jevons maintained that low corn prices led to high accumulation rates. This, however, might reflect two possibilities: (a) a low corn price generates high surplus (taking the form of profits), available for investment; or alternatively, (b) the low price of corn may leave money wages roughly unchanged, and release purchasing power to spend on manufactured wage goods or luxuries. By 1878, Jevons explicitly endorsed the latter; see p. 57.

32 Note the implication in this passage regarding deviations in aggregate supply and aggregate demand. This matter is taken up on p. 61. Cf. 'It is very obvious that a rise in the price of corn is followed by a rise in the rate of interest & by increased bankruptcy…. I also speak of corn [in the diagram] as forming part of the capital of the country. It perhaps sounds rather odd, as we are accustomed to think of capital as so much money, but the expression is theoretically correct' (to Richard H.Hutton, 1 September 1862; **ii,** p. 450).

33 This striking passage is cited as evidence of an early capital theory of the cycle by Black (1981, p. 20 and 1987, pp. 1011–12), and by Robbins (1972). My assessment

agrees with Laidler's suggestion that the sunspot analysis supplements the capital theory of fluctuations (cf. 1982, pp. 341–42).

34 Laidler (1982) suggests that, for Jevons, credit institutions play a part in prolonging the speculative upswing, and that credit contraction was key to generating the turning point, or slump (ibid., pp. 341–43). He remarks that after 1866 Jevons searched for a reason for the credit contraction; in my account Jevons searched for a reason for the altered expectations that led bankers to contract credit. Laidler recognizes also, but does not elaborate upon, the 'strong psychological element' underlying Jevons's analysis of cycles (ibid., p. 343).

35 Presumably the increase in corn prices was caused by a harvest shock, combined with some speculation based upon expectations of the shock (viz: 'which may be anticipated'). Jevons may also have had in mind the transfer of resources from agriculture to 'fixed investment' during the upturn of the cycle causing increased corn prices.

36 But the lecture is difficult to interpret, since Jevons also refers to corn as 'floating capital' (*P&C,* **vi,** p. 121).

37 For a reiteration of the connection between spending on manufactures and corn prices, see pp. 57; 60, and 'Sun spots and Commercial Crises', to *The Times,* 17 January 1879; *P&C,* **v,** p. 45.

38 'These matters are not matters of currency. They involve the whole industry of the country. If we investigated the matter fully we should find a very considerable fraction of the world's population had been during this interval taken away from their ordinary pursuits and devoted to railway making.' Speculation in railway, timber and brick was 'brought to a head' by 'the price of corn' (*P&C,* **vi,** p. 123). The first Lecture on fluctuations, 'Illustrations From Commercial Fluctuations', also emphasized speculation (cf. pp. 115f).

39 Jevons presented diagrams of these variations he had drawn for Mills to the class, and suggested that students refer to Mills's 1867 paper (*P&C,* **vi,** p. 132). This constitutes his most careful description of cycles. A 'fluctuation' is characterized by these features; 'regular' or 'periodic' fluctuations are characterized by these features recurring at regular intervals. He was criticized by contemporaries for his lack of attention to the features of fluctuations. See the 5 December 1878 letter from R.Adamson (*P&C,* **iv,** p. 300).

40 This section on Jevons's sunspot theory relies on a series of papers written by Jevons between 1875 and 1882, and published in *Investigations of Currency and Finance* or in Jevons's *Papers and Correspondence*. These include: 'The Solar Period and the Price of Corn' (1875, *ICF*), 'On the Periodicity of Commercial Crises and its Physical Explanation' (1878a, *ICF*), 'Commercial Crises and Sun-Spots' (1878b, 1879a, *ICF*), 'The Solar Influence on Commerce' (1879b, *P&C,* **vii**), 'Sun spots and Commercial Crises', letter to *The Times* of 17 January (1879c, *P&C,* **v,** pp. 10–12) and 'The Solar-Commercial Cycle' (1882, *P&C,* **vii**). For simplicity, these papers are referred to as noted above, by the date when they were written, followed by the collection in which they were republished. As always, all emphasis is contained in the original.

41 Faced with difficulties fitting periodic price variations to data on fluctuations, Jevons came very close to embracing Mills's position that moods vary, simply because they are suited to do so. But he was never comfortable with that position, and maintained throughout his career that there must be a reason-aside from the

psychological make-up of traders and the institutional features of the British economy—for that variation, and that the social scientist must seek out that reason.

42 Jevons's concern in this work was proving that the variation in agricultural prices occurred with the periodicity of the crop cycle, and his attention was consequently directed towards establishing the correlation; he failed to explain here the relationship between the crop cycle and investment.

43 A review of the *Primer* in the *Manchester Examiner and Times,* 10 April 1878, argued that Jevons 'supplements to what may be called the ethical theory of John Mills, of Manchester, who first called these periods "credit cycles", inferences from Professor Balfour Stewart's research in solar physics' (JA6/50/7).

44 Cf. 'We must not lay to the charge of trades-unions, or free trade, or intemperance, or any other pretext, a fluctuation of commerce which affects countries alike which have trades-unions & no trades-unions, free trade and protection' (1879b, *P&C,* **vii,** p. 91).

45 This phrase is borrowed from Mills; see p. 51.

46 There is some suggestion that Jevons hit upon the argument that solar variation altered trade flows very early on. In the chapter of the *Primer* written in 1877, he suggested that solar variation 'makes bad harvests and deranges many enterprises in different parts of the world' (p. 120).

47 See the JA note, which confirms the importance of credit in creating the cycle: 'If everybody traded with his own capital nothing w[d] happen but an increase or decrease of individual profits & a fulfillment or diappt of individual hopes. But when we have one under engagement to another we have a disruption of ties wh may proceed to any extent' (JA6/6/32). This is written on the back of an envelope dated 26 October 1867. It seems plausible that it was written at about the same time.

48 As we have seen (p. 53), the argument that commercial 'moods' were inherently unstable was by no means new; in 1863, also, instability was said to be the norm.

49 As we have seen (Note 3), Langton also argued the time elapsing between cyclical peaks was long enough that investors did not learn from one episode to the next. In the *Primer* Jevons argued that 'very prosperous trade is sure to be followed by a collapse and bad trade. As a general rule, it is foolish to do just what other people are doing, because there are almost sure to be too many people doing the same thing' (JA6/50/7).

50 Haberler (1937, pp. 151–52) reiterates Jevons's argument that disturbing causes may offset, or reinforce, the harvest variation.

51 This is more in line with the analysis contained in *The Coal Question* [1865] and *ASF* [1863], where Jevons stressed that Britain was primarily a manufacturing nation (see Chapter 2 and pp. 195f). Cf. 'The state of things is not equally bad in all parts of the country; it chiefly affects Lancashire & Yorkshire where industry depends much upon foreign trade. No doubt, too, the destitution will be very temporary' (1879b, *P&C,* **vii,** p. 91). Evidence pertaining to Indian famines originated with the work of Sir William Wilson Hunter [1840–1900], Director-General, Statistical Department of India, and the astronomer Sir Joseph Norman Lockyer [1836–1920], editor of *Nature*.

52 Clearly, however, Jevons gradually changed his emphasis from an earlier focus on capital, to the later focus on 'moods', and the cause of their variation, price fluctuations due to sunspots.

53 In ‘On the Periodicity of Commercial Crises’ [1878a], Jevons insisted that ‘the cause [of ‘so widespread and recurrent a state of trade’] can only be found in some great and widespread meteorological influence recurring at like periods’ (*ICF,* p. 206).

54 In Black’s account, it is Jevons’s ‘complete’ adherence to the Law of Markets which prevented him from elaborating an over-investment theory of cycles; he never developed ‘the idea that plans to save and plans to invest might not coincide’ (1981, p. 20; cf. 1987, pp. 1011–12).

55 Jevons’s contemporaries maintained a similar position regarding monetary policy; see Laidler (1988).

56 The justification for convertibility was outlined in correspondence with R.H. Inglis Palgrave in 1874 (see *P&C,* **iv,** p. 77).

57 See Mills’s remarks (1866, pp. 5, 11–12). Mills brought the weight of J.S.Mill’s reputation to bear on the matter, and cited the *PPE* in this context. Mill supported this position in a 16 November 1866 letter to Mills (*CW,* **xvi,** p. 1214). See also *CW,* **iii,** pp. 671f, and Mills (1867, pp. 36–37).

58 Like Jevons, Mills often proceeded as though increased education implied increased morality. But he allowed that exceptions might occur: dishonest behaviour would be reduced, but not eliminated, by increased education.

59 For Mill’s recommendations concerning education, see ‘On the Probable Futurity of the Labouring Classes’ (*CW,* **iii,** pp. 758f) and, for a discussion of the recommendation for the education of commercial classes to reduce ignorant speculation, see Forget (1990).

60 Jevons’s papers on fluctuations—as well as those by Clarke, Langton and Mills—are replete with meteorological analogies; Jevons refers to the ‘tide’ of human affairs, as well as the ‘currents’ of trade.

61 See the discussion of the ‘Principle of Forced Vibrations’ (*PS,* pp. 451–52). Jevons also described the principle in ‘The Solar Influence on Commerce’ (1879b, *P&C,* **vii,** p. 92). For a discussion of how this relates to his conception of causality, see p. 209.

62 A more telling criticism of Jevons’s research in this regard is that he was carried away in the attempt to establish the correlation between economic fluctuations and sunspots, and was willing to include weakly established crisis observations that supported the correlation, and to exclude weakly established observations which did not. As Mitchell (1928, p. 384) remarked, Jevons was a candid researcher, and yet he was able to fit his cycle data to an 11.11 year sunspot cycle as well as to a revised 10.46 year sunspot cycle. This matter is taken up in Chapter 9, pp. 205–10 on Jevons’s achievements in empirical economics.

63 The section on Early Recognitions of the Role of Expectations (pp. 47–52) has revealed that John Mills and Hyde Clarke also relied on this argument. By contrast, D.H.Robertson, who respected Jevons’s work on fluctuations, stressed the common features of fluctuations, but allowed that agricultural variation was one of several causes of the cycle; see Presley (1981, pp. 179–80).

64 Pigou refers to the result, that:

> Hopefulness in one investor will not, in general, cancel hopelessness in another, but that the whole body will be united, sometimes in confidence, sometimes in fear. This, of itself means that the movements which occur are

> likely to be large. That, however, is not all. There is the further important result that rash trading on the part of a comparatively small number of houses may threaten widespread disaster, and, may, therefore, quite suddenly drive the main part of the business world from the heights of optimism to abysses of suspicion and over-caution.
>
> (Pigou 1913, p. 118)

I am grateful to David Laidler for having pointed out this similarity between Jevons and Pigou on economic fluctuations.

65 Mirowski reads the argument that economic crises are caused by energy fluctuations exogenous to the social operation of the economy, as a 'direct extrapolation' of the new physics, energetics (1984, p. 370).

66 Cf. the remarks by T.E.C.Leslie:

> Adam Smith too leaned to the notion of a code of nature regulating the movement of the economic world with perfect equality and uniformity. Perhaps therefore one need not wonder that Mr. Jevons, whose philosophical powers have enabled him to make real discoveries, should be fascinated by the idea of commercial cycles recurring with the regularity of astronomical phenomena.
>
> ('Political Economy and Society' [1879], 1879, pp. 397–98)

67 Mirowski contends, by contrast, that the sunspot explanation of cycles constitutes a 'unified rational response' to increasing scepticism concerning the smooth functioning of the economic system (1988, p. 46).

4
JEVONS'S *THEORY OF POLITICAL ECONOMY*

1 As White has argued, since the laws of supply and demand are based on 'facts', it is possible, in Jevons's mind, to state them correctly, while at the same time failing to explain them (1989, p. 429).

2 Yet in his notes on Mill Jevons criticized Mill for having capitulated too soon on the wage fund: 'having studied and reviewed Mr. Thornton's work [Mill] was over persuaded by his arguments against the wage fund theory. With his customary candour Mill at once relinquished doctrines which he had long cherished, to the great perplexity of Cairnes. The point is whether there can be said to be a fund of capital predetermined to the payment of wages' (JA6/6/ 14; pp. 5–6). It is this latter sense in which Jevons strenuously objected to the theory; see Hollander (1985, pp. 392f), for the argument that a rigidly determined wage bill is not a necessary component of Mill's analysis. In his 'Concluding Remarks', Jevons allowed that the Wage Fund theory had a certain 'limited and truthful application (see pp. 268–73; and Chapter 6).

3 Black has pointed to this phrase in support of his argument that Jevons's *TPE* is thoroughly Benthamite (1970, p. 18). The *TPE* is 'in fact, an application of Bentham's utilitarian philosophy to the economic problem', a fact which, 'When this

point is borne in mind, the layout of the *Theory of Political Economy* can be seen as clear and logical' (1970, pp. 18–19). By contrast, Mirowski (1989) plays down the importance of Bentham to Jevons's theory.

4 See also Jevons's *Principles of Economics [PE]:* 'There are not wanting economists who have held that value is the alpha and omega of the science of political economy.… I have seen reason to take utility rather than value as the subject-matter of economics' (*PE,* p. 49). Jevons's objections to a Labour Theory of Value were threefold: (i) Classical economists required a special theory of value in situations of limited supplies (such as rare statues); (ii) high labour costs did not imply a high value of the final produce if demand for the product was incorrectly forecast; and (iii) labour was itself a heterogeneous good that can be compared only through the values of its final produce. See G.Stigler (1950, p. 85). Hollander (1987, p. 134) has countered that heterogeneous labour led Mill to abandon the labour theory of value.

5 Jevons reiterated this position in *PE:* 'Perhaps the greatest difficulty of the science of economics lies in the ambiguity of its most important term, value' (p. 50). In his notes on Mill's *Political Economy,* Jevons was also highly critical of Mill's use of the term Wealth. He conceded, however, that: 'On the whole I am inclined to think that in spite of serious faults to be presently mentioned, Mill's Pol Economy is the work which will be most esteemed in the future' (JA6/6/14).

6 This position is reiterated in the *PE:* 'Value only indicates the relation or ratio of quantities which pass in an act of exchange. The reader must begin by dismissing from his mind the idea that value is a thing—that is to say, a concrete thing given for another thing…. Value is a property, or a quality, or a circumstance, or a relation, not a thing. It is abstract, not concrete' (p. 51). Since the passage from Mill quoted above reveals that he, too, clearly understood the relational aspect of value, Jevons was overly eager to include Mill with those who held erroneous views regarding value.

7 Cf. 'there is no such thing as value intrinsic in any commodity, but that, in an economic sense, the values of two things merely express the ratio in which they do as a fact exchange for one another' ('On the Condition of the Gold Coinage of the United Kingdom, with reference to the Question of International Currency' [1868], *ICF,* p. 251). Jevons praised Mill's reference to goods exchanging for each other 'in the ratio of their cost of production'; but he was nonetheless critical of Mill since 'he always omits to say distinctly that exchange value is itself a matter of ratio' (*TPE,* p. 82). Ricardo, Malthus and Smith are equally at fault for this omission, while the French economist, Le Trosne, comes in for praise for the following definition: 'La valeur consiste dans le rapport d'échange qui se trouve entre telle chose et telle autre, entre telle mesure d'une production et telle mesure des autres', a definition which Condillac also adopted (pp. 82–83).

8 In his second edition of the *TPE,* Jevons also included an extensive list of publications that implicitly or explicitly reasoned mathematically in economics, as well as a more extensive justification for the use of mathematics in economics 'to guide our thoughts in the slippery and complicated processes of reasoning' (pp. xxi–xlii). We return to this in pp. 82–83).

9 Jevons acknowledged some exceptions in England also. T.E.C.Leslie, J.L. Shadwell and William Edward Hearn are singled out as those whose treatment of wages was 'from the right point of view' (p. xlv). For the argument that the French

tradition of J.B.Say is substantially identical with that of Ricardo and J.S.Mill, see Hollander (1982).

10 In his 'Concluding Remarks', however, Jevons allowed that the wage fund could operate temporarily; he insisted also in Chapter v of the *TPE,* that his theory of exchange was consistent with a cost of production theory (*TPE,* pp. 192–93; see Chapters 5 and 6 for full discussion).

11 Jevons acknowledged with approbation that Mill 'has a remarkable section' in his *PPE* (*CW,* **iii,** Ch. v), where he extended the analysis of Rent to 'all inequalities, artificial or natural', an analysis which, according to Jevons, 'is a very satisfactory one inasmuch as it tends to support the view on which I am now insisting, a view, however, which, when properly followed out, will overthrow many of the principal doctrines of the Ricardo-Mill Economies' (p. li). But this extension of the analysis of Rent only reinforced Jevons's conviction that Mill was inconsistent. For Jevons on rent, see Chapter 6.

12 Jevons also praised Cournot's method in this regard: 'the method consists in assuming certain simple conditions of the functions as conformable to experience, and then disclosing by symbolic inference the implicit results of these conditions' (*TPE,* p. xxxi; see pp. 204–205 for Jevons's own treatment of a similar process).

13 'The coincidence, however, between the essential ideas of Gossen's system and my own is so striking, that I desire to state distinctly, in the first place, that I never saw nor so much as heard any hint of the existence of Gossen's book before August 1878' (*TPE,* p. xxxvi). Lest any doubt remain concerning his originality, Jevons maintained that it was more probable 'that I should discover the theory of pleasure and pain, than that I should discover Gossen's book, and I have carefully pointed out, both in the first edition and in this, certain passages of Bentham, Senior, Jennings, and other authors, from which my system was, more or less consciously, developed' (p. xxxvii).

14 See the letter to Henry Foxwell dated 14 November 1879, in which Jevons came to the conclusion that 'we are all shelved on the matter of priority' in the light of the work by Dupuit, Cournot and Gossen (*P&C,* **v,** p. 80). The priority makes the case for the influence of energist physics on Jevons's theory difficult to maintain: Mirowski rules out Dupuit as an energist physics adherent, and provides no evidence that Gossen was familiar with the new energy concepts. On this matter see also Hollander (1989a, pp. 464–65) and pp. 112–13 below).

15 Walras is, of course, credited for appreciating the law of diminishing utility: 'It is precisely upon this idea of the degree of rarity of commodities that Léon Walras bases his system' (*TPE,* p. xxxix).

16 Jevons reiterated this argument in *TPE* (pp. 5–7). For the argument that Mill misunderstood the point, see Schabas (1990), and for an examination of Mill's position on exact laws, see Peart (1993a).

17 Pleasure and pain, Jevons reasoned, 'are opposed as positive and negative quantities' (MT, p. 283). Jevons retained this position in *TPE*. See Chapter 6 for the treatment of labour as negative utility.

18 In this treatment Jevons is directly in line with Mill; cf. essay 'On the Definition of Political Economy' [1836], *CW,* **iv,** pp. 309–39. This methodological parallel is discussed in detail, in Chapter 8. For Jevons, 'foresight' is one motivation that 'merely complicate[s] without altering the other parts of the theory' (MT, p. 283).

19 In the *TPE* Jevons cites Smith's argument on this matter explicitly: 'the fact observed by Adam Smith, that "The desire for food is limited in every man by the narrow capacity of the human stomach; but the desire of the conveniences and ornaments of building, dress, equipage, and household furniture, seems to have no limit or certain boundary"' (p. 149). As we have seen in Chapter 3, Jevons relied on this argument in his analysis of fluctuations.

20 White (1994d) contrasts Jevons's acknowledged failure to explain how the equilibrium is reached, with *TPE,* where no such acknowledgement appears (p. 176).

21 Henry Charles Fleeming Jenkin (1833–1885) was an engineer whose papers include the 1870 publication referred to by Jevons: 'The Graphic Representation of the Laws of Supply and Demand and their Application to Labour', published first in *Recess Studies,* edited by Alexander Grant (Edinburgh). Keynes relied on this note by Jevons in order to assess Jevons's priority (see 1933, pp. 280–81). The footnotes by R.D.C.Black accompanying Jevons's undated note, and the ensuing correspondence with Jenkin, are very helpful. See the correspondence from Jenkin to Jevons (*P&C,* **iii,** pp. 167–78).

22 Labour might explain or affect value, Jevons allowed, but as labour itself was reduced to (negative) utility, this served only to confirm the utility theory. See Chapters 5 and 6.

23 Though his purpose was circumscribed, he had no doubt about the correctness of the theory: 'Oversights may have been committed in tracing out [the theory's] details, but in its main features this theory must be the true one. Its method is as sure and demonstrative as that of kinematics or statics, nay, almost as self-evident as are the elements of Euclid, when the real meaning of the formulae is fully seized' (*TPE,* p. 21). White (1990) argues that this conflates kinematics (the science of motion) and dynamics (the study of matter in motion, which encompasses statics as one instance of dynamic equilibrium). See also Smith and Wise (1989, pp. 199–200).

24 Jevons compared his treatment to that of determining the resting position of a lever. For expositions of the lever analogy, see Schabas (1990, pp. 91–92), as well as White (1990). White (1994d) argues that Jevons's discussion of price taking behaviour constituted a response to Thornton's *On Labour*.

25 In reality, Jevons recognized that prices change continuously as a result of ongoing trades. But given that he limited his treatment to a static situation of rest, where trade ceases, the principle of virtual velocities allowed him to then equate ratios of infinitesimals *(dy/dx),* to *y/x,* and thereby to avoid the use of differential equations (see Chapter 5; White 1990 and 1994d; Schabas 1984, p. 412). While Schabas claims Jevons used the 'outmoded' principle of virtual velocities to justify his relatively meagre use of calculus in *TPE,* White (1990) argues that this approach enabled Jevons to link his *TPE* with the statistical laws of supply and demand; the variational forms of the exchange equations would not have provided the link Jevons sought between his marginalist theory and the laws of supply and demand.

26 Indeed, 'it is to the neglect of Economists to obtain clear and accurate notions of quantity and degree of utility that I venture to attribute the present difficulties and imperfections of the science' (*TPE,* p. vii; cf. p. 5).

27 On these grounds, Jevons maintained that not only J.E.Cairnes but also Adam Smith, were mathematical reasoners (*TPE,* pp. xxi–xxii).

28 Explicit recognition, however, of the mathematical characteristics of economic reasoning did not ensure that one obtained 'correct' theory, or 'truth'; instead mathematical presentations reduced the chance of erroneous reasoning, serving to 'guide our thoughts in the slippery and complicated process of reasoning' (pp. xxiii–xxiv). Cf: 'The symbols of mathematical books are not different in nature from language; they form a perfected system of language, adapted to the notions and relations which we need to express. They do not constitute the mode of reasoning they embody; they merely facilitate its exhibition and comprehension' (*TPE,* p. 5).

29 Cf. *'our science must be mathematical, simply because it deals with quantities*. Wherever the things treated are capable of being *greater or less,* there the laws and relations must be mathematical in nature' (*TPE,* p. 3).

30 Schabas (1984) has argued that the parallel between the equilibrium of the lever and the exchange equation in economics provided Jevons with the rationale for the use of calculus in *TPE*. See also the remarks in *Biograph and Review,* No. 29, Vol. **v** (May, 1881): 'The mathematical equations of exchange, only express the statical conditions of equilibrium in any market, and so far as these are concerned the differential calculus scarcely comes into play' (JA6/50/11).

31 Jevons reiterated this call for subdivision, again along the lines of subject manner and methodology, in his 1876 introductory Lecture at University College, 'The Future of Political Economy':

> The fact is it will no longer be possible to treat political economy as if it were a single undivided and indivisible science…. Not only will there be a number of branches, but there are actually two or three different ways in which the division will take place.
>
> There is, firstly, the old distinction of the laws of the science, according as they treat of the production, exchange, distribution, or consumption of wealth. In this respect economy may be regarded as an aggregate of two or more different sciences, there being, in fact, little connection between the principles which should guide us in production and those which apply in distribution or consumption.
>
> Passing now to a second aspect, political economy will naturally be divided according as it is abstract or concrete. The theory of the science consists of those general laws which are so simple in nature, and so deeply grounded in the constitution of man and the outer world, that they remain the same throughout all those ages which are within our consideration. But though the laws are the same they may receive widely different applications in the concrete. The primary laws of motion are the same, whether they be applied to solids, liquids, or gases, though the phenomena obeying those laws are apparently so different. Just as there is a science of mechanics, so we must have a general science or theory of economy.
>
> (*PE,* pp. 197–98; cf. p. 200)

32 Cf. ‘No one who attempts to lay down propositions for the guidance of mankind, however perfect his scientific acquirements, can dispense with a practical knowledge of the actual modes in which affairs of the world are carried on, and an extensive personal experience of the actual ideas, feelings, and intellectual and moral tendencies of his own country and of his own age. The true practical statesman is he who combines this experience with a profound knowledge of abstract political philosophy’ (‘On the Definition of Political Economy; and on the Method of Investigation Proper to It’ [1836]; *CW,* **iv,** p. 333; see pp. 333–36). Black has also argued that the calls for and the subsequent occurrence of subdivision narrowed the discipline of economics: ‘It may be contended that it was Edgeworth’s mentor, Jevons, whose vision of the reconstructed science of economics in terms of sub-division and specialization contributed most, and most directly, to the narrowing of the subject’ (1990, pp. 15–16).

33 Economics ‘is no more one science than statics, dynamics, the theory of heat, optics, magnetelectricity, telegraphy, navigation, and photographic chemistry are one science’ (*TPE,* p. xvii).

34 Cf. ‘The theory here given may be described as *the mechanics of utility and self-interest*’ (*TPE,* p. 21); and ‘The theory which follows is entirely based on a calculus of pleasure and pain; and the object of Economics is to maximise happiness by purchasing pleasure, as it were, at the lowest cost of pain’ (*TPE,* p. 23).

35 Like the Classics, however, Jevons drew a key distinction between these laws of political economy and the ‘laws of property’ which ‘are very different in different countries and states of society’ (*PE,* p. 196).

36 Jevons’s letter to his wife, dated 3 October 1870, reveals that these comments were intended, in part, to enliven his discussion: ‘I have managed to get through the lecture without any conspicuous failure. The attendance was poor, and there was no liveliness worth speaking of, and no other speeches, simply a lecture. The humorous attempts answered very well, except that about the dog’s idea of property, which failed. I am glad the affair is over and not worse’ (*P&C,* **iv,** p. 182). He did, however, recognize substantive differences in the behavioural patterns of rich and poor, as well as educated, uneducated, ethnic, and racial groups. See pp. 96–97 and Part II.

37 The exchange equations, coupled with the lever analogy, were consistent with his claim that he never attempted to measure or establish total pleasure. But Jevons on occasion referred to alterations in total utility (see Black 1970, p. 23)—which is why G.Stigler concluded that he was ‘confused’ on this (1950, p. 87); cf. ‘I have granted that we can hardly form the conception of a unit of pleasure or pain, so that the numerical expression of quantities seems to be out of the question’ (*TPE,* p. 12).

38 Jevons did argue analogously that individuals who can keep track of changes in assets frequently are unsure of their total wealth (*TPE,* p. 52; cited p. 94). Like Jevons’s argument concerning total and marginal utility, however, that argument is without any accompanying theoretical or empirical foundation.

39 Cf. ‘Every mind is thus inscrutable to every other mind, and no common denominator of feeling seems to be possible’; ‘But the motive in one mind is weighed only against other motives in the same mind, never against the motives in other minds’ (*TPE,* p. 14).

40 See also the passage on p. 48, cited in Chapter 5, Note 11.

41 Jevons sometimes presumed that mistakes 'balance' for any one individual, as when a person purchases a bit 'too much' and then 'too little' of a good. In other cases, however, he assumed that aggregate utility maximization occurs, so that while individual consumers may not maximize utility, on average, utility maximization occurs. In the case of intertemporal decision-making, he left no doubt that the complexity of such decisions led to systematic mistakes, as when impatient consumers discount future pleasures relative to present ones. See pp. 96–97, and, for a detailed discussion of Jevons's method in this respect, see Part III.

42 Cf. 'The food which prevents the pangs of hunger, the clothes which fend off the cold of winter, possess incontestable utility; but we must beware of restricting the meaning of the word by any moral considerations. Anything which an individual is found to desire and to labour for must be assumed to possess for him utility. In the science of Economics we treat men not as they ought to be, but as they are' (*TPE,* p. 38).

43

> it then becomes indispensable to admit that a single higher pleasure will sometimes neutralise a vast extent and continuance of lower pains.… Motives and feelings are certainly of the same kind to the extent that we are able to weigh them against each other; but they are, nevertheless, almost incomparable in power and authority.
>
> My present purpose is accomplished in pointing out this hierarchy of feeling, and assigning a proper place to the pleasures and pains with which the Economist deals. It is the lowest rank of feelings which we here treat.
>
> (*TPE,* pp. 26–27)

In the context of discussing bargaining issues, Jevons referred to motives 'more or less extraneous' to economics—disposition, force of character, persistence, adroitness, justice, kindliness. See p. 107. We return to the distinction between 'what is desired', and 'happiness' or 'social good' in Chapters 7 and 8.

44 Jevons was a major influence on Edgeworth (see Creedy 1981). They became neighbours in Hampstead when Jevons resigned from Owens College and took a position at University College (see Chapter 1). Edgeworth lived at 5 Mount Vernon.

45 As Edgeworth pointed out, as long as price taking behaviour pertains and the utility function is additive, his contract curve equation is equivalent to Jevons's equations of exchange (presented on p. 104). See Edgeworth (1881, pp. 39–40, 109f), and Creedy (1992, pp. 125–29). Edgeworth actually made the argument that the additive utility function was not appropriate as early as 1877 (Creedy 1980, pp. 373–74).

46 The other was *Untersuchungen Über die Theorie des Preises,* by Auspitz and Lieben (Fisher 1892, p. 4).

5
JEVONS'S THEORY OF EXCHANGE

1 Yet, as Bowley (1972) has demonstrated, the elements of Jevons's theory were all present in Classical thought: the distinction between total and marginal utility; the ranking of wants; and the diminishing marginal utility formulation.

2 We must, however, exempt Jeremy Bentham from this latter statement, for, as is well known, Bentham did believe that utility might (eventually) be represented formally (see Chapter 7). But he did not proceed far in this attempt.

3 A recent evaluation has argued that: ‘According to Jevons, all economic actions stemmed from an imbalance, within any particular mind, of pleasure and pain’ (Schabas 1984, p. 410).

4 Black argues that the *TPE* ‘shifted the focal point of value theory from longrun ‘normal’ values determined by cost of production to short-run exchange-ratios determined by the psychology of the parties making the exchange’ (1970, p. 11). I would add only that, for the most part, Jevons’s *TPE* does not attempt to explain exchange-ratios (prices), but does instead explain price-taking exchange.

5 In so doing, Jevons turned Classical analysis—which started with analysis of labour and production—around. Jevons cites Mill’s remarks that ‘Political Economy has nothing to do with the consumption of wealth, further than as the consideration of it is inseparable from that of production, or from that of distribution’ in order to show that he differs from Mill in this regard (*TPE,* p. 39). Elsewhere, he argues that his intent is to investigate the ‘exact nature’ as well as the ‘conditions’ of utility (p. 43).

6 Jevons cites Senior on this matter: ‘Utility denotes no intrinsic quality in the things which we call useful; it merely expresses their relations to the pains and pleasures of mankind’ (*TPE,* p. 43). Senior comes in for praise also for recognition of the Law of Variety in human requirements (pp. 40, 53–54). See Bowley (1972) for a discussion of Senior’s exposition of the law of diminishing marginal utility.

7 Elsewhere, he allowed that ‘prospective usefulness’ may give rise to positive utility; for the complication this introduces concerning the allocation of a stock to various uses, see below.

8 Jevons is critical of Smith’s diamond-water paradox for failing to make the distinction between total and marginal utility, thus causing ‘confusion’ and ‘perplexity’ (*TPE,* pp. 52, 78–80).

9 Jevons attributes the statement to Richard Jennings. The law is actually due to G.T.Fechner, and is now known as the Weber-Fechner Law. See Blaug (1962, p. 309). Edgeworth also based the law of diminishing marginal utility on Fechner (1881, p. 62).

10 The same considerations are said to apply to bread, where Jevons speculated that the third pound of bread per day ‘begins to be superfluous’ (*TPE,* p. 44).

11 ‘The law may be considered to hold true theoretically, however small the increments are made…. The laws which we are about to trace out are to be conceived as theoretically true of the individual; they can only be practically verified as regards the aggregate transactions, productions, and consumptions of a large body of people’ (*TPE,* p. 48).

12 This formulation, of course, implies that the utility function for an individual may be written as a function of a single variable: $U=f(x)$. Alternatively, since Jevons refers to U(x) as ‘total utility’, one might presume that the utility function is additive in all the goods possessed by an individual:

$$U(x_1, x_2, x_3, \cdots, x_n) = U_1(x_1) + U_2(x_2) + U_3(x_3) + \cdots + U_n(x_n).$$

See Georgescu-Roegen (1968, p. 240).

13 Thus, *du/dx* is a function of *x,* while the 'final degree of utility' is the evaluation of the function at a point. See Reid (1972, pp. 75–76).
14 'Only in famine or other extreme circumstances do we approach the higher degrees of utility' (*TPE,* p. 51).
15 Elsewhere Jevons calls the final degree of utility, 'esteem' (*TPE,* p. 81).
16 'Senior's so-called "Law of Variety"' was a statement of this general principle, Jevons argued. Credit for appreciating the law of diminishing marginal utility is given also to Thomas Charles Banfield as well as Richard Jennings (see *TPE,* pp. 53–57).
17 'To the desire for articles of taste, science, or curiosity, when once excited, there is hardly a limit' (*TPE,* p. 53). In his 1875 Lecture, Jevons contrasts sugar with corn, suggesting that the final degree of utility line for sugar 'wd. go a long way' compared to that for corn (*P&C,* **vi,** p. 16; cf. pp. 84f).
18 As we will see in Chapter 6, labour also is treated as a 'bad', yielding negative utility. Georgescu-Roegen has suggested Jevons's utility formulation entails what might be called a 'suffocation point', beyond which utility actually becomes negative (1968, p. 240), so that all goods become 'discommodities' at some point. This may explain why Jevons argues that a consumer should satisfy his 'moderate desires'; see p. 87 for the full citation.
19 Actually, however, since Jevons assumes that human beings choose the course which offers the 'greatest advantage', this is not a result but is instead a premise of the reasoning.
20 Additional support for the latter interpretation lies in the second example which clearly pertains to an alteration in the supply of other goods; Jevons described a food shortage in Paris leading to 'a vast stock of horses' being eaten (*TPE,* p. 61).
21 Reid compliments Jevons's 'remarkable concern for measurement problems', of which dimensionality was one aspect (1972, p. 71), but at the same time points to the marred treatment of dimensions by Jevons. As Reid argues (ibid., p. 78), Jevons confused a variable with its dimension, since he refers to integration being performed on the dimension of the variable.
22

> We may mean that a particular piece of iron is at the present moment actually useful to some person; or that, although not actually useful, it is expected to be useful at a future time; or we may only mean that it would be useful if it were in the possession of some person needing it. The iron rails of a railway, the iron which composes the Britannia Bridge, or an ocean steamer, is actually useful; the iron lying in a merchant's store is not useful at present, though it is expected soon to be so; but there is a vast quantity of iron existing in the bowels of the earth, which has all the physical properties of iron, and might be useful if extracted, though it never will be. These will be instances of *actual, prospective, and potential utility*.
> (*TPE,* pp. 69–70)

Jevons is mistaken here: the correct characterization is that the utility associated with use of this iron is outweighed by the disutility associated with extraction.

23 'By far the greater part of what we hold might be allowed to perish at any moment, without harm, if we could have it re-created with equal ease at a future moment, when need of it arises' (*TPE,* p. 70).

24 As noted above, Jevons used a similar phrase for static decision-making: The general result is that commodity, if consumed by a perfectly wise being, must be consumed with a maximum production of utility' (p. 60).

25 As an illustration of this argument, Jevons considers allotting food portions to sailors on a vessel 'which is insufficiently victualled for the probable length of the voyage to the nearest port' (*TPE,* p. 73). The voyage will certainly last ten and may last up to thirty days. Then, 'To determine the most beneficial distribution of the food, we should require to know the probability of each day between the tenth and thirtieth days forming part of the voyage, and also the law of the variation of the degree of utility of food. The whole stock ought then to be divided into thirty portions, allotted to each of the thirty days, and of such magnitudes that the final degrees of utility multiplied by the probabilities may be equal' (pp. 73–74).

26 Recall that Jevons's treatment of decision-making throughout the business cycle also explicitly maintained that investors were unable to make investment decisions correctly throughout the course of the cycle (Chapter 3).

27 Specifically, Mill is chastised for his unfortunate phrase: 'Happily, there is nothing in the laws of Value which remains for the present or any future writer to clear up' (cited *TPE,* p. 76), and is taken to task again for failing to specify clearly that value implies or expresses a ratio (p. 77). It is, Jevons maintained, 'scientifically incorrect' to suggest that, for instance, the value of a ton of iron 'is the ounce of gold' for which it exchanges, since by doing so, value is 'converted' into a 'concrete thing', whereas, correctly speaking, exchange value 'expresses nothing but a ratio' (p. 78).

28 Jevons himself seems to rely on an absolute value notion for esteem here.

29 A similar distinction is made regarding work hours and occupational choice:

> Theoretically speaking, we might regard each person as capable of producing various commodities, and dividing his labour according to certain rules between the different employments; it would not be impossible, too, to mention cases where such division does take place. But the result of commerce and the division of labour is usually to make a man find his advantage in performing one trade only.
> (*TPE,* p. 183)

30 Distinctions among these three phenomena sometimes become blurred. Jevons on occasion refers to lack of competition as a capricious motive, or as a cause of imperfect information. Further, imperfect information is sometimes referred to as a cause of imperfect competition. In fact, lack of competition is rarely discussed as a distinct consideration. Edgeworth, by contrast, started his discussion with the consideration of competition (1881, pp. 17f). While he acknowledged that Jevons, Walras and Marshall had worked out the mathematics of a 'perfect market' (p. 30), and argued that Jevons's Law of Indifference pertained only when there is '*perfect* competition' (p. 109), he was critical of Jevons for not having dealt with the

important problem of the number of people in the market (see Creedy 1992, p. 120).

31 Further, ‘there must be perfectly free competition, so that any one will exchange with any one else for the slightest apparent advantage’ (*TPE,* p. 86). In his call for the elimination of conspiracy and for wide publicity, Jevons followed Adam Smith (see 1776, pp. 68–69).

32 The trading body concept, which takes no account of the role of numbers in exchange, has also been criticized by Blaug (1962, p. 312). The idea is awkward, but its significance is that it represents price taking behaviour, and rules out bargaining situations between two parties where prices are not deterministic. This comes, in part, from Jenkin’s correspondence with Jevons early in 1868—alluded to in pp. 81–82—where diagrams referring to two traders, Jones and Brown, are used, and Jenkin objected that prices were not determinate. See the letters from Jenkin to Jevons, dated 4 and 11 March 1868 (*P&C,* **iii,** pp. 167–78), as well as the exposition in White (1989, pp. 443f). In the *TPE,* Jevons avoided this problem by presenting his diagrams for a single trader, and issuing the caveat that it is ‘hardly possible’ to treat the problem fully using diagrams (*TPE,* p. 96).

33 Cf. ‘our laws of Economics will be theoretically true in the case of individuals, and practically true in the case of large aggregates; but the general principles will be the same, whatever the extent of the trading body considered’ (*TPE,* pp. 89–90). Jevons can make that claim because he has assumed price taking behaviour (i.e. because price taking is not regarded as a result of the numbers involved in the trading body).

34 Cf. ‘A market, then, is theoretically perfect only when all traders have perfect knowldge of the conditions of supply and demand, and the consequent ratio of exchange; and in such a market, as we shall now see, there can only be one ratio of exchange of one uniform commodity at any moment’ (*TPE,* p. 87).

35 This abstracts, however, from exchange rate differences that occur in practice, due to ‘extraneous causes’ such as bad credit, or lack of information (*TPE,* p. 91). Fisher also relied on the ‘supposition’ that ‘prices do not vary’ (1892, p. 19). Significantly, in the light of Jevons’s methodological stance that ‘extraneous’ causes ‘balance’ (see Part IV), Fisher made the explicit argument that deviations from the equilibrium conditions would be ‘self-correcting’: ‘individual caprice is self-corrective. If a man lays in too large a stock of provisions this week he will buy less next. The theory of probabilities therefore substantially harmonizes the theoretical and the actual’ (1892, p. 21). Thus, Fisher reasoned, the theoretical assumption of a constant price was appropriate, even though, in reality, prices would deviate from that equilibrium specification.

36 The conception of trade as motions, or prices as fluctuations about values, is evident also in *TCQ,* where commerce is said to be ‘the free growth of the instincts of gain’ and ‘resolved into a case of complex attractions and perturbations, as between several gravitating bodies’ (p. 413).

37 As Creedy argues, a rate of exchange in terms of amounts of y relative to x given up, is equivalent to the price ratio, P_x/P_y: ‘With his law of indifference Jevons simply argued that he was restricting attention to situations in which all exchanges occur at the same price’ (1992, p. 120).

38 Commentators have speculated on why Jevons never apparently drew supply and demand curves in *TPE,* while he did draw marginal utility curves. White argues that

since supply and demand curves, for Jevons, consist of 'facts', they would not be appropriately drawn. Since the nature of utility and marginal utility is theoretical, however, marginal utility curves are appropriate subjects for a diagram (1989, p. 443).

39 Although Jevons treats only two consumers here, it is worth emphasizing that, in the light of the assumption of fixed prices, they must in some sense be 'representative' of a market. Edgeworth's description is particularly apt: '[Jevons's] couple of dealers are, I take it, a sort of typical couple, clothed in the property of 'Indifference', whose origin in an 'open market' is so lucidly described' (1881, p. 109). Each, Edgeworth argues, is a 'representative particular' and, 'in the background' there is 'presupposed a class of competitors' (p. 109). Elsewhere Edgeworth characterizes the traders thus: 'Professor Jevons's Formulae of Exchange apply not to bare individuals, an isolated couple, but (as he himself indicates, p. 98), to individuals clothed with the properties of a market, a typical couple' (p. 31, Note 1).

40 Contemporary students learn the equimarginal principle, of course, through the use of constrained utility maximization techniques. Jevons arrived at the result without the use of constrained optimization techniques, and when the Danish statistician Harold Ludwig Westergaard [1853–1936] wrote Jevons to show how constrained optimization techniques could be used to obtain his equilibrium equations, Jevons apparently preferred to retain his own formulation (see Westergaard's letter to Jevons, dated July 1878; *P&C,* **iv,** pp. 254–58). Logan and Shieh (1990) provide an appreciative account of Westergaard's contribution. Jevons may have been unable to use Westergaard's advice (see Creedy 1980, p. 372) or he may have retained his formulation in order to appeal to a wide audience. This latter argument is in line with the account in Smith and Wise, whereby Jevons's teacher, Augustus De Morgan, is said to have devoted his life to ensuring that the highest attainments of mathematics be rendered accessible to the widest of audiences (1989, p. 170; cf. p. 176). In his 'Preface' to the Second Edition, Jevons claimed:

> even if I were capable of presenting the subject in the concise symbolic style satisfactory to the taste of a practised mathematician, I should prefer in an essay of this kind to attain my results by a course of argument which is not only fundamentally true, but is clear and convincing to many readers who, like myself, are not skilful and professional mathematicians.
> (*TPE,* p. xiii)

41 Jevons did not consider specific functional forms here, but for a treatment that does, see Creedy (1992, pp. 129–30).

42 Jevons used similar language to describe the logic of his exchange theory in his 'Introduction': 'when a man has purchased enough, he would derive equal pleasure from the possession of a small quantity more as he would from the money price of it' (*TPE,* p. 13). This reasoning does not hold, however, for 'purchases which appreciably affect the possessions of the purchaser'. In those situations, 'if a poor family purchase much butchers'-meat, they will probably have to go without something else. The more they buy, the lower the final degree of utility of the meat, and *the higher the final degree of utility of something else;* and thus these

purchases will be the more narrowly limited' (p. 114). We return to this matter on pp. 107–108.

43 Jevons rules out arbitrage possibilities from indirect trade. For instance, A might sell a unit of *y* for (z_2/y_2) units of good Z from C. This implies a price of X relative to Z such that each unit of X sold gives A $(y_1/x_1)(z_2/y_2)$ units of Z. Direct trade with C means that X is sold for (z_1/x_2) units of Z. To rule out arbitrage, we must therefore presume that $(z_1/x_2) > (y_1/x_1)(z_2/y_2)$. See Creedy (1992, pp. 132–33).

44 Jevons did not elaborate on this situation, but for an extension of his work, see Creedy (1992, pp. 135–39).

45 Jevons allows that one trader might be indifferent to the trade, in which case an equality would prevail for one of the two conditions.

46 Cf. 'It is almost self-evident that the utility of money decreases as a person's total wealth increases' (*TPE,* p. 160). This has implications for taxation policy: Jevons questions Smith's maxim of proportionate taxation on the grounds of diminishing marginal utility of income (see Chapter 8).

47 This is as far as Jevons ever goes, in the evaluation of Black (1970, p. 23), in 'the direction of formulating general welfare propositions' in the *TPE*. See, for example, Jevons's remarks concerning gambling (*TPE,* pp. 160–61, cited in Chapter 8, Note 26).

48 Despite his claim 'never' to make interpersonal utility comparisons, as well as his recognition of the difficulties involved (see pp. 85–86 and Chapter 7), in this context Jevons did draw utility curves for a nation. See *TPE,* pp. 145–46, and Black (1970, p. 23).

49

> I do not hesitate to say, too, that Economics might be gradually erected into an exact science, if only commercial statistics were far more complete and accurate than they are at present, so that the formulae could be endowed with exact meaning by the aid of numerical data. These data would consist chiefly in accurate accounts of the quantities of goods possessed and consumed by the community, and the prices at which they are exchanged. There is no reason whatever why we should not have those statistics, except the cost and trouble of collecting them, and the unwillingness of persons to afford information. The quantities themselves to be measured and registered are most concrete and precise.
>
> (*TPE,* p. 21)

'The deductive science of Economics must be verified and rendered useful by the purely empirical science of Statistics. Theory must be invested with the reality and life of fact' (*TPE,* p. 22).

50 Initially, Jevons argued, the simplifying assumption of constant marginal utility of income might be used (*TPE,* p. 147).

51 In particular, the constant marginal utility of income assumption cannot be used for the 'main elements of expenditure'; see pp. 204–205 for a discussion of Jevons's procedure with the Davenant-King data. Ekelund and Shieh (1989) suggest that Jevons's remarks are consistent with a Marshallian-style demand curve, and that he was well aware of the assumptions involved so that the marginal utility curve might yield a demand curve (constant marginal utility of money, as well as lack of

substitution effects). They acknowledge, however, that in his formal analysis, Jevons was unwilling to link utility functions and demand (pp. 18–22). Creedy (1992) has argued that Jevons's foray into the estimation of an empirical demand curve constituted a digression from his main concern, exchange. This may explain why, as Ekelund and Shieh note (p. 29), he showed little concern with the importance of the budget constraint in the exchange theory.

52 'I know nothing more strange and discreditable to statists and economists than that in so important a point as the relations of price and supply of the main article of food, we owe our most accurate estimates to writers who lived from one to two centuries ago' (*TPE,* p. 154). Jevons had in mind the research of Gregory King (1648–1712), author of 'Natural and Political Observations and Conclusions upon the State and Condition of England' [1696], and Charles Davenant (1656–1714), author of 'Essay upon the Probable Methods of making a People gainers in the Ballance of Trade' [1699].

53 'As I assert that value depends upon desire for more, it follows that any excessive supply of food will lower its price very much more than in the case of articles of luxury' (*TPE,* p. 149).

54 As noted on pp. 75–78, Jevons argued in the 'Preface' to the first edition that the laws of supply and demand are based upon 'facts'. Cf. 'the laws of supply and demand, as generally accepted by economists, are easily deduced from the theory of exchange, so that the theory is verified by experience and statistical science' ('The Progress of the Mathematical Theory of Political Economy' [1874], *P&C,* **vii,** p. 83).

55 While his theory was fully consistent with well-known laws of supply and demand, however, Jevons distinguished his (utility) explanation of value from a labour theory of value: 'This theory is in harmony with the facts; and, whenever there is any apparent reason for the belief that labour is the cause of value, we obtain an explanation of the reason. Labour is found often to determine value, but only in an indirect manner, by varying the degree of utility of the commodity through an increase or limitation of the supply' (*TPE,* p. 2). We return to this matter in Chapter 6.

56 Mill is criticized because '[his] equation states that the quantity of a commodity given by A is equal to the quantity received by B. This seems at first sight to be a mere truism, for this equality must necessarily exist if any exchange takes place at all' (*TPE,* p. 101). Furthermore, Mill failed to recognize that since two parties take part in a transaction, there must be not one but two equations describing that exchange.

57 See Young (1912) who argues that *TPE* is mathematical in a 'superficial' way (p. 588); G.Stigler (1950) finds Jevons to be (albeit 'gallantly') inconsistent (p. 88) and 'confused' (p. 87) on utility measurability, and concludes that 'Jevons's attempt to construct a bridge between utility and demand was seriously hampered, I suspect, by his inability to translate any but simple thoughts into mathematics' (p. 90). See also Brahmananda (1971, p. 135). A more appreciative account is contained in Ekelund and Shieh (1989). Creedy (1992, p. 140) defends Jevons against such charges, and maintains that Jevons's grasp of the mathematics underlying his exchange equations was sophisticated.

58 Creedy (1992, p. 128) argues that these subsections reveal Jevons's 'confident handling of his approach', and suggests that the treatment of Jevons in this regard has been 'rather shoddy' (p. 140).

59 As a recent evaluation has argued:

> In dealing with exchange, there is of course no place for the partial equilibrium supply and demand curves of Cournot, Jenkin and the later Marshall (of the *Principles*)…. Thus it is not really surprising that Edgeworth in 1881, in common with Jevons, Walras and Wicksell (1893), did not use 'standard' demand curves. It is of interest that Marshall, when reviewing Jevons's *Theory* in 1872 and criticizing his use of mathematics, alluded to Jenkin in stating his preference for 'the language of diagrams', despite the fact that Jenkin's diagrams were not appropriate.
>
> (Creedy 1992, p. 128)

60 For a review article concerned with the accuracy of Mirowski's general themes, see Walker (1991).

61 If Jevons had understood the derivation of the law of the lever, Mirowski argues, 'such a derivation would have forced Jevons to state the variational principle involved explicitly and, more telling, to confront the unsavory conservation of utility plus budget constraint' (1989, p. 258; cf. White 1990 and 1991c).

62 'For someone with Jevons's training, it was common to have some familiarity with the equilibrium conditions of rational mechanics without any grasp of the kinematic conditions requisite for a conservative vector field…much less the Lagrangian or Hamiltonian formalisms of dynamics…. Indeed, whether (for instance) Jevons actually ever fully understood the concept of a field is open to serious doubt' (Mirowski 1989, p. 218).

63 For Jevons's circumscribed purposes, the form of his exchange equations was sufficient. Further, criticisms that the equations could not be integrated (such as that put forward by Marshall in *P&C,* **vii,** p. 145), far from 'baffling' Jevons—as Mirowski asserts (1989, p. 258)—were simply not relevant.

64 As one scholar has noted, 'Jevons was well aware of the huge difficulties involved in examining the precise dynamics of moving bodies, which had to wait until the computer age before the many approximations, required to produce differential equations capable of being integrated, could be avoided' (Creedy 1992, p. 121). There is, however, textual evidence that Jevons relied on the energy metaphor for rhetorical reasons. White (1991c) points out that, based on the account in Tyndale, Jevons made utility analogous to a gravitating force. Jevons did frequently invoke the gravitational metaphor (although the use of gravity metaphors was by no means new in British political economy), and he headed off criticism that his 'utility' was unmeasurable, and unobservable, using energy rhetoric. See the remarks in *TPE,* pp. 11–12, cited on p. 85. Such evidence, however, does not show that the energy formalism affected Jevons's economic theory in a substantive way.

65 There is also, I believe, a fundamental inaccuracy in Mirowski's account of the relationship of Jevons to Bentham, a matter to be taken up in Chapter 7. Also damaging to Mirowski is the fact that J.S.Mill and other Classical economists accepted the notions of the budget constraint, the ranking of alternatives in a

preference ordering, maximization, the law of one price, and traded goods as equivalents in equilibrium (see Bowley 1972; Hollander 1989). Finally, one must question the relevance of a metaphor when it is not 'fully understood'.

66 Though Mirowski concedes that the early Neoclassicals reversed this logic: instead of treating utility as the derived phenomenon, they posited the utility as the fundamental exogenous datum to which market transactions adjusted.

6
PRODUCTION

1 See Robbins's remarks: '[Jevons] nowhere shows any real appreciation of the interdependence of the various elements determining the prices of the factors of production. Time and time again he seems to be on the brink of the modern theory…. But he does not develop a general productivity theory' (1972, p. 99). G.Stigler concludes that 'Jevons' theories of distribution contribute little to the solution of the problem of distribution, although they contain the germs of some important later developments' (1941, p. 35).

2 Noller argues that Jevons is 'the originator of the subjective theory of cost' (1972, p. 129) and that cost is placed in an *ex ante* relation to choice (p. 130). We will see several examples of this in this chapter.

3 As we have seen, Jevons maintained a similar position regarding decisions made throughout the economic cycle (Chapter 3). He also allowed that exchange might involve mistaken trades due to the incorrect anticipation of pleasure associated with consumption (Chapter 5). For further examples, see below.

4 Two 'steps' are said to intervene between labour and value: 'Labour affects supply, and supply affects the degree of utility, which governs value, or the ratio of exchange' (*TPE,* p. 165).

5 Schabas has also maintained that Jevons holds labour and capital to be commensurate with utility, arguing that 'he envisioned a more complete model, in which the relative contributions of positive and negative utility in the determination of exchange value would be given equal weight' (1990, p. 47). The fact that he never completed this task, Schabas argues, supports Marshall's contention that Jevons highlighted his novel contribution (positive utility) at the expense of downplaying similarities with the Classics. See Marshall's remarks in his 1872 review of *TPE:* 'We continually meet with old friends in new dresses' (*P&C,* **vii,** p. 143).

6 Logan and Shieh suggest that the 'majority' of Jevons's analyses focused on partial equilibrium situations. While I would except the treatment of exchange from this characterization, it seems a fair assessment of the treatment of production: Jevons examined, for instance, the optimal distribution of a fixed amount of labour across various parcels of land, instead of a full-blown cost minimization problem involving several inputs and substitutability (Logan and Shieh 1990, p. 21).

7 He described this position first in his MT: 'A large part of such feelings [of pleasure and pain] arise periodically from the ordinary wants and desires of body or mind, and from the painful exertion we are continually prompted to undergo that we may satisfy our wants' (p. 282).

8 Jevons reiterated this position late in his career: ‘Labour forms a subject of almost equal importance with utility; it constitutes the main mass of disutility, and it is really the algebraic sum of utility and disutility which we should endeavour to maximise’ (*PE,* p. 71).

9 Jevons did not, however, explore the notion of alternatives in this context.

10 In the second edition Jevons altered his definition, recognizing the complexity of many activities which yield a mixture of both positive and negative utility:

> by inserting the words *partly or wholly,* and I only give it now as provisionally the best I can suggest. The subject presents itself to me as one of great difficulty, and it is possible that the true solution will consist in treating labour as a case of negative utility, or negative mingled with positive utility…. Every act, whether of production or of consumption, may be regarded as producing what Bentham calls a *lot* both of pleasures and pains, and the distinction between the two processes will consist in the fact that the algebraic value of the lot in the case of consumption yields a balance of positive utility, while that of production yields a negative or painful balance, at least in that part of the labour involving most effort.
> (*TPE,* pp. 168–69, Note 1)

11 Jevons cites Jennings here on the law of the variation of labour, thus concurring that effort increases at an increasing rate: ‘it is quite evident that the degree of toilsome sensations endured does not vary directly as the quantity of work performed, but increases much more rapidly’ (*TPE,* p. 171). In the MT Jevons maintains that exertion is ‘rapidly increasing as some function of the intensity or the duration of the labour’ (p. 284).

12 In the ‘Preface’ to the second edition Jevons suggested that ‘the whole theory might probably have been put in a more general form by treating labour as negative utility, and bringing it under the ordinary equations of exchange’—a task which he apparently lacked the energy to finish (*TPE,* p. xiv).

13 ‘it must be remembered that the change is one of convenience only; U and E are essentially quantities of the same nature, and the difference, so far as there is any, arises from the fact that quantities symbolized by E will usually be negative as compared with those symbolised by U’ (*TPE,* pp. 178–79).

14 In some simple cases, as ‘in some kinds of machine labour’ the rate of production is very nearly uniform, and may be normalized to equal 1. Then, instead of the equilibrium condition below, we have x defined by: $du/dx=dl/dx$ (*TPE,* p. 177).

15 As is the case with the exchange equations (pp. 104–105), the solution to this problem is presented as the ratio of infinitesimals, and is not derived from a constrained optimization problem. Elsewhere Jevons argued ‘no increment of labour would be expended unless there was sufficient recompense in the produce’, and ‘that labour would be expended up to the point where the increment of utility exactly equals the increment of pain incurred in acquiring it’ (*TPE,* p. 217).

16 ‘A man must be regarded as earning all through his hours of labour an excess of utility; what he produces must be considered not merely the exact equivalent of the labour he gives for it, for it would be, in that case, a matter of indifference whether he laboured or not’ (*TPE,* p. 177). The MT makes a similar case: ‘Thus, labour will

be exerted both in intensity and duration until a further increment will be more painful than the increment of produce thereby obtained is pleasurable. Here labour will stop, but up to this point it will always be accompanied by an excess of pleasure' (p. 284).

17 'If a workman can earn ninepence an hour instead of sixpence, may he not be induced to extend his hours of labour by this increased result?' (*TPE,* p. 179). For an extension of this analysis to the choice of occupation, see Kenton (1971).

18 Again, we see that institutions matter in Jevons's analysis. We return to policy implications of this on pp. 163–65. See the request for statistical information regarding drunkenness, dated 12 April 1879: The principal point on which I need information relates to the proportion of the drunken who are of Irish birth or extraction; there is reason to think that the differences of drunkenness are much a matter of race' (JA6/33/4). For an investigation of race and class in Jevons, see White (1994b).

19 The optimal spade size depends on both the material to be dug and the size of the labourer (*TPE,* p. 204).

20 Jevons conducted a series of experiments to determine the relation between work and fatigue. See *TPE,* p. 207; 'On the Natural Laws of Muscular Exertion' in *Nature* (1870); and Part IV.

21 This is an example of the type of miscalculation alluded to on pp. 115–16. Note that here fatigue is caused by speed, and not, as Jevons more commonly maintained, duration.

22 This, indeed, is in direct opposition to the erroneous simplification of the science effected by Ricardo, when he assumed that all labourers have a certain uniform power; the higher classes of mechanics and other skilled or learned producers being treated as mere exceptions to the rule' (MT, p. 284). See the remarks in Brahmananda:

> Labour itself is not a homogeneous agent [in Jevons]. Unlike the classical economists, who proxied labour by advances of wage-goods' composites,
>
> Jevons makes the schedule of labour-supply a function of the excess of utilities procured by the consumption of the goods produced over the disutilities implied in the efforts…. Jevons did not acquiesce in the Ricardian notion of an absolute cost of labour. Jevons believed that the necessities of life cannot be precisely set out.
>
> (Brahmananda 1971, p. 119)

For the argument that Ricardo did recognize that labour differed in skill, education and experience levels, thereby generating a wage structure across various types of labour, see Hollander (1979).

23 In the MT Jevons argues:

> Combining the theory of exchanges with that of labour and production, the quantity which each person produces will be dependent upon the result of the exchanges; for this may greatly modify the conditions of utility.
>
> A new set of unknown quantities are thus introduced; but it will be found that just as many new equations to determine them may be established. Each such equation is between the utility of the last increment of the produce and the increment of labour necessary to produce it.
>
> (MT, p. 285)

24 Black has remarked that ‘It is surprising that the second half of this chapter has been so much less noticed [than the first half] for in it Jevons brings together his theories of labour and exchange, pointing out that they “lead directly to the well-known law…that value is proportional to the cost of production”’ (1970, p. 24). Jevons himself may be responsible for this relative neglect, since he deflected attention away from the cost of production theory in his ‘Preface’; see p. 76.

25 It is, of course, significant that Jevons’s focus here is on production by labour, unassisted by other factors of production; as Black has argued, ‘he certainly gives minimal attention to the role of cooperating factors’—which in Black’s mind accounts for Jevons’s often noted failure to develop a theory of the firm (1970, p. 25). Problems of organization and entrepreneurship are excluded here from Jevons’s purview, although they do figure into his assertion that *ex ante* often do not equal *ex post* costs.

26
> The county of Bedford, for instance, would not appreciably affect the markets for corn, cheese, or cattle, whether it devoted every acre to corn or to grazing. Therefore the agriculture of Bedfordshire will have to be adapted to circumstances, and each field will be employed for arable or grazing land according as prevailing prices render one employment or the other more profitable.
>
> (*TPE,* pp. 188–89)

27 Jevons was critical of the ambiguity surrounding the use of the term ‘cost of production’, but not of the analysis, which, he argued, was consistent with his theory. Mirowski takes Jevons’s opposition to the cost of production theory as evidence in favour of his energy thesis (see 1989, pp. 282–83). What emerges from this investigation is that Jevons opposed a cost of production theory presented as an alternative to supply and demand, yet he was confident that cost of production was consistent with supply and demand, and he did not oppose that formulation.

28 Jevons adds the odd qualification noted above to the phrase ‘cost of production’: ‘so far as this expression can be accurately interpreted’ (*TPE,* p. 191).

29 Jevons relied on an increasing cost function here, arguing: ‘But as the increment of labour considered is always the final one, our equation also expresses the truth, *that articles will exchange in quantities inversely as the costs of production of the most costly portions, i.e. the last portions added*’ (*TPE,* p. 187). See Black (1970, p. 25) and Brahmananda (1971, p. 121). He may have once again had agricultural production in mind, (as elsewhere in the chapter), involving fixed quantities of land and variable labour inputs. Jevons recognized that non-constant cost schedules

imply that across-the-board productivity increases result in relative price changes. See also Note 30.

30 Jevons recognized an ‘indirect effect’ here as a result of an across-the-board increase in labour productivity:

> When an increased amount of every commodity can be produced, it is not likely that the increase will be equally desired in each branch of consumption. Hence the degree of utility will fall in some cases more than in others. An alteration of the ratios of exchange must result, and the production of the less needed commodities will not be extended so much as in the case of the more needed ones. We might find in such instances new proofs that the value depends not upon labour but upon the degree of utility.
> (*TPE,* pp. 193–94)

Since no relative change occurs in costs of production, however, this constitutes no disproof of the influence of cost on value. But Jevons’s remarks in this context provide an example of his attempt to play up the novelty of his (utility) contribution.

31 In this context, Jevons criticized Mill’s argument that in situations of joint production, we revert to a law ‘anterior’ to cost of production, the law of supply and demand:

> On some other occasion I may perhaps more fully point out the fallacy involved in Mill’s idea that he is reverting to *an anterior law of value,* the law of supply and demand, the fact being that in introducing the cost of production principle, he had never quitted the laws of supply and demand at all. The cost of production is only one circumstance which governs supply, and thus indirectly influences values.
> (*TPE,* p. 198)

32 Jevons returns to the possibility of producing ‘bads’ in this context:

> As in the cases of cinders, chips, sawdust, spent dyes, potato stalks, chaff, etc, etc., almost every process of industry yields refuse results, of which the utility is zero or nearly so. To solve the subject fully, however, we should have to admit negative utilities…. The waste products of a chemical works, for instance, will sometimes have a low value; at other times it will be difficult to get rid of them without fouling the rivers and injuring the neighbouring estates; in this case they are discommodities and take the negative sign in the equations.
> (*TPE,* p. 202; see p. 95)

33 Black argues that Jevons’s analysis here ‘seems to contain little more than an orthodox restatement of the Ricardian theory of rent; but it has often been pointed out that the Ricardian theory was a form of marginal analysis, and Jevons did not fail to see its implications’ (1970, p. 26).

34 'It is quite impossible that we could go on constantly increasing the yield of one farm without limit, otherwise we might feed the whole country upon a single farm' (*TPE,* p. 212).

35 The 'best statement' of rent theory is said to occur in MacCulloch's supplementary notes to the *Wealth of Nations* (cited in *TPE,* pp. 212–13). James Mill and James Anderson are also given credit for their treatments (pp. 211–14).

36 Justification for omitting capital from consideration is, in part, that 'the functions of capital remain to be considered', and that James Mill, J.S.Mill and MacCulloch 'hold the application of capital to be synonymous with the application of labour' (*TPE,* p. 215).

37 'The laws of rent depend on the undoubted principle, that the curves always *ultimately* decline towards the base line *ox,* that is, the final rate of production always *ultimately* sinks towards zero' (*TPE,* p. 221). Negative marginal productivity is ruled out: 'The whole produce of a piece of land is *x,* the whole labour spent upon it is *l*; and *x* varies in some way as *l* varies, never decreasing when *l* increases' (p. 217).

38 Black has remarked that 'we are taken to the very brink of the idea that in a two-factor case the reward to both factors is determined by marginal productivity; certainly the common assertion that Jevons had only a produce-less-deductions theory of wages must result from reading his section on the relation of wages and profit in Chapter VIII (pp. [255–58]) without regard to these earlier passages' (1970, p. 26).

39 'It is therefore the rent which he would ask before yielding it up to another person, or equally the rent which he would be able and willing to pay if hiring it from another' (*TPE,* p. 218).

40 'Precisely the same view may be applied, *mutatis mutandis,* to the rent yielded by fixed capital, and to the interest of free capital. In the last case, the Law of Indifference peculiarly applies, because free capital, loanable for a certain interval, is equally available for all branches of industry; hence, at any moment and place, the interest of such capital must be the same in all branches of trade' (*TPE,* p. l). Jevons recognized in this context that Mill understood these principles, having 'a remarkable section at the end of chapter v. of Book III. of the *Principles,* in which he explains that all inequalities, artificial or natural, give rise to extra gains of the nature of Rent. This section is a very satisfactory one inasmuch as it tends to support the view on which I am now insisting, a view, however, which, when properly followed out, will overthrow many of the principal doctrines of the Ricardo-Mill Economics' (pp. l–li).

41 The lack of necessary connection arises, Jevons argued, because it 'is conceivable' that one has the 'advantages of capital without those of exchange' (*TPE,* p. 222).

42 Jevons conceived it to be possible to exchange without production; and, as pp. 117–24 and pp. 127–28 reveal, to produce without the benefit of Capitalization (see Brahmananda 1971, p. 127). Mirowski takes this separation of capital and exchange as evidence that Jevons reverted to a (Classical) substance theory of value in the context of production, the 'shoddiest of all options' for the attempted reconciliation of neoclassical production and exchange theories (1989, p. 296; see p. 297).

43 Jevons disagreed, however, with the doctrine of Adam Smith, that 'the moment goods pass into the possession of the consumer they cease altogether to have the

attributes of capital' (*TPE,* p. 259). This view, he maintains, leads to contradictory conclusions 'that the very same thing fulfilling the very same purposes will be capital or not according to its accidental ownership' (p. 260; cf. pp. 261– 64).

44 'I define capital as consisting of *all useful objects which, in supplying a labourer's ordinary wants and desires, enable him to undertake works of which the result will be deferred for a greater or a less space of time*. Capital, in short, is nothing but the maintenance of labourers' (MT, p. 286).

45 Ricardo's distinction between circulating and fixed capital is cited with approval here (*TPE,* p. 242). Black suggests that Jevons goes beyond Ricardo in 'refusing to draw any sharp distinction between fixed and circulating capital', a procedure that 'amounts to making all capital into a wages fund, which may seem surprising in view of Jevons's insistence on the connexion between wages and product rather than wages and capital' (1970, p. 27). But, as noted on pp. 133–34, Jevons maintained that the wage fund acts in a temporary manner, and derives from producers' anticipations of the value of produce that can be obtained by labour assisted by capital (cf. Peart 1990a).

46

> Abundance of free capital in a country means that there are copious stocks of food, clothing, and every article which people insist upon having—that, in short, everything is so arranged that abundant subsistence and conveniences of every kind are forthcoming without the labour of the country being much taxed to provide them. In such circumstances it is possible that a part of the labourers of the country can be employed on works of which the utility is distant, and yet no one will feel scarcity in the present.
> (*TPE,* pp. 243–4)

47 Support for this argument is found in the fact that when he does measure the amount of capital, he does so in money units (see p. 130). A second important consideration is why Jevons referred to the 'form of capital' here. Steedman argues that the phrase is designed to 'stress the relationship between his concept of capital as maintenance and the then more common conception of capital as consisting of not only maintenance of labourers but also tools, buildings, semifinished products, etc. Jevons, as it were, 'resolves' the tools, buildings, etc., into quantities of maintenance invested at various points in time in the past' (1972, p. 107). As we will see below, Jevons consequently stressed the difference between the amount of capital and the amount of investment.

48 James Mill and William Edward Hearn are singled out as economists who clearly recognized that 'the time elapsing between the beginning and end of a work is the difficulty which capital assists us to surmount' (*TPE,* p. 224).

49 'Capital enables us to make a great outlay in providing tools, machines, or other preliminary works, which have for their sole object the production of some important commodity, and which will greatly facilitate production' (*TPE,* p. 224); 'Capital simply allows us *to expend labour in advance*' (p. 226).

50 This position, which is fully consistent with the position of Smith, Ricardo and Mill, was already developed in the MT: 'Without capital a person must have immediate returns, or else he perishes. With capital he may sow in the spring that he may reap in the autumn; or he may undertake labour-saving enterprises, such as roads and railways, which will not make a full return for many years. Most

improved modes of applying labour require that the enjoyment of the result shall be deferred' (p. 286).

51 Reid (1972) and Schabas (1990, p. 51) both remark on the fact that capital is commensurate with utility for Jevons.

52 When capital is invested over different periods of time, the amount of investment is said to be found by summing each amount of free capital times the amount of time that capital is invested, a procedure which, as Steedman argues, is valid only for simple interest (1972, p. 108).

53 Jevons considered other cases such as the planting of forests of trees, wine making and the construction of public works, as examples of investments over long periods of time (see *TPE,* pp. 238–41).

54

> Men and families consume much the same kind of commodities, whatever may be the branch of manufacture or trade by which they earn a living. Hence there is nothing in the nature of free capital to determine its employment to one kind of industry rather than another. The very same wages, whether we regard the money wages, or the real wages purchased with the money, will support a man whether he be a mechanic, a weaver, a coal miner, a carpenter, a mason, or any other kind of labourer.
>
> (*TPE,* p. 244)

See also the exposition in MT: 'the interest of all capital in a market is of one rate only, and that, therefore, the lowest rate; because capital consists only in the maintenance, and may therefore be applied indifferently to any branch of industry' (p. 286). Sunk capital that has a single use is said to earn economic rent: 'Buildings, tools, &c., which have hitherto been classes with capital, are, on the contrary, usually applicable only to the single purpose for which they were designed. The profit they bring, therefore, in no way follows the laws of the interest of capital, but rather those of rent, or the produce of natural agents' (p. 286).

55 Cf.:

> As labour must be supposed to be aided with some capital, the rate of interest is always determined by the *ratio which a new increment of produce bears to the amount of capital by which it was produced.* As the interest of all capital must be uniform, the benefit which the mass of capital already confers upon the labourer goes for nothing in determining the rate of interest, which depends solely upon the portion last added, or which may be added.
>
> (MT, p. 286)

See Reid (1972, pp. 78–79) for a discussion of Jevons's treatment of the dimensions of the expression for interest.

56 See G.Stigler (1941, pp. 26–29) for the charge that Jevons here conflates this instantaneous rate of interest with an annual rate. Steedman (1972) demonstrates that Jevons's rate of interest pertains only to the case of simple interest. This is because, given Jevons's definition of investment (p. 130), the amount of

investment increases from *wt* to (*w*+ *w*)(*t*+ *t*) if the commodity wage is represented by *w,* when the time period is increased from *t* to *t*. But the difference between these amounts cannot equal *t.F(t)* when the rate of interest is positive. Steedman concludes Jevons must have abandoned his definition of investment when he came to the compound interest case (1972, p. 114). Hennings (1979) presents Darwin's criticisms of, and alternative analysis to, Jevons's interest rate discussion.

57

> We can now easily explain the known fact, that the interest of capital always tends to fall very rapidly as its amount increases, in proportion to the labour it supports. It is because for equal increments of time the necessary increments of capital increase with the time. Thus, if I undertake a work which I can finish in one year, I have to await the result on an average only half a-year. If, however, I work a second year before getting the result, I wait a whole year for the former year's work, and half a-year for the second year's work. Thus I employ at least three times as much capital in the second year as in the first. In the third year I should employ at least five times as much capital, in the fourth year at least seven times, and so on. Unless, then, the advantages of the successive deferments increase in the arithmetical series 3, 5, 7, 9, &c., the proportional profit from the new additions must fall, and, as was said before, the lowest rate for which capital may be had governs the rate of all other capital.
>
> (MT, pp. 286–87)

58 Jevons's son, Herbert Stanley Jevons, elaborated upon the formula in the Appendix to *TPE,* pp. 279f.

59 'Our formula for the rate of interest shows that unless there be constant progress in the arts, the rate [of interest] must tend to sink towards zero, supposing accumulation of capital to go on' (*TPE,* p. 254).

60 Cf.:

> It is the accepted opinion of writers of the present day, that the rate of interest tends to fall because the soil does not yield proportionate returns as its cultivation is pushed. But I must hold that this decrease in the proportionate returns would chiefly fall upon the wages of the labourer. The interest of capital has no relation to the absolute returns to labour, but only to the increased returns which the last increment of capital allows.
>
> (MT, p. 287)

61 Apparently, while profit rates are said to equalize within England, barriers to capital mobility prevented profit rate equalization throughout the world.

62 In 1882 Jevons reiterated that the wage fund theory:

> represents the rate of wages as depending upon the amount of capital which employers think proper to disburse as wages. The wages rate was regarded as the dividend, found by dividing the wages fund by the number

> of labourers. But, though this division doubtless takes place, there is nothing in the theory to determine either the whole amount which is to be divided, or the proportional share which any particular labourer may obtain. Nobody can possibly suppose that workmen in different branches of production, or in different ranks of the same branch, receive the same wages. Nor can anybody imagine that the capitalist distributes his capital simply because it is his capital, irrespective of the produce he expects from the labour bought.
> (*SRL,* p. 95)

63 At the same time, as noted on pp. 127–28, workers of different degrees of skill receive very different shares according as they contribute a common or a scarce kind of labour to the result (*TPE,* p. 273):

> the rate of wages which workmen can demand will depend upon the relation of supply to demand of such a particular kind of labour. The demand depends upon the expected value of the produce. If a certain kind of commodity is much wanted by consumers, it means that considerable quantities can be sold at a fair or high price. There will therefore be money value in plenty to be divided between landowners, capitalists, and labourers. But if the production of such commodity requires a

> peculiar skill in certain of the workmen such as happens to be enjoyed by few men, there is no limitation by competition, and any price can be obtained by that skill, and labour, provided, indeed, that the shares of the other producers are not reduced below what they could acquire in other occupations. The whole affair, therefore, is one of comparative advantage, each contributor to the hotch-potch trying to get the largest share of the proceeds, short of the point at which he will drive the other contributors to find other hotch-potches where their shares will be better.
> (*SRL,* p. 93)

64 Cf.: 'The result which emerges is that the supposed conflict of labour with capital is a delusion. The real conflict is between producers and consumers. The capitalist employer is a part of the producing system, and his conflict is naturally with the consumer who buys from him. But his function of acting as discounter of the labourer's share gives rise to a further conflict with the labouring class' (*SRL,* p. 98).

7
JEVONS AND UTILITARIANISM

1 Relying in part on the justification that economists are better equipped than ethicists or politicians to measure social welfare, contemporary economists have attempted to estimate welfare empirically. Their procedure is to assume that individuals are the same in their capacity for enjoyment, but not in their circumstances; utility is presumed to be the same function of various determinants

of utility for all individuals (or households), while parameters characterizing individual functions are allowed to differ (Tinbergen 1991, p. 7). These empirical endeavours are grouped by Tinbergen into the American procedure, (associated with Jorgenson), which has used a translog utility function, where the log of utility is a quadratic function of the logs of three or five determinants of utility (consumption goods or services). Family size, age of head, region of residence, race and type of residence are the parameters that characterize groups of consumers (p. 8). The procedure of the Dutch group (associated with Van Praag) has been to specify the welfare function as a function only of income: $W = \Sigma\alpha_i \ln(x_i + 1)$, where *x* represents income (p. 9). This functional form has the advantage of yielding diminishing marginal utilities: $\delta W/\delta x_i = \alpha_i/(x_i + 1)$.

2 As Sen has argued recently, the pioneers of modern welfare economics (Arrow 1951) presume that Social Welfare represents the 'goodness of the social state'; the determination of that 'goodness', however, is left 'completely open' in the sense that neither the arguments in nor the functional form of the social welfare function is restricted in the analysis of modern welfare economics (1991, p. 15). The utilitarian social welfare function, $W = \Sigma U_i$, implies that *only* individual utilities, $\{U_i\}$, contribute to the evaluation of social good; non-utility information plays no role in the evaluative judgements concerning various social states. In addition, because the ranking of any two alternative states, such as *x* and *y*, relates only to the utility *difference* that an individual has between these alternatives, the levels of utility play no direct role in the ranking of different welfare states.

3 Robertson argues that Jevons 'subtly rejected' Benthamite utilitarianism (1951, p. 234); Spengler concludes without elaboration that Jevons's examination of the role of the state evinced empiricism and utilitarianism (1972, pp. 480–81); while in Hutchison's extensive examination of Jevons on economic policy (1978, pp. 96–102), there is no mention of Utilitarianism. Blaug has argued that there was continuity between neoclassical and classical economic policy analysis, marginal utility theory being 'largely irrelevant' to economic policy (1972, p. 279; cf. p. 269). I agree that there was continuity; and, as far as concerns Jevons and Mill, this must be explained in terms of a common interpretation of the utilitarian principle.

4 In Hutchison's evaluation, 'For Jevons, as, until quite recently, for almost all economists, political economy was first and last a fruit-bearing subject concerned, above all, with the alleviation of real-world problems of poverty, insecurity and efficiency' (1982, p. 366).

5 Edgeworth's phrase (cited on p. 165) is very similar; he refers to 'just perceivable increments of pleasure'.

6 That Bentham knew the logical limits of his procedure has been recognized by Robbins (1970, pp. 56–57; 1981, p. 5), Hollander (1985, pp. 615f), and Mitchell (1918, p. 167).

7 This discussion has been ongoing; in 1903, Pigou remarked on the further distinction between 'pleasure' and 'what is desired' (p. 67). For recent treatments, see Sen (1991) and Broome (1991). Arrow (1951, p. 22) argues that by identifying happiness with hedonist pleasure, utilitarians also identified good with happiness. But, since utilitarians in the tradition of Mill favoured wide ranging reform, 'good' was not necessarily identical with 'happiness' or with the consequences of choices made.

8 For a full discussion of Mill's vacillations regarding Bentham and utility, see Hollander (1985, pp. 602f). In some undated notes on Mill's logical methods, Jevons refers to Mill's 'own mental progress from the ultra Benthamism of his youth, if youth he ever had, to the state of opinion expressed in his later essays, for which I can find no name at all' (JA6/5/43).
9 The utilitarian standard for policy was therefore capable of changing through time. See Mill's correspondence with Edward Herford, dated 22 January 1850 (*CW,* **xiv,** p. 45), as well as 'The Claims of Labour' [1845] (*CW,* **iv,** p. 375), and Stephen, who argues that Mill's Utilitarianism addresses the issue of 'development', altering the 'elements of happiness itself' (1900, p. 308, pp. 304f).
10 Compare Jevons's remarks concerning the efficacy of higher wages at achieving 'lasting improvement' when workers are not educated as to the need to restrain population growth (pp. 34–35 and pp. 163–65).
11 Hollander maintains that, for Mill, this position is *not* a presupposition of the doctrine, but rather constitutes the essence of Utilitarianism (1985, p. 650).
12 This allowed Mill to argue that morality was a changing standard: if moral improvement, (the transition to a distribution of pleasures containing a larger proportion of 'higher' pleasures), can occur, there is room for policy to encourage this transition. Mitchell argues that Bentham also allowed for pure pleasures to vary qualitatively: 'Indeed in this whole treatise Bentham relies upon classification, and not upon calculation. He splits everything he discusses—pleasures, pains, motives, dispositions, offenses, 'cases unmeet for punishment' etc.—into kinds, limits his quantitative comparisons to relations of greater and less, and makes even these comparisons chiefly among phenomena belonging to the same kind' (1918, p. 169).
13 See Stephen (1900, pp. 304f).
14 In this context, Mill does not envisage smooth trade-offs of qualitatively different pleasures: a superior pleasure is preferred to 'any' quantity of an inferior pleasure.
15 Cf. 'the test of quality, and the rule of measuring it against quantity, being the preference felt by those who, in their opportunities of experience, to which must be added their habits of self-consciousness and self-observation, are best furnished with the means of comparison' (*CW,* **x,** p. 214). Mill relies on this criterion to argue that 'the manner of existence which employs their higher faculties' is, qualitatively speaking, superior to the pleasure entailed in a life of base animalistic pleasure.
16 See Robson (1968, pp. 156–57).
17 Jevons interpreted this passage uncharitably. See pp. 145–46.
18 In fairness to Mill, of course, it bears emphasizing that many diseases of his time were in fact related to poor sanitary conditions, and thus preventable to the extent that education improved cleanliness.
19 Education should be required, and available to all, but state-provided education should not be compulsory. See *CW,* **xviii,** p. 302; **xiv,** p. 89; and the discussion in Robson (1968, pp. 124–27). In the light of these recommendations, Jevons's strictures against Mill's 'packed jury' (p. 147), may have been overly harsh.
20 See *CW,* **xix,** pp. 606–607. Jevons also praised the Poor Laws on these grounds, see pp. 158–59.
21 Cf. 'I regard utility as the ultimate appeal on all ethical questions; but it must be utility in the largest sense, grounded on the permanent interests of a man as a progressive being. Those interests, I contend, authorise the subjection of individual

spontaneity to external control, only in respect to those actions of each, which concern the interest of other people' (*CW,* **xviii,** p. 224).

22 Jevons again relied on this rationale (see pp. 157–58).

23 Cf. 'The aim of improvement should be not solely to place human beings in a condition in which they will be able to do without one another, but to enable them to work with or for one another in relations not involving dependence' (*CW,* **iii,** p. 768).

24 'We hail, therefore, the cheap Libraries, which are supplying even the poorest with matter more or less instructive, and, what is of equal importance, calculated to interest their minds. But it is not only, or even principally, books and book learning, that constitutes education for the working or for any other class. Schools for reading are but imperfect things, unless systematically united with schools of industry; not to improve them as workmen merely, but as human beings' (*CW,* **iv,** p. 378). Compare Jevons on libraries, pp. 160; 277–78, Note 31.

25 Like Jevons, however, Mill insisted that unions be voluntary.

26 Co-operation, the association of labourers as equals 'collectively owning the capital with which they carry on their operations, and working under managers elected and removable by themselves', would encourage independent and moral behaviour among both labourers and managers, by ending the wage relationship that symbolized the dependent nature of the labouring classes (*CW,* **ii,** pp. 207f; cf. **iv,** p. 382).

27 Jevons reserved his sharpest criticisms for Mill's philosophical methods. In his notes on Mill's logical method, he referred to Mill as 'one of the most illogical writers who ever wrote' (JA6/5/43), and the 'philosophic nothingness' of Mill (JA6/5/42); cf. Jevons's letter to the *Criterion,* dated 27 June 1874 (JA6/5/8), and 'A fragment on Mill's logic', *Owens College Magazine,* Vol. **xi,** no. 2, January 1879, pp. 81–87 (JA6/5/9).

28 This is the only reference in the 1879 review, however, to the issue of interpersonal comparisons of utility.

29 The passage in Jevons is, as he puts it, an 'abridgment' of Bentham's *An Introduction to the Principles of Morals and Legislation,* cited in pp. 138–44.

30 In the 1876 *Fortnightly Review* article, 'Cruelty to Animals—A Study in Sociology', Jevons extended Utilitarianism beyond the human race, arguing that cruelty to animals also violates utilitarian principles: 'But I need hardly go on at any great length to show that the sentiments of the public in respect of cruelty to animals are simply in a chaotic state. There is no approximation whatever to the utilitarian standard' (*MSR,* p. 219).

31 As Dimand argues, Bentham sometimes gives the impression that the simple social welfare function presented above, is the correct representation of Social Utility. But in Dimand's view, implicit even in the (Benthamite) utilitarian conception is a distributional element; the social welfare function for Bentham might therefore be more accurately represented by $W=\{u_1+ \cdots +u_n\}/(j+1)$, where j is the number of individuals with lower than average utility (1991, pp. 17–18).

32 In line with his analysis of exchange and production (see Chapters 4, 5 and 6), Jevons allows that people make mistakes, and presumes that the course of action which in the majority of cases brings happiness, yields the greatest total happiness for the individual. This may constitute the basis for Edgeworth's call for the use of 'wide averages'; see pp. 165–66.

33 'By the same method of decision, we might all be required to get up at five o'clock in the morning and do four hours of head-work before breakfast, because the few hard-headed and hard-bodied individuals who do this sort of thing are unanimously of opinion that it is a healthy and profitable way of beginning the day' (1879, p. 532).

34 It is not clear, however, why altruism has to enter into this calculation: altruism is not necessary for a pleasure to extend to large numbers.

35 An undated note in the Jevons Archives confirms this point: 'There can be little doubt that all greatest difficulties in moral Phil[y] and—? arise from the impossibility of exact definition and measurement. An act is allowable if it adds to the happiness of the community as a whole. But we have no means of determining exactly in any case whether there is a clear addition, and we certainly could not teach interested individuals to make the estimation' (JA6/48/27).

36 There is yet another problem. For the transformation from individual to social pleasure is itself no simple matter: the functional form chosen to combine individual pleasures into a social total, itself involves a value judgement. On this matter, see Robbins (1932 and 1981) and Arrow (1951, pp. 16–17).

37 In 'The Use and Abuse of Museums' [1883], Jevons referred to the difference of 'kind' as well as the 'degree' of benefits received from museums and concluded that measurement of total benefits was impossible: The degree of instruction derived is quite incapable of statistical determination. Not only is there great difference in degree, but there is vast difference also in the kind of benefit derived' (*MSR,* p. 55).

38 Compare Robbins, who criticized Jevons for suggesting that there are no general criteria for intervention: 'the net effect of his discussion here, however unintentional, is certainly to leave the impression that all questions of practice are completely open questions, and that there are no rules of any degree of generality which social science, combined with the Utilitarian norms, may enable us to devise' (1970, p. 187). My interpretation is that, while Jevons insisted that specific policies be evaluated on a case-by-case basis, a number of overriding guidelines are evident throughout the writings on policy.

39 As G.Stigler pointed out, however, Jevons was not always entirely consistent on this matter (1950, pp. 87–93).

40 Cf. 'But, then, value there really means utility, because what people want ultimately is command over conveniences and luxuries. Now as I have said there is no real way of measuring and defining utility, and the only approximation we can make to a standard of value is something which shall exchange for other articles, on the average, in as nearly an unchanged rate as possible' (*P&C,* **vi,** p. 95).

41 For Cairnes's objections to this procedure, see his review of *TPE,* reprinted in *P&C,* **vii,** pp. 150f.

42 For a similar argument, see Tinbergen: 'Clear examples can be found in physics where initially qualitative characteristics were followed by very satisfactory quantitative measurements' (1991, p. 9).

43 Jevons's contemporary, T.E.C.Leslie, denied that the broader utility, encompassing 'moral' questions, was quantifiable, although he apparently allowed that ordinal rankings of pleasure were possible:

> But the very reference which Mr.Jevons proceeds to make to morals militates against the assumption that 'political economy must be mathematical simply because it deals with quantities', and that 'wherever the things treated are capable of being greater or less, there the laws and relations must be mathematical'. [He] instances Bentham's utilitarian theory, according to which we are to sum up the pleasures on one side and the pains on the other, in order to determine whether an action is good or bad. Comparing the good and evil, the pleasures and pains, consequent on two courses of conduct, we may form a rational judgment that the advantages of one of them preponderate, that its benefits are greater, its injurious results, if any, less; but it by no means follows that we can measure mathematically the greater or less, or that the application of the differential calculus would be appropriate or possible in the matter.
> (*P&C,* **vii,** pp. 159–60)

44 Individual interests were in all cases to be balanced against the general good, a consideration which in 1876 is said to require 'the nicest discrimination' 'to show what the Government should do, and what it should leave to individuals to do' ('The Future of Political Economy', *PE,* p. 206).

45 See the remarks in Coats: 'as time passed there was a growing realization that the process of reforming the labouring classes would be neither quick nor easy' (1971, p. 153). Robson (1968) has argued that Mill, also, became increasingly convinced that reform would be a drawn-out process.

46 In his 1875 *Nature* article, 'Heredity', Jevons argued: 'It becomes evidently impossible to uphold any longer the views of the older utilitarians, from Locke down to the two Mills and Buckle. As M.Ribot remarks, it is surprising to find a writer such as Buckle attributing little importance to psychological heredity. It is impossible any longer to look upon the mind and moral nature of the child as a *tabula rasa,* which can be marked by education at our will. If so, Mill's views of the philosophy of morals fall to the ground, and the doctrine of the moral sense in a modified form must be again taken in hand' (p. 504).

47 In his notes on Mill's political economy, Jevons claimed that 'The errors contained in this book [book 5 of *PPE*] are comparatively few, and his treatment of the functions of government has but one fault—brevity' (JA6/6/14).

48 Jevons did not specify the 'opinions' of Mill he contested.

49 This point is reiterated by Paul (1979, p. 283).

8
JEVONS'S ANALYSIS OF POLICY

1 Hutchison writes that Jevons was 'fundamentally and philosophically' anti-dogmatic, having abandoned his early 'thoroughgoing free-market view' (1982, p. 376). His policy analysis also is said to have undergone a transition between 1857 and 1882; a new 'cautious' and 'empiricist' policy stance and methodology emerged 'somewhere about 1870' (1978, pp. 94, 95). Hutchison points to the abandonment of the 'sweeping application of *laissez-faire* principles', with Jevons envisaged as 'if not a "revolutionary", at least a transitional figure', who

appreciated that the issue of intervention must be decided on a case-by-case basis, by 'empirical examination' (pp. 96, 97). Paul also concludes that Jevons abandoned *laissez-faire* doctrine, but recognizes that he was close to Mill methodologically (1979, p. 278).

2 See also Black (1982c, pp. 7, 13).

3 Mirowski has a diiferent perspective: that Jevons's economics must be understood as an attempt to shore up the case for *laissez-faire* in the face of increasing scepticism about *laissez-faire* political economy (1988, p. 47). If Mirowski intends to point to Jevons's increased (compared to Mill) scepticism about the malleability of human nature, this evaluation supports that thesis. I do not, however, find that Jevons was attempting to shore up a case for non-intervention.

4 Hutchison, by contrast, argues that Jevons's applied economics reveals a new set of policy concerns which are linked to his theoretical achievements: 'That they both occurred around 1870 in Britain is surely not entirely coincidental' (1978, p. 94). In the case of the policy revolution, the 'definite shift' in ideas purportedly entailed new consideration of 'the poverty problem', progressive taxation, and unemployment, as well as 'a new questioning of the *laissez-faire* maxim' (pp. 95, 257, 291). This contrasts, according to Hutchison, with the policy analysis of J.S.Mill whose continued belief in 'the great Malthusian difficulty' inhibited proposals for the improvement of the condition of the poor, and who in any case 'can be regarded as concerned much more with prophetic hopes than with operational policies' (p. 95).

5 Jevons thus emerges as more conservative and less willing to call for intervention than J.S.Mill. This supports Hutchison's argument that Jevons was 'cautious', but refutes the position that it was Jevons who ended the 'sweeping' adherence to *laissez-faire*.

6 If, by his argument that Jevons began to lose faith in the virtue of 'self-reliance', Black has in mind that Jevons questioned whether policy could encourage the acquisition of self-reliance among labourers (while he remained convinced that self-reliance, once obtained, was the key to improvement), the analysis in Chapters 7 and 8 supports that assessment.

7 As we have seen on pp. 85–87; 96–97, Jevons argued that some mistakes tend to 'balance' out, whereas others do not, as when workers repeatedly overestimate earnings capacities during the course of the business cycle as well as their lifecycle.

8 See the evaluation by John Kells Ingram:

> [Jevons] proposed in other writings (collected in *Methods of Social Reform,* 1883) a variety of measures, only partly economic in their character, directed especially to the elevation of the working classes, one of the most important being in relation to the conditions of the labour of married women in factories. This was one of several instances in which he repudiated the *laisser faire* principle, which, indeed, in his book on

The State in Relation to Labour (1882), he refuted in the clearest and most convincing way, without changing the position he had always maintained as an advocate of free trade.

(J.K.Ingram 1888, p. 226)

9 Mill used the example of slum housing as a case for justifiable intervention also: '[The government] has made unlawful the construction of houses which it deems unfit for the habitation of human beings; though the pure doctrine of competition would leave it to the poor to correct the evil by refusing to live in them' ('Centralisation' [1862], *CW,* **xix,** p. 592).
10 'Speaking of liberty and rights, it must be apparent, too, that the parties most seriously concerned in the matter are the infants' (*MSR,* p. 177).
11 In Mays's evaluation, 'Whenever possible, Jevons believes, legislation should observe the order of nature and proceed tentatively', a type of experimentation which resembles 'that involved in habit learning' (1962, p. 243). Jevons credited Dupuit with appreciating the importance of imitation in social affairs (*MSR,* p. 261).
12 These are equality, certainty, convenience, and economy. Cf. Mill, *CW,* **iii,** p. 805.
13 The argument relied upon the assumption of diminishing marginal utility of income: 'The general idea…was the £10 was of more importance to a man whose income was only £100 a year than £100 would be to a man whose income is £1, 000; and of *vastly more* importance than £1,000 would be to a man whose income was £10,000 a year' (*P&C,* **vi,** p. 135). Mill also appreciated this argument: 'To take a thousand a year from the possessor of ten thousand, would not deprive him of anything really conducive either to the support or to the comfort of existence; and if such *would* be the effect of taking five pounds from one whose income is fifty, the sacrifice required from the last is not only greater than, but entirely incommensurable with, that imposed upon the first' (*CW,* **iii,** p. 809).
14 Exemption, however, is really a separate logical issue.
15 See Jevons's remarks of 3 November 1866: 'I hope to see every child educated, and every exception to the equality of all classes before the laws of justice removed' (*P&C,* **iii,** p. 138). We take up this matter in detail on pp. 163–65.
16 'With the increase of education and general intelligence, libraries will be far more esteemed institutions half a century hence than they are now (*MSR,* p. 48).
17 Labour supply restrictions in the building trades were 'particularly injurious', since The general effect is to make really wholesome houses a luxury for the wealthier classes, while the residuum have to herd together between whatever walls they can find' (*SRL,* pp. 104–105).
18 On only two occasions Jevons looked at the general case, and concluded that general wage increases were unattainable. See 'Trade Societies: Their Objects and Policy' [1868], *MSR,* pp. 113–14; and *SRL,* p. 106.
19 This was a reluctant endorsement. As we have seen in Chapter 6, Jevons insisted throughout his career that all labourers should recognize that their interests were aligned with producers, and he never endorsed union attempts to raise wages.
20 There are problems reconciling the formulation with *TPE.* See Stewart (1989).
21 This is the justification of 'all the laws of property, and…their only sufficient warrant' (*P&C,* **iii,** p. 152; cf. p. 132).

22 Partnership would lead to ‘peace’, ‘steady, zealous work’, mutual ‘confidence and esteem’, and less ‘drunkenness’, ‘fighting’, ‘swearing’, and ‘gambling’ (*MSR,* p. 130).

23 In 1882 Jevons clarified his notion of partnership. He described a system involving payment of ‘subsistence’ weekly wages ‘to enable the labourer and his family to await the completion of the interval between manufacture and sale’, and, in addition, a ‘share of all surplus profits’ (*SRL,* p. 142). He also considered conciliation and arbitration, and favoured arbitration for settlement of labour disputes, and conciliation for disputes concerning the ‘future rate of wages’ (pp. 145, 152).

24 A recent evaluation maintains that Alfred Marshall exhorted the ‘middle and upper classes to consume more conscientiously’ (Lipkis 1993, p. 95). Lipkis also argues that Jevons, as well as Marshall, linked consumption and morality (p. 95).

25 As we have seen (Chapter 3), producers, also, were inclined to make mistaken decisions during the course of economic fluctuations: Jevons insisted that temporary over-production occurred cyclically as a result of investors misreading the state of the market.

26 For recent examinations of the distinction between what is desired and what is desirable, see Broome (1991), Sen (1991), and Peart (1995). Jevons did maintain neutrality in his discussion of gambling:

> If a person with a certain income prefers to run the risk of losing a portion of it at play, rather than spending it in any other way, it must no doubt be conceded that the political economist, as such, can make no conclusive objection. If the gamester is so devoid of other tastes that to spend money over the gaming-table is the best use he can discover for it, economically speaking, there is nothing further to be said. The question then becomes a moral, legislative, or political one. A source of amusement which, like gaming, betting, dram-drinking, or opium-eating, is not in itself always pernicious, may come to be regarded as immoral, if in a considerable proportion of cases it leads to excessive and disastrous results.
> (*TPE,* pp. 160–61)

27 See Georgescu-Roegen, who asserts that, ‘according to Jevons’ law, if an individual were given his life income in one lump sum, he would not distribute it over time in such a way as to obtain the maximum *actual* pleasure out of it’ (1968, p. 250).

28 Jevons also maintained that decisions concerning working hours depend upon the character of the labourers involved, with the implication that certain types of character are hard working and in some sense ‘better’ than others (see pp. 120–121).

29 This position, however, is difficult to reconcile with such pronouncements in Jevons’s *TPE* outlined in Chapter 5, such as: ‘perfect freedom of exchange must be to the advantage of all’ (*TPE,* p. 142; see p. 141). There is a tension in Jevons’s work between the presumption that static decision-making is, on average, utility maximizing, while—at least without education—intertemporal decisions are not. Biggs (1990) has pointed to a similar tension in Marshall.

30 Compare Mill's analysis: 'It is seldom by the choice of the wife that families are too numerous; on her devolves (along with all the physical suffering and at least a full share of the privations) the whole of the intolerable domestic drudgery resulting from the excess. To be relieved from it would be hailed as a blessing by multitudes of women who now never venture to urge such a claim, but who urge it, if supported by the moral feelings of the community' (*CW,* **ii,** p. 372). As noted in Chapter 2, Mill predicted that a fall in birth rates would occur as a result of increased labour force participation by women.

31 In 1881 Jevons argued that the establishment of Free Libraries would reduce future expenditures on poor-rates by improving the behaviour of the poor: 'Now, this small cost is not only repaid many times over by the multiplication of utility of the books, newspapers, and magazines on which it is expended, but it is likely, after the lapse of years, to come back fully in the reduction of poor-rates and Government expenditure on crime. We are fully warranted in looking upon Free Libraries as an engine for operating upon the poorer portions of the population' (*MSR,* p. 32; cf. p. 33). The Post Office Savings Bank, Jevons argued further, was justified only as a means of teaching thrift (p. 32).

32 In the 1870 'Opening Address as President of Section F', Jevons argued 'only with the increase of education and temperance' would increased wages lead to lasting improvement (*MSR,* p. 209). His correspondence reiterated this argument: 'Surely there is always over-population when people are improvident, and unable, or careless, to provide for the inevitable vicissitudes of the seasons. Ireland has furnished the clearest case of over-population, [pauperism,] and I think that the same may be said of the whole agricultural population of the United Kingdom, which has only been to a certain extent saved by the extension of manufacturers, as I tried to show in the chapters on population in my *Coal Question*' (5 December 1872; *P&C,* **iii,** p. 255).

33 This phrase was criticized by Fisher, who attempted to avoid the problems associated with differences in realized versus anticipated pleasure, by arguing that desire, and not pleasure, motivates actions (1892, pp. 17, 11).

34 It is significant that Edgeworth's methodology here followed that advocated by Jevons in 1874 and used by Jevons in his empirical studies; see Chapters 9 and 10. As Dimand (1991) has pointed out, this is not a legitimate procedure, however, if the sample is not representative of the population.

35 The idea of money as a measuring rod for utility was not new in 1890. As noted above, Jevons proposed the procedure in his *TPE* (see p. 105). Bentham also refers to money as a measuring rod. He was stopped, moreover, by the problem of diminishing utility of wealth. See Mitchell (1918, pp. 169–71).

36 This tradeoff between exactness and reality is one that troubled J.S.Mill, and led him to oppose quantification in applied economics. For an elaboration, see Peart (1993a and 1995); see also Part IV.

37 Cf. 'Professor Edgeworth, like every one else, is obliged to admit that a shilling represents different degrees of utility to different people, and even to the same people at different times. If these differences are recognized I fail to see how the same measure can be applied; if they are not recognized the conclusion is unreal, for the people or their feelings are made identical' (1894, p. 345).

38 Robbins maintained that rough estimates of utility or welfare have long been commonplace:

Of course I do not deny that, in every-day life, we do make comparisons between the satisfactions of different people. When the head of a family carves up a turkey, he may take account of his estimate of the satisfaction afforded to different members by different portions; and, in more serious judgments of social relationships outside the family, whenever we discuss distributional questions, we make our own estimates of the happiness afforded or the misery endured by different persons or groups of persons.

(Robbins 1981, p. xx)

39 To use a simple example adapted from Sen: Suppose we compare three states of the world: one in which you can read any book and you choose to read Miriam Monfredo's *North Star Conspiracy;* a second in which you can read only one book, *North Star Conspiracy;* and a third in which you can read only one book, *Winnie the Pooh*. In the last two states of the world, your freedom has been unequally reduced, even though you have the same number of possible things to read in both cases. In the *Winnie the Pooh* situation you have less freedom than in the *North Star Conspiracy* case, where you are offered the restricted reading choice that happens to be what you would choose in the unrestricted case. Thus, preference information is a key to evaluating the existence of freedom.

9
THE RISE OF EMPIRICAL METHODS

1 See the 11 February 1867 entry in his Journal concerning *The Principles of Science:* 'I should wish to produce a work which will not only embody a new & luminous system but will be readable & read by many' (*P&C,* **i,** p. 209). Schabas has argued that the 'new direction' set by Jevons for economics late in the nineteenth century was methodological. But her focus has been on the introduction of mathematical techniques in economics (1989, p. 22). I do not deny the importance of that development, but suggest, in addition, that the introduction of statistical methods in economics by Jevons also constituted a significant methodological development.

2 Black focuses upon the capacity to handle 'large masses of statistical data' combined with the ability 'to strike out novel and potentially fruitful hypotheses for their interpretation' as 'pioneering' characteristics of Jevons's applied economics (1981, p. 11).

3 S.Stigler has argued that the slow development of statistical procedures in social science resulted from 'major conceptual barriers' entailed in combining economic data (1986, pp. 4–5, 158). Morgan argues that lack of the relevant data, and statistical methods that were not advanced enough to treat the complex, multiple cause relationships in social science slowed the development of econometrics (1990, p. 4). Elsewhere Morgan describes additional problems faced by early practitioners of econometrics: theories were often expressed in words; relationships between variables were frequently vaguely defined; and the variables themselves were difficult to measure (1988, p. 200).

4 Many accounts emphasize methodological differences between Mill and Jevons, though there is as yet no consensus on what those differences were. Hutchison characterizes the contrast as that of an 'overly confident' Mill and a 'characteristically cautious' Jevons (1978, p. 224, cf. p. 101; 1982, p. 372). Black argues that Jevons's 'conception of scientific method and technique' is close to the 'approach of the economist of the present day', and contrasts with the 'deductive approaches' of the Classical economists (1981, p. 11). Hammond notes without elaboration that Jevons downplayed the importance of the 'disturbing causes' that were so important to Mill (1991, p. 95). Schabas suggests that Jevons initiated a 'shift in the line of demarcation between theoretical and applied economics' (1990, p. 138), a distinction which Marshall is said to have subsequently removed (Hammond 1991, pp. 95–96).

5 We will see in Chapter 10 that in his own applications, too, he maintained that omitted causes might be treated as 'balancing' in the drawing of a mean, so that, for instance, the 'general variation of the price' might be attributed to the gold influx; he therefore proceeded to 'attack' his data 'by the use of wide averages'.

6 See the correspondence from Léon Walras, alluded to in Chapter 1: 'en vous envoyant mon' Mémoire sur le *Principe d'une théorie mathématique de l'échange,* je vous connaissais de réputation, mais seulement comme auteur de travaux estimés sur la question de la variation des prix et de la dépréciation de la monnaie. Je vous savais mathématicien, mais je me figurais que vos applications mathématiques étaient plutôt statistiques qu'économiques' (23 May 1874; *P&C,* **iv,** p. 45). J.K.Ingram maintained that 'The combination which [Jevons] presented of a predilection and aptitude for exact statistical inquiry with sagacity and ingenuity in the interpretation of the results was such as might remind us of Petty. He tended strongly to bring economics into close relation with physical science. He made a marked impression on the public mind by his attempt to take stock of our resources in the article of coal. His idea of a relation between the recurrences of commercial crises and the period of the sun-spots gave evidence of a fertile and bold scientific imagination, though he cannot be said to have succeeded in establishing such a relation' (1888, p. 225). Ingram concludes that Jevons's 'name will survive in connection, not with new theoretical constructions, but with his treatment of practical problems, his fresh and lively expositions, and, as we have shown, his energetic tendency to a renovation of economic method' (p. 229).

7 For a detailed examination of the treatment that Jevons's theory of fluctuations has received in the literature, see Peart (1991, pp. 259f). Robertson stresses the 'modern' features of Jevons, who 'is without precursors' in applied analyses, 'in the sense that no one before him approached his sheer ability in the sifting and interpretation of economic statistics' (1951, pp. 247, 244). This same theme appears in a recent study which contains high praise of Jevons's business cycle work as an instance of early econometrics. Walker concludes that 'Jevons's work on the sunspot theory was revolutionary in method not only in regard to its inductive character…but also with respect to its econometric nature. Jevons developed not only a theory of business fluctuations but [also] a model with numerical coefficients derived from economic measurements' (1985, p. 166).

8 The presentation below also supports Morgan: 'applications formed the catalyst necessary for econometricians both to recognise their difficulties and to search for solutions' (1990, p. 11)

9 This wording is due to Hacking (1983) who has pointed to a full range of 'cracks' in the concept of determinism by 1870.

10 It is this view, in Aldrich's estimation, that creates the distinctly important role for probability in Jevonian social science: 'probability was the necessary basis for our judgements in science because certainty was unattainable' (1987, p. 235). White argues that Jevons's conception of probability followed Laplace, Poisson, Quetelet, and De Morgan (1989, pp. 426–27). On De Morgan's influence on Jevons, see Black (1972a). Schumpeter similarly sees the 'strikingly original' characteristic of the *PS*—a 'work of truly Jevonian force and originality'—to be 'the basic position assigned to probability—to the idea that scientific truth is basically stochastic' (1954, pp. 826, 777, Note 14).

11 Aldrich maintains that Jevons was able to reconcile this deterministic conception of causality with calls for probabilistic inference, because the laws of probability were regarded as rules for regulation of belief rather than empirical laws of chance phenomena (1987, p. 236). This claim is supported by Schabas (1990, pp. 69–70).

12 See, however, Jevons's 1869 *Nature* article, where the notion of *orderly progression* prevails: 'I conceive it to be the essential consequence of Darwin's views that no form of life is to be regarded as a fixed form; but that all living beings, including man, are in a continual process of adjustment to the conditions in which they live' (p. 231). See also *PS,* p. 762, and, for Mill's position, Note 15.

13 I am grateful to Abe Hirsch and Sam Hollander for helpful comments concerning Mill's methodology. See Hirsch (1992) for a lengthy discussion of the theory-practice distinction in Mill, and Peart (1995) for a comparison of the distinction in Mill and Jevons. I follow Hirsch (1992, p. 846) in assigning the following meanings to Mill: 'cause' is an antecedent that invariably precedes an effect; while 'law' is an observed uniformity of nature.

14 Jevons also used this argument. Mill insisted, however, that this must not lead to methodological narrowness or a separation of theory from application (*CW,* **iv,** p. 334). For a contemporary criticism of Mill's argument in favour of a distinct science of economics, see Ingram (1878, pp. 608–12).

15 Laws of change, however, were said to be deterministic; cf. *CW,* **viii,** p. 878.

16 See *CW,* **viii,** pp. 888, 893, as well as the account in Oakley (1993, p. 30).

17 Cf. 'the laws of number and extension are applicable, if at all, only on that large scale on which precision of details becomes unimportant' (*CW,* **vii,** p. 459). Hollander has argued that Mill was opposed to the 'abusive' use of mathematics in social science, not to mathematics per se (1985, pp. 938–43). See Mill's complaints concerning Jevons's use of mathematics in a letter to J.E.Cairnes, 5 December 1871; *CW,* **xvii,** p. 1862. Cairnes concurred that economics was not susceptible to numerical precision:

> ['these principles'] do not, from the nature of the case, admit of being weighed and measured like the elements and forces of the material world: they are therefore not susceptible of arithmetical or mathematical expression; and hence it happens that, in speculating on results which depend on the positive or relative strength of such principles, perfect precision, numerical accuracy, is not attainable. Political Economy seems on this account necessarily excluded from the domain of exact science.

(Cairnes 1875, p. 120; cf. p. 132, pp. iii–iv)

18 The accuracy of these causes was to be established and verified empirically: ‘Although sufficiently ample grounds are not afforded in the field of politics, for a satisfactory induction by a comparison of the effects, the causes may, in all cases, be made the subject of specific experiment’ (*CW,* **iv,** p. 329; cf. Whitaker 1975, p. 1038).
19 The two countermotives are the aversion to labour, as well as the ‘desire of the present enjoyment of costly indulgences’ (*CW,* **iv,** p. 321), and Mill urged the political economist to take these into account (p. 322).
20 Cf. *CW,* **iv,** p. 323; **i,** pp. 16, 22. Mill used an example from astronomy for justification of this method. Jevons also endorsed the ‘comparatively abstract and general’ methodology for economic theory, ‘treating mankind from simple points of view, and attempting to detect general principles of action’ (*PS,* p. 760). In his *TPE,* he reiterated his endorsement of Mill’s method (see pp. 184–85).
21 Hirsch argues that true verification of the implications of economic theory is consequently impossible for Mill, or for J.E.Cairnes. Instead, specific experience reveals the existence and significance of disturbing causes (1978, p. 324). Cairnes outlined his position in 1875:

> Statistics are collections of facts arranged and classified with a view to particular inquiries; and it is by availing ourselves to this systematized method of observation that we can most effectively check and verify the accuracy of our reasoning from the fundamental assumptions of the science; while the same expedient offers also by much the most efficacious means of bringing into view the action of those minor or disturbing agencies which modify, sometimes so extensively, the actual course of events.
> (Cairnes 1875, p. 97)

22 Jevons also often presumed that effects of multiple causes could be added together to find the total effect. See p. 188.
23 Blaug suggests that Mill was ‘at best a lukewarm verificationist’ (1980, p. 76; for recent discussions, see DeMarchi 1986; Hausman 1992; Peart 1993a).
24 Cf. ‘but he must still continue to exercise the same discipline upon every new combination of facts as it arises; he must make a large allowance for the disturbing influence of unforeseen causes, and must carefully watch the result of every experiment, in order that any residuum of facts which his principles did not lead him to expect, and do not enable him to explain, may become the subject of a fresh analysis, and furnish the occasion for a consequent enlargement or correction of his general views’ (*CW,* **iv,** pp. 335–36).
25 Mill alludes to the ‘impossibility of being quite sure that all the circumstances of the particular case are known to us sufficiently in detail, and that our attention is not unduly diverted from any of them’ (*CW,* **iv,** p. 330). That caution is reiterated on p. 337.
26 In ‘simple instances’, however, when ‘the action of each cause was not intermixed or interfered with’ by ‘other causes whose laws were unknown’, discovery of a numerical or geometrical causal law is relatively straightforward (*CW,* **vii,** p. 458).

Mill also allowed that in instances of independent though multiple causation it was possible to determine the effects of a particular 'constant cause' by experimental methods (p. 530). Here, as long as there is reason to believe that variable causes have a mean of zero, a mean result reveals 'the part, in each experiment, which is due to the cause A', the 'variable remainder' being the effect of causes which vary from experiment to experiment (pp. 530–31).

27 Jevons also used this example in his *Theory of Political Economy* to illustrate the difficulties associated with experimentation (pp. 18–19); see p. 185.

28 Mill never spelled out why he believed 'all possible combinations' of the 'various influential circumstances' had to be observed. There is some evidence, however, that his notion of causality ruled out independent causes: 'The effects, therefore, of different agents not being different in quality, while the quantity of each is the mixed result of all the agents, the variations of the aggregate can not bear an uniform proportion to those of any one of its component parts' (*CW,* **viii,** p. 884). Thus relationships could not be presumed to entail independent errors (as Jevons supposed; see p. 188).

29 This example is due to Adolphe Quetelet, and Mill's description, in terms of 'variable' and 'constant' causes, reflects contemporary understanding (Morgan 1990, p. 8). Jevons used similar terminology; see p. 185. Quetelet was the only statistician to attend the opening meeting of the famous Section F (statistics and economics) of the BAAS in 1833. See Cooper (1994, p. 6).

30 Mill was cautious even in this case, since the general circumstances may have seen a change throughout the year (*CW,* **viii,** p. 933).

31 Cf. 'all the functions involved are so complicated in character that there is not much fear of scientific method making rapid progress in this direction' (*PS,* p. 760). Jevons may have felt the need for even a very crude approximation, which could then be improved upon by economists. In practice, he acknowledged that these laws would indefinitely remain 'approximate and empirical' (MT, p. 285).

32 'Before we can investigate the actions of any aggregate of men, we must have fairly mastered all the more abstract sciences applying to them, somewhat in the way that we have acquired a fair comprehension of the simpler truths of chemistry and physics. But all our physical sciences do not enable us to predict the weather two days hence with any great probability, and the general problem of meteorology is almost unattempted as yet. What shall we say then of the general problem of social science, which shall enable us to predict the course of events in a nation?' (*PS,* p. 760).

33 Unlike Mill's *Logic,* Jevons's *PS* contained no separate section on economic methodology. This is quite likely because, as Aldrich (1987) argues, he envisaged a common method for physical as well as social sciences. Compare Jevons's description of the method for physical sciences, entailing 'deductive reasoning', 'extensive generalisation', 'happy prediction', 'satisfactory verification' and 'nice calculation of probabilities' (*PS,* p. viii) with the method for economics endorsed in *TPE.*

34 The method of focusing on a few important causes of interest is said to characterize meteorology as well:

> Moreover, under varying circumstances, a hundred thunder-clouds may be produced which will appear to a superficial observer to differ completely in form and nature, but in which closer examination may detect, in greater or less degree, all the essential characteristics of the perfect or typical thunder-cloud. To obtain, indeed, the type or single clear conception of a thunder-cloud, it is necessary for the mind to carry on a process of *abstraction* upon all thunder-clouds which meet the eye.
>
> ('On the Forms of Clouds', 1858, p. 250)

35 Jevons attributed this methodology to Mill (as well as Cairnes), although he objected to Mill's nomenclature. While Mill called this the 'Concrete Deductive Method', Jevons insisted that it be called the 'Complete Method' to emphasize that it 'is no special method at all, but simply induction itself in its essential form' (*TPE,* p. 17).

36 In the *TPE* Jevons acknowledged that the 'difficulties of this union' of theory and statistics 'are immensely great' (p. 22). Cf. 'These data would consist chiefly in accurate accounts of the quantities of goods possessed and consumed by the community, and the prices at which they are exchanged' (*TPE,* p. 21):

> Man in his economic, sanitary, intellectual, aesthetic, or moral relations may become the subject of sciences, the highest and most useful of all sciences. Every one who is engaged in statistical inquiry must acknowledge the possibility of natural laws governing such statistical facts. Hence we must allot a distinct place to numerical information relating to the numbers, ages, physical and sanitary condition, mortality, &c., of different peoples, in short, to vital statistics. Economic statistics,
>
> comprehending the quantities of commodities produced, existing, exchanged and consumed, constitute another extensive body of science.
>
> (*PS,* p. 334)

As noted on p. 185, Jevons urged that 'a perfect system of statistics' be established to render Economics an exact science.

37 A notable exception is the subject of pp. 204–205. The second exception consisted of an empirical study of muscular action which Jevons conducted and described in *TPE* (p. 207). Two hundred and thirty-eight trials were conducted to find the relationship between work done and fatigue. The 'average useful effect' (weight×time) is then calculated for various weights of an object:

Weight	18	14	10	7	4	2	1
Useful Effect	266	455	603	612	592	438	321

38 As we have seen (Note 29), Mill also refers to 'constant' and 'variable' causes.

39 'There are certain cases in which a disturbing cause can with ease be made to act in opposite directions, in alternate observations, so that the mean of the results will be free from disturbance' (*PS,* p. 356).

40 Aldrich remarks that, for Jevons, averaging constitutes 'a means of cutting through the complexity' of social science (1987, p. 237).

41 When 'It may fairly be assumed as a first principle…that large errors will be far less frequent and probable than small ones', and secondly that 'positive and negative errors shall be equally probable', then 'the probability of the error must be a function of an even power of the magnitude' (*PS,* p. 376). Under these conditions, Jevons argued, it followed that 'the most probable result of any observations is that which makes the sum of the squares of the consequent errors the least possible' (pp. 376–77).

42 Cf. Jevons's 'Remarks on the Statistical Use of the Arithmometer' [1878]: 'I should like to add, that if our science of statistics is to progress in the spirit of the times, frequent use must be made of the Method of Least Squares. This method is merely the method of means or averages employed in a more complete and elaborate way, to disentangle the probable values of several unknown quantities which happen to be involved together in our statistical data.' Use of the arithmometer, Jevons argued here, would greatly reduce the tediousness of the calculations involved (*P&C,* **vii,** p. 87).

43 Blake *et al.* argue that, for Jevons, formulating a law entailed the replacement of an empirical formula by a rational function (1960, p. 247).

44 This is precisely the process that Jevons envisaged in the discovery of the forms of clouds:

> In proposing, as I think, a fresh and original theory of the thunder-cloud, I am not unaware of its crudeness. Whether by others or myself, a *quantitative* estimation must be made of the forces and velocities upon which it so entirely depends; having suggested that the form of the thunder-cloud is a simple mechanical phenomenon, it will remain a mere suggestion until it is presented as a rigorous mathematical theorem. The simplicity, however, of the principles involved, naturally inspires much confidence that this may be achieved.
>
> ('On the Forms of Clouds', 1858, p. 252)

45 The recommendation involved gathering observations on a variant and a variable ('by a well-conducted experiment'), and attempting to determine 'what mathematical function the variant is as regards the variable' (*PS,* p. 483).

46 'Suppose, for instance, that there is some cause which alters the dimensions of a body in the ratio of 1 to 1+ , and another cause which produces the alteration in the ratio of 1 to 1+ . If they both act at once the change will be in the ratio of 1 to (1+)(1+) or as 1 to 1+ + + . But if and be both very small fractions of the total dimensions, will be yet far smaller and may be disregarded; the ratio of change is then approximately that of 1 to 1+ + , or the joint effect is the sum of the separate effects' (*PS,* p. 478; cf. pp. 336, 475).

47 Thus, he observed, economic effects are frequently 'simply added together algebraically, and are inextricably merged into a general total'. The total number of poor relief recipients, for instance, was the result of trade fluctuations, seasonal variations, and legislative interference ('Experimental Legislation and the Drink Traffic' [1880], *MSR,* pp. 264–65).

48 Morgan maintains that 'Jevons even hoped statistics could be used to obtain the numerically precise (or 'concrete') laws thought to be typical of good physical science' (1990, p. 3).

49 Jevons's experiments on fatigue, described in Note 37, yielded a 'fair degree of approximation' and thus 'a presumption in favour of its being a true function'. Subsequently, Jevons discovered that the purely empirical law followed from Professor Haughton's theoretical explanation (*PS,* p. 490).

50 This was especially the case in economics, where 'Human life may be subject at different ages to a succession of different influences incapable of reduction under any one law. The results observed may in fact be aggregates of an immense number of separate results each governed by its own separate laws, so that the subjects may be complicated beyond the possibility of complete resolution by empirical methods' (*PS,* p. 501).

51 Cf. Schabas: '[Jevons] constantly reminded his readers that science could never grasp more than a small fraction of the goings-on in nature' (1990, p. 135).

52 But see Jevons's caution against hasty inference based on analogy in 'The Railways and the State' [1874]: 'analogies are very dangerous grounds for inference, unless carefully founded on similar conditions' (*MSR,* p. 354).

53 See Jevons's definition of a 'function' in this passage: 'Any quantity, then, which depends upon and varies with another quantity may be called a function of it, and either may be considered a function of the other' (*PS,* p. 489). This is curious in the context of the discovery of a law, for it implies that causality can always run in either direction.

54 This treatment raises an issue originating with David Hume, that has been termed 'the asymmetry between induction and deduction, between proving and disproving, between verification and falsification, between asserting truth and denying it' (Blaug 1980, p. 13; cf. p. 14). Modern procedures for statistical inference approach the problem in terms of Type I and Type II errors: mistakenly rejecting H_0, and mistakenly accepting H_0.

55 Mere collections of data did not, Jevons insisted, constitute statistical information, since facts required explanation. See the Report of Committee appointed at the BAAS meeting of Liverpool, 1870, consisting of Jevons, R.Dudley Baxter, J.T.Danson, James Heywood, Dr. W.B.Hodgson, Professor Jacob Waley, and Edmund Macrory: 'for the purpose of urging upon Her Majesty's Government the expediency of arranging and tabulating the results of the approaching Census in the

three several parts of the United Kingdom in such a manner as to admit of ready and effective comparison' (JA6/42/1).

56 Cf. *PS,* pp. 334, 481. Improperly arranged facts hindered scientific reasoning: 'Large tables of figures are but a mass of confused information for those casually looking into them. They will probably be the source of error to those who pick out a few figures only' ('The Variation of Prices and the Value of the Currency since 1782' [1865], *ICF,* p. 120). Tooke and other early researchers were unable, Jevons argued, to elicit the uniformities underlying their masses of unarranged data.

57 Jevons's emphasis, however, is clearly upon increased precision as opposed to the addition of causes or the alteration of the causal framework.

58 Verification for Jevons extends beyond Machlup's sense of reconciliation of data with the hypothesis (in Hausman 1984, p. 98), to encompass a continuing process of revision rendering hypotheses more and more precise. For a somewhat different view, see Mays, who argues that Jevons's method is essentially Popperian, consisting of the choice and testing, or 'trial', of probabilistic hypotheses, and suggests that the Jevonian scientist goes beyond the study of data for regularities: 'Jevons's conception of scientific method is surprisingly modern. As is the case with some contemporary methodologists, for example, Karl Popper, he was highly critical of the Baconian theory of induction.… For Jevons the essence of the inductive process consists in the invention and the successive trials of hypotheses' (1962, p. 225).

59 White (1989) has distinguished between Jevons's marginalist theory and his laws of supply and demand, based on 'facts'. I suggest that this distinction between theory and application holds generally in Jevons's methodology.

10
JEVONS'S EMPIRICAL STUDIES

1 Aldrich (1987) has suggested that some of Jevons's techniques for empirical work in economics, in particular those designed to deal with periodicity, were appropriated from physical sciences, such as meteorology.

2 This is not an exhaustive review of Jevons's empirical studies in economics. Specifically, the investigation of muscular activity described in Chapter 9, is omitted. In addition, two early and impressive studies of periodicity which rely on methods similar to those described on pp. 195–201 and 201–203, 'On the Study of Periodic Commercial Fluctuations' [1862; *ICF,* pp. 1–2] and 'On the Frequent Autumnal Pressure in the Money Market, and the Action of the Bank of England' [1866; *ICF,* pp. 160–93] are not investigated in detail.

3 See Morgan's evaluation concerning early developments in econometrics: The role of mathematics was to aid in the task of deductive theorizing, whereas the role of statistics was to help in the empirical task of measuring economic laws, verifying or testing theories, and even suggesting theories' (1988, p. 200). Aldrich also argues that Jevons's use of the King-Davenant data was designed to complement the mathematical equations in the *TPE* (1987, p. 238). See p. 195, p. 203 and pp. 205–10, however, for examples of empirical work that served rather a different purpose than complementing the mathematical equations developed in the *TPE.*

4 Many commentators have been impressed by Jevons's work on index numbers. See Fisher (1922), Hutchison (1978, p. 101), and Blaug, who suggests that Jevons 'probed deeply into the problem of index numbers' (1962, p. 316).

5 The long run value of gold is said to be determined by its cost of production. See 'Bimetallism' [1881], *ICF,* p. 318; the correspondence with Cairnes of 2 June 1863; *P&C,* **iii,** p. 20; *ICF,* p. 71; *Primer,* p. 106; and *MME,* p. 82. Bordo (1975) argues that the underlying rationale for the studies by both Jevons and J.E.Cairnes was a defence of a quantity theory of money in the face of criticisms by contemporary analysts, such as William Newmarch, who had argued that the gold influx would increase income (pp. 354–57); cf. Goodwin (1970), Sayers (1933) and (1935), and pp. 210–12 below for further discussion.

6 We have seen in Chapter 5 that Jevons accepted the proposition that values conform to costs of production in the long run. Thus, as Black maintains, there is no paradox between Jevons's subscription to a quantity theory and his value theory: 'any such paradox is more apparent than real. For Jevons saw the problem of changes in the value of money as essentially a long-term one, and in the long run he fully accepted "that value is proportional to the cost of production"' (1981, p. 19).

7 Jevons was not facing a new problem. In 1817, David Ricardo reasoned, 'If I found that an ounce of gold would exchange for a less quantity of all the commodities above enumerated, and many others; and if, moreover, I found by the discovery of a new and more fertile mine, or by the employment of machinery to great advantage, a given quantity of gold could be obtained with a less quantity of labour, I should be justified in saying that the cause of the alteration in the value of gold relatively to other commodities was the greater facility of its production, or the smaller quantity of labour necessary to obtain it' ('On the Principles of Political Economy and Taxation', *The Works and Correspondence of David Ricardo,* **i,** p. 18).

8 In 'The Variation of Prices, and the Value of the Currency since 1782' [1865], Jevons reiterated that 'the price of each commodity and group of commodities varies both from causes peculiar to each commodity, and from causes affecting gold, the measure of value. The latter are common to all, and their effects are more or less completely shown in the general variation of the price of all commodities' (*ICF,* p. 128); cf. 'price may be affected either by circumstances attaching to the commodity itself or to the measure of value in which it is estimated. Thus, if we first distinguish causes of variation according as they affect the supply or the demand for the commodity, there will obviously be four heads—namely, causes affecting (1) supply of a commodity, (2) demand for commodity, (3) supply of measure of value, and (4) demand for same' (*PE,* p. 149).

9 'A searching inquiry into the conditions of supply and demand of every article would result in every one being thrown out as unworthy of reliance as a measure of the value of good. It is only by ignoring all these individual circumstances, and trusting that in a wide average, such as that of 118 articles, all individual discrepancies will be neutralized, that we can arrive at any conclusion in this difficult question' (*ICF,* p. 58).

10 Edgeworth explicitly outlined the assumption required here: 'when the conditions of each observation are such that, if an indefinite number of observations under the same conditions were taken, the number of those which err by exactly *(plus* or *minus) x*' is proportionate to

$$\frac{1}{\sqrt{(\pi c)}} e^{-x^2/c^2}$$

(1883, p. 715). In 1925, Edgeworth conceded that observations of relative prices were not independent (p. 564).

11 Aldrich (1987, pp. 240–41) has suggested that *ASF* is flawed because it failed to integrate the measurement and causation sides of Jevons's argument, a flaw which is said to be remedied in Jevons's 1869 letter to *The Economist,* 'The Depreciation of Gold'.

12 Jevons's calculation of these odds is confused. The qualitative result, that the odds are an increasing function of the number of goods whose price varies, is, however, correct.

13 Data for 1844 were unavailable, and consequently Jevons used an average for 1845–50. He also constructed ratios of the yearly averages to the six-year average in order to represent the proportional variation attributable to cyclical influences (*ICF,* p. 43). In the 1862 'Study of Periodic Commercial Fluctuations', Jevons noted that the 'revolution of the seasons' also affected industry and commerce, and argued that 'we must allow for what is due to this cause before we can learn what is due to other causes' (*ICF,* p. 3; cf. p. 6, and 'On the Frequent Autumnal Pressure in the Money Market', *ICF,* pp. 165f).

14 'The principle I adopted, therefore, was to try all systems of classification which seemed to be founded on any material distinctions; in short, to try as many different systems as I could, and then to adopt any which seemed to elicit important information' (*ICF,* p. 126). It proved impossible to classify most goods according to the location of production, since many were grown in several areas. 'The natural and impassable division of tropical and temperate regions', however, provided an exception, and Jevons considered goods produced in those areas separately (p. 127).

15 The arithmetic mean, by contrast, is (200+50)/2=125, which incorrectly, in Jevons's mind, shows a 25 per cent average rise in price (*ICF,* p. 23).

16 An additional reason to rely on the geometric mean, Jevons argued, is that the calculated price increase was more marked using the arithmetic than using the geometric mean (*ICF,* p. 122). Thus his desire to be cautious, and to understate his results, may also have influenced this choice.

17 S.Stigler (1982) notes that among the reasons Jevons provided for the geometric mean, was the statistically sound one that prices might be disturbed multiplicatively. My own impression is that Jevons relied on intuition, the desire to present his results using logarithmic diagrams, and his conviction that working with economic data entailed using ratios, as opposed to absolute numbers. See his remarks concerning the usefulness of logarithmic diagrams, which 'furnish the true mode of representing all statistical and other numbers of which the ratios, not the absolute amounts, are in question' (*ICF,* p. 128, note). For an appreciative account of the logarithmic diagrams, see Field (1917).

18 Mitchell argues that Jevons 'tested his result' with the larger sample (1928, p. 195; cf. Fisher 1922, pp. 459, 468). Yet the argument for including more goods in the study is problematic, since one would expect that agricultural outputs are highly correlated. To address this, Jevons attempted to choose items 'mostly distinct' from those in his smaller sample, and 'likely to vary independently of them and of each

other' (*ICF,* p. 50). He never elaborated, however, on the criteria used to ensure this approximate independence. See Appendix 10.1 for Jevons's sample commodities.

19 Leslie's argument in this context was that the rate of change of prices varied across England and the world: 'Beef, mutton, veal, butter, eggs, and poultry, for example, have risen about twenty-five per cent, in the London market; but they have risen a hundred per cent, above their rates a few years ago in the inland parts of Ireland and Scotland on the new lines of the railway' (The Distribution and Value of the Precious Metals in the Sixteenth and Nineteenth Centuries' [1864], 1879, p. 277). See pp. 210–12 for a detailed discussion of Leslie's objections to Jevons's method.

20 'The average then must in all reasonable probability represent some single influence acting on all the commodities' (*ICF,* p. 156).

21 This is the only instance in Jevons's research of explicit reliance on least squares methods and probabilistic inference. S.Stigler (1982, p. 362), has remarked on the 'anomaly' that Jevons's use of least squares was so infrequent, given the accolades to the method in *PS,* described on pp. 187–88. In fairness to Jevons, however, one must note that the problems with which he dealt did not always lend themselves readily to least squares (see Note 36).

22 This argument is similar to that in a recent analysis by Bostaph and Shieh, who suggest that in the investigation of corn prices, Jevons derived a 'curve connecting time series data to present a 'law of variation of price' generated by supply changes, and assuming a fixed long-run market demand' (1987, p. 121). The authors cite the opening remarks to *ASF,* that 'an article tends to fall in value as it is supplied more abundantly and easily than before, is a most familiar fact' (*ICF,* p. 15), as support for their argument.

23 In response to critics who argued that price rises had been caused by ongoing increases in demand, Jevons maintained, 'to a similar extension of trade and manufactures generally must be attributed the *fall of prices* between 1820 and 1850. Similar causes have similar effects. He *who allows prices to have risen since 1850, but denies it to be the effect of the gold discoveries, must point out something else in the progress of industry since 1850 entirely different and contrary to the progress before;* otherwise it is natural to point to these gold discoveries as that which has entirely altered the course of prices' (*ASF,* Note C; *ICF,* p. 111).

24 Jevons estimated an average price rise. If true price changes are normally distributed, the correct interpretation is that 9,999 times out of 10,000 sampling procedures will yield an estimated price change that is positive; the cause of the alteration cannot be inferred.

25 Keynes was highly critical of the assumption that errors 'cancel' in this context. See pp. 210–12 for a more detailed examination of his criticisms.

26 For a discussion of Jevons's response to Cairnes's remarks on this issue, see pp. 210–12.

27 As S.Stigler points out, Jevons used several different techniques in these studies to demonstrate the robustness of his result (1982, pp. 361–62). This is true also of his examination of coin weights in Britain, the subject of pp. 201–204.

28 Cf. 'there exists a regular system, whereby the older coins are continually returned into the hands of the public, and the new heavy coins alone are remitted to the Bank of England, and to those who would melt or export them. The lightness of a coin is

so far from being a reason why it should be withdrawn from circulation, that it is the very reason why it is retained in it' (*ICF,* p. 279).

29 Elsewhere the practice is called *'picking and culling'* (*ICF,* p. 278).

30 As Kim (1995) has argued, this estimation did not require the use of least squares techniques, since Jevons is interested in a single parameter, the rate of wear, which can be estimated simply using the method of means. But a least squares estimate should have been preferred on the grounds of precision of the estimate, to which Jevons paid little attention in this context.

31 Cf. 'The fact that some of the older coins are still of legal weight does not prevent the age from serving as a criterion of *average* weight, because such old and heavy coins are balanced by an equivalent of new coins which by some accident are light. My own weighings show that 10 per cent, of the sovereigns of 1850– 67 are below the limit of legal currency' (*ICF,* p. 288).

32 He reminds the reader, however, that Jevons's defence of his technique 'was not accompanied by a conceptual structure' for combining price data ensuring that measurements are made 'under conditions that could be viewed as identical, or as differing only in ways that could be allowed for in the analysis' (1986, PP. 4–5).

33 Charles Davenant [1656–1714] described the first demand schedule in his 'Essay upon the Probable Methods of Making a People Gainers in the Balance of Trade' [1699]. The schedule, relating the price of corn to different harvest sizes, is sometimes attributed to Gregory King [1648–1712], but Jevons asserted that he could find no mention of the schedule in King's work. Jevons complained that 'It is very curious that in this subject, which reaches to the very foundations of Political Economy, we owe more to early than later writers' (*TPE,* p. 153).

34 Bostaph and Shieh (1987) argue that the procedure entailed estimation of a long run demand curve, whereby supply variations occur and tastes are fixed. This is consistent with Jevons's argument in *PE,* cited in Note 35. Creedy (1986) maintains that Jevons believed the Davenant law of demand was based on observations, although William Whewell had shown it to be probably hypothetical. He has also demonstrated that the method of differences can be used to fit the schedule to a functional form, yielding a cubic formula. Jevons was apparently unaware of this hint in Whewell (1992, pp. 9–17). See also White (1989, p. 434).

35 Cf. Jevons's remarks in *PE:* 'Assuming the demand to be constant, in the sense that there is a constant population of purchasers with fixed tastes, we should make the supply of commodity—say, wheat, sugar, or tea—the *variable,* and then ascertain the changes of price, the variant' (p. 146).

36 As Creedy points out, the equation is non-linear in the coefficients, so that estimation of *a, b* and *n* would have been difficult (1992, p. 11). Jevons's recommendation, outlined on pp. 189–90, whereby a polynomial of degree 1, 2 or 3 was to be fit to the data using least squares, thus did not apply in a straightforward way. Aldrich argues that Jevons probably transformed the data and used linear least squares to make these estimates (1987, pp. 250–51). Jevons did not, however, describe in detail how his estimates were obtained, and it seems unlikely that he applied least squares in this context. For a recent, plausible, explanation of how Jevons's estimates were obtained using simple numerical techniques, see S. Stigler (1994, pp. 187–88; the technique is reproduced in Appendix 10.3).

37 Creedy has estimated the function using a maximum likelihood iterative procedure. He obtains values for *a, b* and *n* equal to 2.299 (±0.505), −0.631 (±0.110) and 4.

736 (±0.384), where standard errors are in parentheses. The estimated demand curve is then p_c=2.299/(q_c+0.631)$^{4.735}$ (1992, pp. 13, 17). The choice of 2 for the exponent was incorrect, and the parameter *b* is negative, which implies that the curve in fact does intersect the ordinale. Jevons's initial assumptions, then, steered him in the wrong direction in his attempt to fit data to an empirical curve.

38 Oddly, in the second edition Jevons moved to a 'rough' approximation of the relationship: 'Roughly speaking, the price of corn may be said to vary inversely as the square of the supply, provided that this supply be not unusually small' (*TPE,* p. 158), a position which is attributed to Whewell.

39 See White (1989) for a discussion of these simplifications.

40 Jevons's interest in studying periodic phenomena is evident as early as 1862, when he argued that 'Every kind of periodic fluctuation, whether daily, weekly, monthly, quarterly, or yearly, must be detected and exhibited, not only as a subject of study in itself, but because we must ascertain and eliminate such periodic variations before we can correctly exhibit those which are irregular and non-periodic, and probably of more interest and importance' ('On the Study of Periodic Commercial Fluctuations', *ICF,* p. 4). At some point in his career, he became convinced that periodic fluctuations in commerce were, in fact, more interesting than irregular fluctuations.

41 See the 1934 attempt to reconcile psychological and solar phenomena by Garcia-Mata and Shaffner.

42 Two exceptions to this were noted: the Black Death, as well as secular changes in real wage rates (*ICF,* p. 197). Significant causes other than those underlying the decennial fluctuation created worse problems for more recent price series:

> It might seem easy to decide whether any such dependence exists or not by taking tables of prices, such as those given in Tooke's 'History of Prices', and observing whether there is any tendency to fluctuate in a similar manner at intervals of eleven years. During the last hundred years, however, the prices of grain and all other commodities have been greatly affected by all kinds of political and social events. There have been great wars, great industrial discoveries, and great inventions. The currencies of the principal nations have been, at two or more distinct times, revolutionised by the introduction of paper currency, which, by driving out specie, has produced enormous fluctuations in the values of the precious metals.
> (*ICF,* p. 195)

43 'As, indeed, the sun-spot period is believed to be more nearly of a length of 11.11 years than exactly eleven years, it was requisite in arranging the prices to omit one year's quotations in the course of the one hundred and forty years' (*ICF,* p. 197). See Aldrich (1987) for discussion of a contemporary criticism of the technique.

44 Minimum prices, however, did not seem to conform so readily to Jevons's theory, leading him to suggest 'that it is remarkably high rather than remarkably low prices which manifest a tendency to periodical recurrence' (*ICF,* p. 202).

45 'I do not venture to assert positively that the average fluctuations as given in the preceding tables are solely due to variations of solar power. They seem to show that the subject deserves further investigation' (*ICF,* p. 203).

46 Having omitted these years from the calculation, Jevons found the averages were not much altered. For this reason, and because he believed the famine was itself caused by solar variations, he retained the observations (*ICF,* p. 200).

47 Jevons later acknowledged that 'Subsequent inquiry convinced me that my figures would not support the conclusion I derived from them, and I withdrew the paper from publication. I have since made several attempts to discover a regular periodicity in the price of corn in Europe, but without success' ('On the Periodicity of Commercial Crises and its Physical Explanation' [1878], *ICF,* p. 207).

48 Morgan argues that this is why Jevons's work on fluctuations deserves attention: 'he relied on evidence of uniformity in statistical data, from which a general theory was derived using inductive reasoning' (1990, p. 26).

49 An 1882 Postscript to this paper provided additional evidence of the decennial nature of cycles, using bankruptcies in England and Wales from 1867 to 1881 (*ICF,* p. 220).

50 See Jevons's letter to W.Vissering, requesting evidence for Holland (8 February, 1878; *P&C,* **iv,** p. 225).

51 'But we must not suppose that things are the same all over the world as they are in England, or in Western Europe' (*ICF,* p. 216).

52 This subject was, Jevons argued 'altogether too new and complicated to take the absence of variation in certain figures as conclusive negative evidence. The distinct and unquestionable tendency to a decennial period shown in these curves [of British exports to India] seems to me an important corroborative fact' (*ICF,* pp. 218–19).

53 Jevons reiterated that European cereal crops 'depend for their success on very complicated conditions, so that the solar influence is disguised' *(ICF,* p. 231). As noted on p. 62, the sunspot work is problematic, since Jevons first discarded, and then retained, weakly established crisis years. See Mitchell (1928, p. 384).

54 'Yet the accounts of the merchandise (not including bullion) exported by the English East India Company between the years 1708–9 and 1733–34 display a wonderful tendency to decennial variation, as is apparent on examining with care the diagram representing these statistics' (*ICF,* p. 232).

55 Cf. Jevons's remarks to T.E.Jevons, of 31 March 1879, referring to the 'required keystone to my commercial crisis theory', the 'wonderful periodicity' of Indian corn prices (*P&C,* **v,** p. 36).

56 For a review of criticisms of the sunspot studies, see Morgan (1990, p. 23). Particularly amusing is an unsigned 1879 article alluded to in Chapter 3, by Richard Anthony Proctor, published in the Journal of the Royal Statistical Society, entitled 'University Boat Races and Sun-Spot Cycles', which attempted to explain the periodicity of race victories by Cambridge using sunspots (see *P&C,* **v,** pp. 51–52).

57 The notion that a cause follows an effect is also key. Thus, as we have seen on p. 200, Jevons argued that as long as a rise of prices followed the gold inflows, this was grounds for inference of causality.

58 In 1878 Jevons openly confessed to being biased in this respect: 'I am free to confess that in this search [for decennial crises] I have been thoroughly biased in favour of a theory, and that the evidence which I have so far found would have no weight, if standing by itself ' ('Commercial Crises and Sun-Spots', *ICF,* p. 228).

59 In his 1879 Review of *TPE,* Leslie made a similar criticism of Jevons's work with the Davenant data: 'Could we even get accurate statistics of the harvests of the world, it would be found that its price is affected by so many other conditions that it bears no constant mathematical ratio to the amount of supply' (*P&C,* **vii,** p. 161). Leslie maintained that improved transportation methods affected prices differentially, counteracting the gold effects on tropical goods; see Sayers (1933).

60 'The actual situation of matters in England is, then, that a number of causes, of which the new gold is only one, have raised the cost of living' (Leslie 1879, p. 354). Leslie was, however, very much in favour of the marriage of statistics and economics, which, he hoped, would facilitate careful study of causal relationships: 'if statisticians have often been content to collect phenomena without heed to their laws, economists more often still have jumped to the laws without heed to the phenomena; if statistics have lain chiefly in the region of dry figures and numerical tables, economics have dwelt chiefly in that region of assumption, conjecture, and provisional generalization' ('Economic Science and Statistics' [1873]; 1879, pp. 377–78).

61 It should be remarked that while Jevons stood by his use of empirical methods in economic research, he objected early in his career to the overuse of the method of means in meteorological contexts: 'while fully admiring the method of investigation by *mean results,* I must object to the almost exclusive employment of it which now seems usual in meteorology and some other sciences' ('On the Semidiurnal Oscillation of the Barometer' [1859], p. 314). He called for further theoretical investigation into the causes influencing barometric oscillations, before statistical work could proceed: 'The further prosecution of this problem belongs rather to the mathematician than the meteorologist'; 'Eventually we may hope that an endless variety of facts, only apparently capricious, will be made to harmonize together under a simple mechanico-mathematical theory, and the science of the atmosphere will be raised to a new position' (pp. 322, 323).

62 Keynes described the method thus:

> For the purpose of isolating 'changes on the side of money' they [Jevons, Bowley, and Edgeworth] employ the Doctrine of Averages based on the Theory of Probability. If we take enough unbiased observations of individual prices, their relative movements will, it is argued, cancel out in accordance with the law of error, and we shall be left—subject to a probable error calculated in the usual way—with a reasonably satisfactory index of the residual movement of the price-level itself which is our quaesitum…; We have, in short, to this way of thinking, a typical problem in the combination of observations, where each individual observation is subject to a disturbing factor which it is our business to eliminate.
>
> (Keynes 1930, pp. 82–83)

63 Keynes was also concerned with the distributional assumptions underlying the choice of (arithmetic, geometric, or harmonic) mean (1930, p. 84). Cf. Keynes (1921, pp. 234–38).

64 Cairnes's investigation of the gold question was theoretical, in contrast to Jevons's empirical method (Hirsch 1978); he maintained that the fall in the value of money

need not be uniform; see Bordo (1975, pp. 338–40). In opposition to Jevons, Cairnes argued that the relative stability of tropical prices resulted from the relatively undeveloped credit institutions there; see Sayers (1933). See the correspondence between Cairnes and Jevons on this matter: Cairnes to Jevons, 28 May 1863 (*P&C,* **iii,** pp. 16–18); Jevons to Cairnes, 2 June 1863 (pp. 19–22); Jevons to Cairnes, 3 June 1863 (pp. 22–23); and Cairnes to Jevons, 4 June 1863 (pp. 23–25). Cairnes's general appraisal was highly favourable: 'Indeed, considering the entirely distinct methods of inquiry we have pursued, and our complete mutual independence, I have thought the coincidence of sufficient importance to call attention to it in the columns of the *Economist'* (*P&C,* **iii,** p. 18); Cairnes cited Jevons in his introduction to his *Essays in Political Economy,* p. 41. See Black (1960) for evidence of Jevons's respect for Cairnes.

65 See Kim (1995), Prasch (1994, p. 30), and White (1989, p. 436).

66 See the letter from Fawcett to Jevons, dated 1 October 1863 (*P&C,* **iii,** pp. 44– 45), as well as the account of a newspaper controversy arising from Fawcett's citation of Jevons's work (pp. 36–37). Jevons did not use 'many hundreds' of observations; in ASF, he used 39 and then 118 goods; see Appendix 10.1 for the commodities included in the large sample.

11
CONCLUSION

1 It is not merely that which goes into the eyes and ears of a student which educates him; it is that which comes out. A student may sit on the lecture-room benches and hear every word the teacher utters; but he may carry away as much useful effect as the drowsy auditor of a curate's sermon. To instruct a youth in gymnastics, you do not merely explain orally that he is to climb up one pole, and come down another, and leap over a third. You make him do these motions over and over again, and the education is in the exertion. So intellectual education is measured, not by words heard or read, but by thoughts excited.

(*MSR,* pp. 91–92)

2 Many adjectives have been applied to Jevons's economics. But S.Stigler's (1982) description of Jevons's statistical procedures as 'thin' and 'bright' best reflect, perhaps, my own conclusion that his economics is characterized by a distinct lack of connections.

3 See, for example, the titles in the section of the Bibliography covering Secondary Sources Relating to Jevons, including, but not limited to, Black (1972a, 1972b, 1972c, 1990); Bostaph and Shieh (1986, 1987); Ekelund and Shieh (1989); Kenton (1971); Laidler (1982); Mays (1962); Paul (1979); Peart (1990a, 1990b, 1991, 1993a, 1995, 1996; Reid (1972); Steedman (1972); Stewart (1989); Stigler (1982); and White (1989, 1991a, 1991b, 1994b, 1994c).

4 See the exchanges between Hutchison and White (Hutchison 1984; White 1984), Bostaph and Shieh, and White (Bostaph and Shieh 1987; White 1989), between White and Samuels (White 1991a; Samuels 1991), and between White and Peart (White 1994a; Peart 1994a).

5 The evaluation by Winch, which suggests that the Marginal Revolution entailed a narrowing of focus (see Chapter 1; Winch 1972, p. 342), is thus confirmed.
6 See the categories listed in the *JEL*.
7 This narrowing of training has caused some concern recently among the economics profession. See, for example, Bateman (1992), Kasper (1991), Krueger (1991), and Peart (1994b).
8 There is no way of knowing whether Jevons had completed most of his life's work by 1882, having a flame 'less steady and pale' at the close of his career, as Keynes argued (1933, p. 304), or whether Jevons would have been able to do justice to the 'work of his life', had he lived. Higgs argued the latter case in the Preface to *PE* (p. v), while Foxwell made a similar argument in his introduction to *ICF* (p. xix).
9 Mirowski's perspective is that 'in the theory there never is any feedback in the economic system from market processes to the underlying value determinants (that is, the utility functions or given endowments), which are then portrayed as 'natural' or 'exogenous to the analysis' (1988, p. 101). Accordingly, economics became 'indifferent to history, because it posited its goal as deterministic and hence fully reversible equations' (1989, p. 201).
10 This may explain why Jevons's policy has been interpreted so differently: he is regarded as fundamentally non-interventionist (Mirowski 1988); and as having initiated a trend towards increased intervention (Bladen 1959).
11 On the role of hypothesis testing, see Blaug (1980); for review of some of the assaults against data mining, as well as a rare defence of the procedure, see Hoover (1994).

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