

Piero Sraffa and the Production of Commodities by Means of Magic

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Abstract

Piero Sraffa's *The Production of Commodities by Means of Commodities* is the seminal attempt to create a physical, rather than a social, numeraire to measure the price of commodities. Sraffa's physical numeraire is predicated on the physical identity and, therefore, direct commensurability of inputs and outputs. It is considered to be the viable alternative to Ricardo and Marx's social numeraire that used labour time to measure the value of incommensurate inputs and outputs. Sraffa's assumption of the identity of inputs and outputs contradicts the essential nature of the production process itself, where human activity changes one set of inputs into a different, and therefore incommensurate, set of outputs. This false premise underpins every critique of labour value theory, including from Samuelson and Steedman. Paradoxically, Sraffa's assumptions also underpin the work of Marxists, notably Freeman and Kliman, who attempt to defend labour value theory in models where it does not apply.

Keywords

Labour theory of value, Marx, physicalism, political economy, Ricardo, Sraffa, transformation problem, TSSI

Introduction

In 1951 Piero Sraffa, the Italian economist and editor of David Ricardo's collected works and correspondence, aimed to "get rid of the problem of value" (Kurz and Salvadori, 2000: 12). Sixty years later, Steve Keen concluded his wide ranging and very popular critique of the mainstream, *Debunking Economics*, by asserting that it was best to consider Marx "without the labour theory of value" (2011: 439). The labour theory of value was a "dead end"; it was better to "forget the whole question of 'where does the surplus come from?'" (2011: 429) or by implication what the "surplus" is, or even whether it exists at all. There is no reason to be either so dismissive or so pessimistic: a

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re-examination of the original arguments around the development of the labour theory of value, alongside the assumptions used to reject it, demonstrates its ongoing purpose and usefulness.

Sraffa, Ricardo and Malthus

Sraffa “got rid” of the value problem by developing a version of David Ricardo’s “corn model”, that originated in Ricardo’s 1815 *Essay on Profit*. In the agricultural sector, Ricardo argued, corn was both the only input and the only output of production. Wages were paid in corn, seed was sown in corn and output was measured in corn. As a result, inputs and outputs were commensurate, they had the same physical identity, and so the value of output and the rate of profit could be measured directly in physical terms as a ratio of quantities of corn. According to Sraffa, although “this argument is never stated by Ricardo in any of his extant letters and papers, he must have formulated it either in his lost ‘Papers on the profits of Capital’ of March 1814 or in conversation [with Malthus]” (in Ricardo, 1951–73: xxxi). Thomas Malthus replied to Ricardo by simply pointing out that, “In no case of production, is the produce exactly of the same nature as the capital advanced” (Malthus to Horner, 14 March 1815, in Ricardo, 1951, VI: 187). Since the production process transforms a physical set of inputs into a different physical set of outputs, this means that inputs and outputs are incommensurate and so cannot be measured physically. Ricardo answered Malthus’s point by accepting it.

Just two years later, in his 1817 *Principles of Political Economy and Taxation*, Ricardo adopted and developed a version of the labour theory of value as described in Adam Smith’s *Wealth of Nations*. The incommensurability of physical inputs and outputs, their transformation from one thing into another different thing during the production process, was the essential premise for the entire labour theory of value. The chronology is important, for Sraffa rejects Ricardo’s labour value theory to resurrect a version of the physical corn model that Ricardo rejected himself. In other words, he returns to Ricardo before he was a Ricardian.

Ricardo explains in the *Principles* opening chapter, “On Value”, that useful commodities may acquire their value either from their cost of production or from their scarcity. However, scarcity only applied to that very small minority of commodities that were not manufactured, like rare wines and statues, pictures, books and coins. Most commodities are not scarce at all but rather produced “almost without any assignable limit” (1990 [1817]: 12). Commodities are produced by people to satisfy a need, demand or utility, but utility is a subjective measure that cannot be aggregated. Rather, Ricardo argued, the property that renders different commodities commensurate is the amount of labour time necessary for their production. It is the quantities of direct and indirect labour necessary for commodities’ production that determined their exchange value or price: surplus product and social capital can be measured in terms of embodied labour.

Sraffa later remarked that the difference between the physical and the labour cost of production was that the labour cost does not include “the natural resources used up in the course of production (such as coal, iron, exhaustion of land). ... This is fundamental because it does away with ‘human energy’ and such metaphysical things” (in Martins, 2014: 17). Sraffa’s disagreement on this point was fundamental and quite wrong. Ricardo’s system did not do away with the use of natural resources; rather it simply asserted that their value was determined by the labour time required for their production. Nonetheless, Sraffa’s insistence on this was the rationale for the development of his alternative physical price system, and for his reversion to Ricardo’s 1815 position. Labour may have been metaphysical or even metaphorical in the hushed and hallowed halls of Cambridge University (Sraffa was notoriously tardy in producing any work) but, for the actual ordinary producer, labour is very real: it is their productive activity that transforms useless inputs into, necessarily different, useful outputs.

In 1820 Malthus, eclectic as ever, developed a critique of Ricardo which was based on the very corn model that he had caused Ricardo to reject. Malthus used quantities of corn to represent physical quantities of embodied labour (De Vivo, 2012: 106–7). Malthus pointed out that, against the precepts of Ricardo's value theory, capital did not earn profits in proportion to the amount of labour it employed. Malthus demonstrated that if the value added by labour and the cost of its wages was constant, then there was a contradiction between the determination of price by value added in production and value commanded on exchange or between value and price. This point was not so easily dealt with. Ricardo responded by attempting, but ultimately failing, to create an invariable measure of value. Sraffa noted that for Ricardo "to the determination of value by embodied labour there corresponds an invariable measure in the shape of a commodity produced by a constant quantity of labour; and in so far as there are exceptions to the theory, to the same extent the accuracy of the measure is affected" (in Ricardo, 1951–73, I: xli).

The divergence of values from prices and of profits from surplus value seemed to fatally conflict. On the one hand the production of commodities for exchange on a market required the labour theory of value to ensure their commensurability, while on the other hand it required that capitals had the right to an equal rate of profit as market exchange was predicated on the exchange of equivalents.

Marx

Marx realized that Ricardo's invariable measure of value was simply another name for a concept of the nature of value itself. Value was not to be seen as a physical thing, another commodity against which value could be measured, but as a set of social relationships. Labour was embodied in commodities during the production process, but the measure of that value was not that embodied quantity of labour, but in its social average. Gold, the symbol of value in an economy based on commodity production, was a measure of value only because it itself had a cost, i.e. the socially necessary labour time required for its production. This was no invariable standard of value but rather a variable one, a relative measure that changed according to its own cost and the cost of every other commodity against which it was measured.

Marx (1861–63) criticized physical value measurements in a discussion of Robert Torrens. Torrens rejected Malthus' insistence that value was distinct from physical output, and resurrected Ricardo's corn model, to claim that if a quantum of corn increased from 100 quarters to 120 (assuming no change in prices) profit was equal to the physical surplus of 20. Marx criticized this procedure as firstly, and most basically, any corn used as an input was transformed into a different output – even if that output took the same physical form – through the production process. Secondly, following Malthus, he pointed out that in addition to corn "various chemical ingredients supplied by the manure, salts contained in the soil, water, air, light, are all involved in the process" of production, so that the physical quantities of inputs and outputs were incommensurate. Thirdly, as prices could change, 90 quarters of corn could have a higher value than 120. Finally, "even considered physiologically, as use-value, his example is wrong since, in actual fact, the 20 quarters of corn which form the surplus product already exist in one way or another in the production process, although in a different form". Simply considering it as a physical example, there is no surplus at all, as the physical quantity of output is simply a different form of the physical quantity of input.

Marx traced the development of commodity production through history from a pre-capitalist form of simple commodity production or circulation, based on small handicrafts, middling farmers and trade, to its modern form as a mode of production of generalized commodity production and exchange. As capitalist production developed and the organic composition of capital rose, so socially necessary labour times systematically diverged from the sale price, as value was

transferred between capitals of different organic compositions to equalize profits. Marx explained that “The exchange of commodities at their values, or at approximately these values, thus corresponds to a much lower stage of development than the exchange at prices of production, for which a definite degree of capitalist development is needed” (1981 [1894]: 276).¹ Marx’s abstractions described the essence of commodity production and exchange, but they also traced the actual historical development of commodity production within previous modes of production, indeed “viewed apart from real history, these abstractions have in themselves no value whatsoever” (Marx and Engels, 1845). In the capitalist mode of production, values, when transformed into prices of production, are set at the price which maintains the capital that financed its production. Values are appreciated or depreciated depending on their composition. This process of transformation creates an average rate of profit based on an appreciated or depreciated price of capital (Fridman, 2014).

In *Capital I*, as there was no transfer of value between capitals to equalize profit rates, Marx assumed that values equalled prices – that in effect every individual capital had the same organic composition of capital. In *Capital III*, Marx showed how the movement of value between capitals to equalize profit rates transformed values into prices of production. Marx provided a famous table in *Capital III*, Chapter 9, to demonstrate this movement. Marx’s table assumed: constant labour values; no depreciation or appreciation of capital values after the redistribution of values into prices of production; equal rates of surplus value; equal wages; equal profit rates, and no change of the structure of production through this transformation. As a result, his final table showed a mix of transformed and untransformed values and prices which meant that, if the output prices were taken as the input prices for the next cycle, the correspondence between the total of price and value, and of surplus value and price, no longer existed.

Marx was obviously aware that in the real capitalist mode of production, input prices were already transformed into prices of production. The idea that Marx forgot to transform the value of inputs into prices of production is a non-sequitur; the purpose of his table was to demonstrate the movement from values into prices. The transformation of values into prices of production does not alter the social laws that Marx describes throughout *Capital*, as even though capitalists do not know, and cannot separate, values from prices of production, they nevertheless must combine quantities of indirect and direct labour together to transform one set of inputs into a different set of outputs, in order to produce commodities for sale on a market and to enable the accumulation of capital to take place. They must reduce costs, i.e. the quantity of socially necessary labour time required for production, and increase revenues the quantity of social labour time commanded on sale, to maximize profits. Nevertheless, Marx’s assumption of constant labour values to illustrate the transformation of values into prices of production meant that his table could be interpreted – and subsequently was interpreted – as representing embodied invariant labour times. This confusion, misreading or misinterpretation was to become a key element in the later attempts to refute Marx’s transformation procedure.

The Classical Interpretation

Eugen Von Bohm-Bawerk, in the first marginalist critique of Marx’s value theory, accepted that “it was true, as Marx had claimed, that two goods must have some common property in order for them to be exchanged for each other” (Howard and King, 1989: 51). Bohm-Bawerk (1975 [1896]) sought to explain why this common property could not be the socially necessary labour time required for the production of a commodity. Rather, it was the use value of the commodity or, if not that, then its scarcity or, if not that, then the fact that commodities were all objects of supply and demand or, if not that, that they were privately appropriated or, if not that, that they were products of nature. Bohm-Bawerk did not direct his criticism at the mathematical basis of Marx’s

transformation procedure – possibly as he understood that unless he could provide an alternative common property to socially necessary labour time, the mathematical limitations or otherwise of Marx's procedure were entirely a secondary matter (1975 [1896]: 70–80).

Rudolph Hilferding, at the age of just 25, wrote the classical reply to Bohm-Bawerk, which centred on this point. Hilferding explained that the total of value can only be compared with the total of price if “though quantitatively different, they are qualitatively homogenous, both being expressions of materialised labour” (1975 [1904]: 161). Hilferding rejected Bohm-Bawerk's argument precisely because use values or the physical form of commodities are not qualitatively homogeneous – only socially necessary labour is. Many things have use value, but have no exchange value or price. While supply and demand may redistribute value, it does not create it; what is a loss for one is a profit for the other in the opposite direction but to the same degree. Private appropriation is necessary, but not sufficient, for commodity exchange. Slaves were privately appropriated and so are the profits of highwaymen. Commodities are precisely not the product of nature, but of human manufacture and production.

Sweezy and Seton

The post-war debate around Marx's transformation procedure began with Paul Sweezy's 1942 revival of Von Bortkiewicz in his *Theory of Capitalist Development* (1970 [1942]). Von Bortkiewicz (1907 [1952]), building on the work of Dimitrev (1974 [1898]), had shown, on the assumption of invariable embodied labour values, that when Marx's output prices were used as input prices in the next cycle of production, the combination of transformed and untransformed values and prices meant that either the total of value diverged from price or the total of surplus value diverged from profits. Von Bortkiewicz considered that this revealed a fundamental flaw in Marx's system itself. But this contribution was essentially ignored at the time. No doubt, as Hilferding's article showed, if physical use values are incommensurate, then the details of the mathematical solution to the transformation model are essentially trivial. Sweezy, a former neo-classical economist, who was won to Stalinism and later to Maoism, suggested that Marx had forgotten to transform the input prices in his table to demonstrate the transformation of values into prices. Sweezy considered whether values could be abandoned altogether, but rejected the possibility on the grounds that the “entire social output is a product of human labour” (1970 [1942]: 129). Marx had of course developed his table precisely to illustrate this point. It would have been entirely illogical for him to transform input values into prices, as this would have violated the essential point of the illustration.

Francis Seton's (1957) critique of Marx's transformation procedure was the origin of the two “invariance postulates”, i.e. that the total of value must equal the total of price and the total of surplus value must equal the total of profit – not as a social average but as an unchanging absolute. While Seton believed that his analysis had vindicated “the internal consistency and determinacy of Marx's conception” (1957: 160), he nonetheless believed that it was possible to replace value coefficients by physical ones and that this would not alter latent prices (1957: 151). It is true that, in a market economy, because value is fungible, both labour and capital or physical output are already valued according to the socially necessary labour time modified by the movement of capital, to create prices of production. But this does not mean that a physical numeraire can replace a social one, for the simple reason that this is no physical numeraire. Or at least that is what was generally believed until Sraffa's seminal 1960 work.

The Production of Commodities by Means of Commodities

Piero Sraffa's 1960 *The Production of Commodities by Means of Commodities* develops a step-by-step refinement of the model that attempts to show how, starting from the most simple form of

two-commodity subsistence economy and ending with a complex economy with multiple producers and goods, it is possible to derive the exchange proportions of goods from their physical proportions alone. Sraffa's model is based on the production of material commodities. It does not attempt to, and indeed could not, cope with services that are consumed as they are produced and therefore have no physical output beyond the moment of production (as not only do services not have a physical equivalent output to inputs but as there is no time in Sraffa's model, so there can be no differentiation between types of output based on time). Nuno Ornelas Martins (2014), a contemporary Sraffaite, notes that the analysis of change would cause Sraffa a "problem" due to the multiplicity of causes and effects. This "problem" was the issue of commensurability. Sraffa's model is predicated upon the identity of physical inputs and outputs. This is the pre-condition for his physical numeraire and his entire model is subordinated to it. As production is of necessity a process of change – one thing being changed into another thing – so Sraffa's model contradicts the essential nature of production: the very thing it models. Sraffa explains that his work does not assume constant returns, as the "investigation is concerned exclusively with such properties of an economic system as do not depend on changes in the scale of production or in the proportions of 'factors'" (1960: v). Martins considers that, for Sraffa, the prices of inputs and outputs are simultaneously determined but, as there is no change and so no time in his model, this cannot be so – for simultaneous determination is a determination of change, albeit simultaneously, in time. It would be more accurate to say that inputs and outputs simply exist outside of time. They are neither determined simultaneously or temporally but simply are, or maybe are not – for, if nothing exists outside time, Sraffa's model is a model of nothing.

Sraffa begins by describing an extremely simple society that produces just enough to maintain itself. Commodities are produced by separate industries and are exchanged in a market after harvest. There are only two commodities: wheat and iron. These are used both as consumption goods and as means of production – or at least are symbolic of them. However, if they are symbolic, the necessity for physical correspondence disappears so, for the schema to work, they must be regarded as literal quantities of physical things. Sraffa takes 400 quarters of wheat and 20 tons of iron as inputs, and 400 quarters of wheat and 20 tons of iron as outputs. He then adds 60 pigs. Through triangular trade, the values of the relative inputs and outputs can be established simply in physical terms. This is necessarily so, as the amount of physical inputs is identical to the amount of physical outputs. To describe this as production or as an economy is a misnomer. The quantities and type of inputs are exactly the same as the quantities and type of outputs. Simple reproduction for a physical economy means the transformation of the one quantity of inputs of the same type, into the same quantity of outputs of the same type. This is no transformation at all but rather a re-distribution of existing and identical inputs and outputs. It is a stable state; the economic equivalent of three friends sitting round a table and swapping stuff the one with the other. It is qualitatively distinct from simple reproduction in a value economy where different use values have been produced and consumed, while there has been no expansion of the value of production.

Sraffa then writes this algebraically by replacing wheat, iron and pigs with a , b and k . The sum of the equations on the left-hand side necessarily equals the sum of the equations on the right-hand side as they are the same thing. Sraffa then adds the rate of profit or surplus, which must be known in advance and be proportional on both sides of the equation to maintain the standard relationship between the terms. Sraffa then increases the output of wheat from 400 quarters to 575 quarters, which gives a social surplus of 175 quarters. This increase in wheat is the product of magic. No possible combination of wheat and iron alone can produce more wheat. The surplus comes from nowhere and is the product of nothing. In Sraffa's system this must be so, for if the production process transforms the nature of the use value from input to output, the physical form of the input

and output would be incommensurate. There would then be no physical and therefore no algebraic correspondence between them.

Sraffa explains that national income in this system is a self-replacing state that “consists of the set of commodities which are left over when from the gross national product we have removed item by item the articles which go to replace the means of production used up in all the industries” (1960: 12). This is Sraffa’s equivalent of the double deflation method, which measures the difference between the value of inputs and outputs in order to arrive at the national income for a year. The physical proportions of inputs and outputs form Sraffa’s “composite commodity”, which itself forms the basis for the “standard commodity” or invariant measure of value. The perfect composite commodity “consists of the same commodities (combined in the same proportions) as does the aggregate of its own means of production – in other words such that both product and means of production are quantities of the self-same composite commodity” (1960: 21). “Can such a commodity be constructed?”, Sraffa asks; of course it can – magic can do anything.

Sraffa takes an economy with 180 tons of iron, 285 tons of coal, 410 quarters of wheat and 1 unit of labour spread across three industries. This combination of wheat, iron, coal and labour produces 180 tons of iron, 450 tons of coal and 480 quarters of wheat. The quantity of iron used as an input is just equalled as an output, so the national income consists of the extra 165 tons of coal and 70 quarters of corn. Labour disappears from the output side as do the physical quantities of subsistence that make up its wage from the input side. This must be the labour of elves, as Sraffa’s labourers exist on nothing, create surplus out of nowhere and disappear into the nether world leaving only coal and wheat! Not even a pair of shiny new shoes.

Has there been any national income created? Yes– but only because the physical inputs that make up the consumption fund are not included in Sraffa’s calculation. If they were, it would be impossible to say if the physical increase in the quantity of coal and wheat output (magically created out of nothing by “labour”) is larger than the quantity of physical inputs used up by labour as these physical quantities are incommensurate and so defy physical value measurement.

The physical proportions of the three commodities that form the means of production are 180:270:360; these are the same proportions in which they enter the aggregate means of production (150:225:300), and so Sraffa’s composite commodity consists of 1 ton iron to 1.5 tons of coal and 2 quarters wheat. This provides the basis for the standard commodity in the standard system. As this standard commodity consists of an arbitrary combination of physical inputs and outputs, it is itself arbitrary. There is no reason why the unit of measurement should be labour time but there are good reasons to think it must not be, for if Sraffa’s conditions hold, the physical output is directly commensurate and so labour is unnecessary to measure the output of the physical surplus.

Sraffa draws a distinction between what he calls *basic* and *non-basic* commodities. *Basic* commodities are those that enter directly or indirectly into the means of production of all commodities, *non-basic* commodities do not do so. This distinction is subjective, but its significance for the physical measurement system is that it is the excuse to exclude the physical components of the wage fund, or consumption goods from the input side. This is necessary as it means the “surplus” shown on the output side has no different physical equivalent on the input side that would render physical measurement impossible. Sraffa explains: that “the various commodities are produced in the same proportions as they enter the aggregate means of production implies that the rate by which the quantity produced exceeds the quantity used up in production is the same for each of them” (1960: 23). What is true of the production of a single commodity is also true of joint production and of multiple commodities; in each instance the physical nature of the input is the same as the output, they are only quantitatively distinct or any additional output has no corresponding input that is physically different from it.

Labour appears on one side of the equation only and it has the magical property of transforming all inputs into different outputs irrespective of their physical form. This is reflected in the algebraic terms. These are identical on both sides of the equation, unless they are aggregates of other algebraic terms, which amounts to the same thing. It is irrelevant how this output is distributed between wages and profits as the physical proportions have been determined physically.

Steedman (1977) claims that Sraffa's system provides a logical (or at least a mathematical) alternative to subjective value theory based on utility and objective value theory based on labour. Steedman claims that Sraffa creates an alternative physical pricing system that enables market values to be derived from the physical correlation of production under conditions of static equilibrium, without the detour of using labour values or marginal utility.

It does. These claims are all true – provided Sraffa's assumptions are valid. If the physical process of production does not transform one set of physical inputs into a different set of physical outputs and if these unchanged physical inputs and outputs expand in the same physical proportions, then value relations can indeed be determined physically. If physical commodities are commensurate, then they can be measured commensurately. But they are not.

Physical commodities are incommensurate. There is no reason, based on their physical properties, why a "coat" should be exchanged for half a "sheep" or a "computer", or why a "computer" produced one year with a certain physical character should be worth less, have a lower price than, a more powerful "computer" produced a year later. Indeed Sraffa indirectly acknowledges this point in his treatment of fixed capital. How to value the contribution of fixed capital to production when the output, the depreciated machine, is qualitatively different from, and therefore incommensurate to, the input – the undepreciated machine? By labour time of course. Sraffa values machinery by the amount of dated labour embodied in it: if "the original value represents the quantity of labour that has been required to produce the machine ... its value at any given age represents the quantity of labour which it 'embodies'; that is to say the quantity which has gone to produce it, minus such quantities as year-by-year have passed into the product" (1960: 81).

Sraffa is able to establish a physical numeraire, the standard good, on three assumptions: firstly, that the physical form of the inputs is the same as the outputs in order that they can be differentiated quantitatively; secondly, that "labour" has the ability to transform any input into any output; and thirdly that the physical cost of labour, the consumption or wage fund, does not appear on the input side. This means that the "surplus" output created is a simple addition. If the physical composition of wages on the input side has to be compared with the physical composition of "surplus" on the output side, there is no way of telling by means of a physical comparison alone whether this is "surplus" at all. As all of these assumptions directly contradict the very nature of the production process in general and capitalist production in particular, Sraffa's model failed to demonstrate the possibility of a physical numeraire as opposed to a social one.

Dobb and Meek

Maurice Dobb and Ronald Meek were two British Stalinist economists working at Cambridge University after the Second World War. Dobb was, alongside Sraffa, the co-editor of Ricardo's works and correspondence. More importantly, he was a proponent of the Stalinist view that, while the Soviet centrally planned economy produced physical output, measured as use values and not exchange values, somehow value (if not exchange value) continued to exist there (Dobb, 1966). This eclectic assertion formed official Soviet orthodoxy from 1930 onwards, following the arrest and defeat of the "Idealist" group of Soviet economists around I.I. Rubin.

During the mid-1920s Rubin had explained how value was a form of exchange value and insofar as the centrally planned economy employed the conscious allocation of physical inputs and

outputs, it would have no value. Rubin was opposed by the “Mechanist” group led by I.I. Stepanov-Skvortsov and A.A. Bogdanov. The Mechanists argued that value was a natural category and value categories would continue under the central plan. Although they were criticized by the apparatus, their ideas provided the basis for what was to become Soviet orthodoxy from the inception of the plan period in 1928.² Official Soviet “national income” measurements were based on aggregates of concrete labour hours and were limited to the material production sector, to physical output alone; they did not include services or the government sector in their measurements (Jefferies, 2015). The parallels with Sraffa’s model are obvious. Meek (1956) particularly championed Sraffa’s work as a “magnificent rehabilitation of the classical approach” (1961: 119) which had resolved the problems of Marx’s value theory.

Paul Samuelson

Paul Samuelson, the Nobel Prize winning father of the post-war neo-classical synthesis, was uniquely placed to capitalize on the weaknesses in what had become the accepted Marxist solution to the transformation question. Samuelson was a contemporary of Sraffa, Paul Sweezy and Joan Robinson. He was a protégé of the Marxist trained Wassily Leontief. Leontief was, in his turn, a graduate of Leningrad University immediately after the revolution and had completed his PhD under the supervision of Von Bortkiewicz. Virtually uniquely, for mainstream neo-classical economist, Samuelson had actually studied Marx and Sraffa. Samuelson’s critique of Marx was essentially a recapitulation of Von Bortkiewicz but incorporated Sraffa’s insights into his work, although his ‘Wages and Interest: A Modern Dissection of Marxian Economic Models’ (1957) anticipated Sraffa’s seminal work by three years. In it Samuelson explained that:

I have no space to deal with the defensive argument that Volume I’s labor theory is a (needed or unneeded) simplifying first assumption. Modern science and economics abound with simplifying first approximations, but one readily admits their inferiority to second approximations and drops them when challenged. (1957: 891).

Samuelson rejected Marx’s simplifying assumption that all manufactured commodities are produced by people, something that is *always* true, in favour of a simplifying assumption that outputs are homogenous – something that is *never* true. He established a simple two industry model in which, “Industry I produces homogenous physical machines or raw materials. Industry II produces homogenous consumption goods called Y. Production in both industries requires homogenous labour and physical capital” (1957: 884). Based on this, necessarily, untrue assumption, Samuelson proved the inconsistencies of Marx’s labour theory of value. Consequently, there was no problem using “Machine numeraire units and consumer goods numeraire units” (1957: 900). In an economy with homogenous physical inputs and outputs, that is, an economy predicated on the absence of a value system, Samuelson found that the application use of a value system produced some curious results. He concluded unsurprisingly, “The Marxian model with fixed coefficients presents some quite pathological features” (1957: 901).

Samuelson’s 1971 ‘Understanding the Marxian Notion of Exploitation: Summary of the So-Called Transformation Problem Between Marxian Values and Competitive Problems’ was his major statement on the transformation question, in which he notoriously asserted that it was best to “erase and replace” values with prices, or Marx’s *Capital III* with *Capital I*. Samuelson castigated Marx’s use of the labour theory of value, which could only occur, he claimed, in the special case that every capital had identical compositions of capital. Samuelson analysed the transformation of values and prices in a two-commodity corn and coal economy, where inputs and outputs were

identical and labour values were embodied and invariant or an economy which never exists even in the “special case”.

Samuelson later pointed out that “In a one-good (corn) world every viable increase in organic composition automatically raises the rate of surplus value” (1972: 56). In a one-good world, all sorts of things may happen and indeed in a two-good world too. Samuelson later elaborated further features of his corn and coal economy (1982: 14; 1973: 64; 1974: 65) with similar results.

Samuelson continued to work until he was a venerable age and at the turn of the millennium he contributed to a series of essays celebrating the centenary of Sraffa’s birth. Samuelson again considered an economy with two goods although, perhaps showing his age, on this occasion he chose silk and corn representing luxury and subsistence (2000: 29). Samuelson proved that, where physical inputs and outputs are identical, prices can be derived from the physical form of the good alone. On the assumption that homogenous goods mean that value is irrelevant, value is indeed irrelevant. Samuelson criticized the narrowness of Sraffa’s example of joint production, using mutton, wool and labour (2000: 34). He pointed out that Sraffa’s standard commodity “is useless to ameliorate the faults of a labour theory of value or to reveal the essence of labour exploitation” (2000: 37). For if it is assumed that inputs and outputs are identical and physical goods are commensurate, why bother with a labour theory of value at all? Samuelson pointed out that if labour and wheat are transformed into bread – that is, an incommensurate output – then “the labour theory of value cannot tell us, what is true, namely that only at interest rates below a critical one will this invention be a viable one” (2000: 38), for concrete labour, bread and wheat are incommensurate as physical things.

In a curious twist, Samuelson denounced the use of Sraffa’s standard commodity by Sraffians and Marxists who sought to reconcile Sraffa with Marx. Samuelson showed that it was impossible for workers’ subsistence on the input side to increase in equal proportions to the output side, the very reason why Marx had rejected an invariable theory of labour value at the outset. Samuelson’s criticism was of course the reason why Sraffa had originally developed the distinction between basic and non-basic goods. The inclusion of the physical goods that make up the consumption fund on the input side removed the possibility of establishing the commensurability of the input and the output sides (2000: 40).

Samuelson proved the redundancy of the labour theory of value on the simplifying assumptions that: inputs and outputs are identical; there are one or two homogenous goods; that labour is embodied, simple, concrete and invariable; and there is static equilibrium. And it is certainly true, in an economy of such a type, that there is no need for value theory. Curiously, Marxist and Sraffian critics of neo-classicism accepted Samuelson’s terms of debate and attempted to demonstrate the usefulness of the labour theory of value in models designed to show its redundancy.

The criticism of the use of homogenous inputs and outputs developed here also vindicates Joan Robinson’s critique of neo-classical capital theory in the Cambridge capital controversy. Robinson, who rejected Marx’s value theory, nonetheless refuted the foundation of mainstream theories of capital. Robinson showed the contradictions of the neo-classical theory that valued capital by the rate of interest. This meant that not only could there be a re-switching between capital and labour, in defiance of marginal theory, but there could be only one rate of interest. Any change in the amount of interest must lead to a similar proportionate change in the amount of capital and vice versa. Robert Solow (1956, 1957) only escaped this circularity through a growth model based on the assumption of a single homogenous capital good which never exists.

Ian Steedman

Ian Steedman summarized the post-war discussion among Marxists and Sraffians in his *Marx After Sraffa* (1977). Surprisingly Steedman’s work barely referred to Sraffa’s original, while asserting

that the “Sraffa-based critique of Marx cannot be met head on and rationally rejected, for the simple reason that it is correct” (1977: 25). Steedman considered Marx’s transformation question is “intrinsically unimportant” (1977: 29) while being logically incoherent. Marx had forgotten to transform the value of input prices into prices of production Steedman claimed. The solutions to it provided by Dimitrev, Bortkiewicz and Sraffa were, unlike Marx, “logically coherent”. These solutions were “never”, he continued, the subject of “logical criticism” for the simple reason that “there is no logical criticism to be made” for they “are logically sound” (1977: 33).

Steedman then repeated Sraffa’s example of expanded production – albeit with a different selection of commodities. Steedman showed how a combination of inputs, in his case iron and labour, can produce a different combination of outputs – iron, gold and corn (1977: 38–43). Expanded production was assumed. As with Sraffa the outputs are the product of magic, or perhaps alchemy? Not only does the “labour” live on nothing – there are no material inputs to form the wage– it has the capacity to achieve what the best minds of late medieval Europe could not: the transformation of base metal into gold and, even better, iron into corn. Now this may be entirely logical, but what kind of logic is it? Based on this logic, Steedman went on to show that when embodied labour times are allocated to the different inputs and outputs, Seton’s invariance postulates mean that the total of profit cannot equal the total of surplus value at the same time as the total of value equals the total of price. As outputs either appear out of thin air or, in the case of iron, take the same form as input and output, prices can be derived from the physical correspondence of inputs and outputs. Who could doubt it? A logical criticism might perhaps assert that as all of Steedman’s later examples share the same flawed premise as the original then, speaking strictly logically, they fail on the same grounds.

Marxists after Steedman

Paradoxically, even Marxist critics of Sraffa accepted the premise of the physicalist argument – albeit as developed by Steedman. As Alan Freeman, a champion of the Temporal Single System Interpretation (TSSI), explains:

The new approaches arise because a tiny group of thinkers *accepted* Steedman’s criticisms, took the contradictions seriously, chose not to wish or explain them away and launched instead the rather lonely programme of examining their own preconceptions to see where the errors came from. They overturned all common prejudices about Marx and constructed a reading which, they then found, not only corrected the supposed errors but led onwards to a deep and devastating criticism of neoclassical theory, demonstrating the neoclassical origin of the standard interpretation of Marx and re-establishing the rigorous foundation of all Marx’s discarded criticisms of political economy. This is a scientific, not a dogmatic reaction. (1997; emphasis in the original)

The new Marxist approaches reduced the distinction between value and price to a “trivial” matter (Nicholas, 2011). They used one-commodity economic models and embodied or historic labour. This was a Marxist defence of Marx that was predicated on an acceptance of the same false premise as Marx’s critics. Hence the response was to “construct a reading” of Marx that reconciled Marx with his critics even while it aimed to defend Marx against them.

Andrew Kliman, another prominent adherent of the TSSI, rejects “physicalism”, i.e. the attempt to replace labour values with physical ones in a single-commodity corn model that assumes identical inputs and outputs and which uses embodied rather than socially necessary labour time (2007: 79, 85, 121, 158, 172, 178). For Kliman, Sraffa’s (or Steedman’s) key mistake is not the assumption of unchanging inputs and outputs – an assumption which removes the essential premise for the

labour theory of value – but the “simultaneous” valuation of inputs and outputs. This is not even strictly true, as Sraffa’s (or Steedman’s) model abstracts from both change and time itself: inputs and outputs are neither temporarily or simultaneously determined, but just exist. This means that Kliman’s main point is essentially beside the point. Inputs and outputs are different things and so will have different prices determined at different times, including temporally and simultaneously, at any point up to the point of sale. After sale they may change again before their use. When that point is, is essentially irrelevant. There is no reason why the input prices or values of one period should equal the output price or values of the previous period. Indeed it is highly unlikely they will. Once Kliman has accepted a model which does not require value theory by definition, it is no surprise that he can only show the relevance of value theory through a strange set of assumptions that have essentially no foundation in either Marx’s work or, more importantly, in the market mechanism. In an even more recent paper, Alan Freeman (2014) does the same thing and attempts to prove the validity of the TSSI in a single-commodity corn economy with embodied labour times, which are precisely conditions in which its validity cannot be proved.

Inputs Are Outputs

The acceptance that commodities have some shared property in common is a pre-condition for their measurement. Once the physical form of production is transformed through the production process, it is impossible to say by physical quantities of outputs alone what the value of production is and whether there is a surplus or loss. Physical value theories circumvent this problem by a literary sleight of hand: they assume, in words if nowhere else, that inputs and outputs have the same physical form. If there is no physical transformation then a becomes $2a$ with a surplus of a and not $1b$ where it is impossible to say if there is any surplus at all.

And so Sraffa dealt in “wheat”, “pigs”, “coal” and “iron”, Dimitrev (1974 [1898]) dealt in “machines”, Shibata dealt in “labour”, a “consumer good” and a “machine” (Howard and King, 1992: 232), Samuelson used “labour”, “coal” and “corn” (1971: 420), Steedman used either “iron”, “gold” or “corn” (1977: 38) or “tools”, “labour” and “corn” (1977: 96) or “corn”, “old machines”, “new machines” and “labour” (1977: 141) or even less imaginatively “commodity 1”, “commodity 2” and “labour” (1977: 151), Howard repeats Steedman with “commodity 1”, “commodity 2” and “labour” (1983: 54–5), Farjoun uses “machines”, “cars”, “labour”; “machines”, “cars” (1984: 17) or “C1” and “C2” (1984: 37), Giussani uses “Commodity A” and “Commodity B” (1984: 116), while Foley uses “steel”, “labour” and “wheat” (Howard and King, 1992: 277).

Once the qualitative identity of inputs and outputs is established, a physical numeraire can be developed that is suitable for algebraic manipulation. The ability of “labour” to transform any input into any output enables the development of an “ n ” series that models unlimited inputs and outputs, and so the trick is complete. As the production process is quantitative only, physical commensurability is ensured and the unique role of social labour removed, both from production and the valuation of it.

Steel Production – Something Does Not Come from Nothing

World steel production requires in excess of three billion tonnes of raw materials per year to produce around 1.5 billion tonnes of steel. One tonne of steel produced in a basic oxygen furnace requires, on average, 0.96 tonnes of liquid hot metal (lhm) (which, in turn, requires about 1.6 tonnes of iron ore (io) and 0.6 tonnes of coking coal (cc)) and 0.21 tonnes of steel scrap (ss). A tonne of steel produced via an electric-arc furnace requires around 0.85 tonnes of steel scrap and some combination of liquid hot metal and steel scrap supplements amounting to approximately

0.31 tonnes. There is the addition of other metals in varying quantities such as manganese (m), silicon (si), nickel (n), chromium (c), zinc (z), tin (t), molybdenum (mo), vanadium (v) and tungsten (tu) (OECD, 2012: 8).

And then there is the labour. Highly productive steel workers produce around 1000 tonnes per annum each. This means that the world steel industry employs at least 1.5 million workers (although actual productivity varies between country and plant). The wage of the worker buys a basket of physical use values that is necessary to reproduce them and their families. Wage rates vary across countries and between firms, and cultural differences mean that preferences differ too. The aggregate of these physical goods could nonetheless be added up and divided across each tonne of steel, so that each tonne, in addition to the direct physical inputs required for its production, also contains a thousandth part of the aggregate of use values consumed by the worker in the given country. For example, they might consume so many egg cress sandwiches (ecs), hot spicy pork noodles (hspn) and football matches (f), pints of beer (b), car braking systems (cb), bike tyres (bt), etc. These physical inputs would vary according to the time of day (e.g. morning or afternoon, after breakfast or after lunch) and the time of year (e.g. whether it is Christmas or Eid or the summer holidays). Consequently, every single tonne of steel will be made up of a different combination and of a different quantity of physical use values and so it is impossible to determine whether any given tonne of steel will be worth more than the physical aggregate of the inputs necessary to produce it. But a social average of physical inputs could be established so that it is theoretically possible to find out what each tonne of steel incorporates as a social average of physical inputs, or to express it algebraically:

$$\begin{aligned} & lhm + io + cc + ss + m + si + n + c + z + t + mo \\ & + v + tu + ecs + hspn + f + b + db + bt = \text{an amount of steel} \end{aligned}$$

As the physical inputs are equally divided across the entire physical output, unpaid labour that is the part of the working day not paid for by the capitalist, i.e. the value created by the worker in excess of the value of the wage, disappears. There is an equivalence but no surplus value.

The differences in the socially average quantity of physical inputs required to produce each tonne of steel does not affect the price or exchange value of steel, as the steel manufacturer is indifferent as to how or what the worker spends his wages on (i.e. the particular combination of use values he or she consumes). The steel manufacturer pays the workers an amount of money that enables the worker to purchase a particular basket of goods and requires that, in exchange, they work a given length of time or produce a given amount of steel. This can then be compared by the purchaser with every other tonne of steel produced by every other steel manufacturer, the nature of which the purchaser is completely indifferent to – for it is the physical form of the output that matters, not the input.

This example uses one sector producing one rather basic output, so how much more so for the economy as a whole? Every year, physical quantities of inputs produce different quantities of different physical outputs. But there is no fixed correspondence between these physical quantities of inputs and outputs, as the type, nature and quantities of inputs and outputs constantly change. One year a certain quantity of physical inputs and outputs would represent growth; another year, exactly the same combination of inputs and outputs might represent contraction. This is true for the simple reason that the physical combination of inputs and outputs has no fixed correspondence with the value or price of these inputs and outputs which is measured in terms of something else. There is no composite or standard commodity and the nature of use value is transformed through the production process. Wassily Leontief (1951) noted in his discussion of the US economy between 1919 and 1939:

... the basic properties of an economic system are uniquely determined by the (relative) *value* figures of all different kinds of outputs and inputs. Two systems with identical value patterns will have also the same price and output reactions. Even if the prices and quantities taken separately were quite different. ... For the subsequent empirical analysis, this invariance is of cardinal importance. It makes it possible to determine the most significant properties of the actual economic system on the basis of its value pattern alone. (1951: 65; emphasis in the original)

If two different physical systems of production can have the same value composition, the physical system cannot be the basis of the value one. Samuelson later pondered why Leontief never cited Sraffa in any of his works. Perhaps the answer is that they were incompatible?

Conclusion

As physical things, commodities are incommensurate; inputs are transformed into different outputs through the production process. Therefore, they must share some other property than their physical form that allows their common measurement or exchange, the labour required for their production. As has been demonstrated, this was the original premise for and reason why David Ricardo adopted a labour theory of value. The fundamental economic problem is not scarcity, for commodities are manufactured and so not scarce, but rather distribution and production. Hilferding noted that “value in the Marxist sense is an objective, quantitatively determined magnitude” (1975 [1904]: 159). This must be so if there is a social division of labour beneath the physical production and reproduction of things. The qualitative aspect of the labour theory of value means nothing if it cannot determine the division of labour quantitatively or, more specifically, the actual physical quantities of different inputs required to produce actual quantities of outputs.

Sraffa proved the commensurability of physical inputs and outputs by abstracting from the essential nature of production itself, as a process which transforms one set of physical things into a different one. Following Sraffa, every critic of the labour theory of value, whether in its Ricardian or Marxist form, assumes a one or two commodity economy with physically identical inputs and outputs. This establishes direct commensurability and so means a labour theory of value is unnecessary by definition. Sraffa’s physical system of exchange and prices is predicated on a constancy, an equivalence or identity of physical inputs and outputs that abstracts from time, change and, indeed, production itself. The conditions for his physical value system or numeraire never exist, are precluded by and fundamentally contradict the process of production itself.

But post-war Marxists retreated from the quantitative aspect of Marx’s value theory, under the combined challenge of Von Bortkiewicz, Sraffa, Samuelson and Steedman (Howard and King, 1992: 282). This retreat abandoned the essential premise of the labour theory of value itself, the heterogeneity and, therefore, non-equivalence or incommensurability of different inputs and outputs. Without the physical equivalence of inputs and outputs, or the creation of outputs from nothing, Sraffa’s schema collapses. It is not that it is illogical, simply that it is unreal and, therefore, irrational or untrue. As Marx (1861–63) pithily commented about the theory of an earlier neo-Ricardian, “not only the difference between man and animal disappears but even the difference between a living organism and an inanimate object”.

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Notes

1. For some reason, whether the labour time did in fact determine exchange value in historical periods before the capitalist mode of production is a matter of great controversy. Alex Callinicos (2014) recently claimed that Marx's assertion, when developed by Friedrich Engels in the postscript to *Capital III* (Engels, 1981 [1894]: 1027–1047), proved that Engels had a “complete misunderstanding of Marx's value theory” (2014: 42). This no doubt explains why, when Marx discussed, in the preface to *Capital I* how the human mind had sought to explain value for “2,000 years” (1976 [1867]: 90), it was such an unfathomable problem – value had yet to exist for another 1800 years.
2. Alex Callinicos (2014) champions the work of I.I. Rubin and insists that value is a form of exchange value and only exists in economies based on commodity production and exchange. Callinicos also champions the work of Chris Harman, who argues that, although the central plan produced use value and not exchange value, somehow the law of value continued to operate in an economy in which it did not exist. This was the argument of Rubin's Mechanist opponents, I.I. Stepanov-Skvortsov and A.A. Bogdanov. Unwittingly, Callinicos effectively sides with both sides in the 1920s Soviet value debate.

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