Transformations of physical conditions of production: Steedman's economic metaphysics*

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Abstract

Steedman's rejection of Marx's theory of value rests on the proposition that one can derive both values and prices from physical conditions of production, the real wage and the capitalist drive to accumulate. This proposition is examined with respect to the kind of relations assumed to rule among both economic agents and economic objects in order to accomplish the transformations of physical data into values and prices. It is argued that the transformations not only rest on the adoption of an equilibrium framework, but that they also are rooted in metaphysical notions endowing physical conditions of production with the properties requisite to derive from them economic determinations. It follows that there is no need to accept the 'Sraffa-based critique of Marx', whatever problems one may have with Marx.

In his *Marx after Sraffa*,[1] Steedman arrives at the conclusion that 'Marx's value reasoning . . . must . . . be abandoned, in the interest of developing a coherent materialist theory of capitalism' (p. 207). This conclusion rests on the following basic arguments:

(A1) the demonstration that Marx did not solve the problem of transforming values into prices of production and arrived at false propositions as to the nature of their connection;

(A2) the demonstration that correct determinations of prices of production, the rate of profit, and accumulation are derivable from physical conditions of production, the real wage, and the capitalist drive to accumulate;

(A3) the demonstration that values are equally derivable from these data but remain without relevance for the determinations of prices and profits.

If these three arguments are sound, Steedman's conclusion as to the obsolescence of Marx's theory of value is justified.

Enough has been written on argument (A1). I will discuss arguments (A2) and (A3), without bothering to deal with the more complex issues of accumulation. The discussion centres on the issue of the functions of a theory of value. What those functions are will, hopefully, become evident in what follows.

To a reader of Marx and Steedman who is unfamiliar with the usual 'arithmomorphism'[2] of mathematical economics, the arguments (A2) and (A3) are surprising mainly because of the proposition that one can derive values as well as prices from physical conditions of production, the real wage, and capitalist propensities. This should not be surprising. As it turns out, both values and prices are, for Steedman, nothing but 'transformed' physical data. I will illustrate the nature of these 'transformations' using Steedman's examples. Then, I will discuss their explanatory value.

1 Values

Under the usual assumptions for simple linear models, Steedman starts from the following description of an economy in physical terms (p. 38):

(Q)	i	L		i	g	c
industry i:	28	56	→	56	—	—
industry g:	16	16	→	—	48	—
industry c:	12	8	→	—	—	8
Total	56	80	→	56	48	8

(where i, g, c, L are iron, gold, corn, labour measured in physical units). From (Q), Steedman proceeds to determine values by recapitulating what Marx meant: 'By the value of a commodity, Marx meant the quantity of labour socially necessary for the production of that commodity' (pp. 39f.). Then, Steedman introduces a notation: 'Let the values of a unit of iron, a unit of gold and a unit of corn be denoted by l_i, l_g and l_c, respectively' (p. 40). Now, the crucial step is taken. It consists of transforming the descriptions in (Q) into equations:[3]

(V)

$$i: 28l_i + 56 = 56l_i$$
$$g: 16l_i + 16 = 48l_g$$
$$c: 12l_i + 8 = 8l_c$$

Using equations (V), numbers for l_i, l_g and l_c are easily calculated. Steedman claims that these numbers are 'the values of the com-

modities (l_i= 2, l_g= 1, l_c= 4)' and that they 'have been determined solely from the physical data given' (p. 40).

Of course, physical data do not arrange themselves in the form of equations. In order to evaluate Steedman's claims we have to examine the presuppositions which allow for the transformation of (Q) into (V). Taking as an example the first row in (Q)

$$(28i, 56L) \rightarrow 56i$$

and in (V)

$$28l_i + 56 = 56l_i$$

we may simply note three differences: (a) the equational form, with an operation of addition and a relation of equality; (b) the disappearance of L; and (c) the substitution of entries l_i for entries i.

As to (a), the equational form seems to be quite unjustified unless we know more about the nature of processes of production (which seem to hide behind the connection '$\rightarrow$'). While there may not be much of a problem with the entries for physical goods as inputs and outputs, the entries for labour ('naturally measured in time-units', p. 39) are something quite weird, because they depict a process — in contrast to the palpable, peaceful nature of physical goods. An operation of addition seems to be completely impossible in (Q), because one cannot add red beets to brown boots, just as one cannot add red beets and the process of growing red beets, to arrive at numbers of red beets. Finally, a relation of equality could hold in (Q), at best, among entries for identical physical goods as inputs and outputs, if we neglect the fact that they must appear at different points in time.

As to (b), the transformation of the entry 56L in (Q) into the entry 56 in (V) is explained by the desire to map the heterogeneous elements of production processes and their results into the one dimension of homogeneous labour. Thus, all entries in (V) are entries in terms of labour-time, so that the first row reads

$$28l_i L + 56L = 56l_i L$$

where L can be eliminated, of course.

As to (c), we can now account for this and the other differences between (Q) and (V) by specifying a general *rule of transformation* of physical data into values which Steedman seems to apply:

(1) $l_i L = i$ (i = 1, . . . , n; a list of all goods).

Whether one can derive values from physical data depends on possible justifications of this, or some similar, rule.

1.1 *Production and reproduction*

Before discussing the rule of transformation, a possible misunder-
standing of Steedman's frame of reference has to be cleared away.
One may be tempted to accept too literally Steedman's repeated
claim that physical conditions of production, the real wage and
the capitalist drive to accumulate are sufficient to derive either
values or prices. Too literally, in the sense of a supposition that
Steedman's derivation would be placed strictly in the context of
production in physical terms.

Indeed, this is not the case. A look at (V) shows that specific
relations between labour and goods have to be assumed to accom-
plish the derivation of values. These relations have certain proper-
ties, as the one of equality assumed in the rule of transformation.
If it is required for the derivation of values to assume the relations
between labour and goods to be, e.g. reflexive, symmetrical,
and transitive, then reference to the context of production in
physical terms is insufficient. Within this context, there is no
logically consistent way to endow the relations between labour
and goods with these properties. This can be seen by considering
the time aspect of production.

In (Q), it is evident that physical inputs along with labour are
used to produce physical output. The process of production takes
time. The time dimension is also presupposed to be able to measure
labour. Time is usually thought to be irreversible, so if we want
to even start thinking about, say, symmetry in the relation between
goods and quantities of living labour appearing at different points
in time, we have to adopt some device to 'neutralize' time. The
device is to refer to a system in a steady-state, capable of repro-
ducing itself without change in an endless time horizon. Thus, the
context of reference necessarily is one of *re*production, not
simply one of production in physical terms.

There are several other ways to demonstrate that it is necessary
to refer to the context of *re*production in order to derive either
values or prices from physical conditions of production, the real
wage, and the capitalist drive to accumulate. Such a demonstration
is unnecessary, because Steedman is quite explicit on this point,
listing among his assumptions, taken as read: 'The capitalist
economies considered are always in a self-reproducing state, . . . so
that production, exchange and distribution are always considered
as a unity' (pp. 18f.) It is arguable that a repetition of this assump-
tion in connection with the repeated claim of a derivability of
values and prices from physical conditions of production, etc.,
would have an enlightening effect on Steedman's readers. But be
that as it may, it is more interesting to examine the implications
of this assumption.

In considering 'production, exchange and distribution . . . as a unity', unity can mean two things. It may mean the simple proposition that the distinguishable parts of the process of reproduction belong together. It may also mean that the exchange and distribution relations corresponding to and complementing a system of production are assumed to be in a state of equilibrium. I will argue that it is necessary for Steedman to assume such an equilibrium in order to accomplish his derivation of values and prices, the difference between the two derivations being that values are derived with the use of an equilibrium rule of exchange only, while the determination of the rate of profit and prices of production involves the additional adoption of an equilibrium rule of distribution among capitalists. The argument may not be surprising. After all, Sraffians work on the assumption that the market has done its job, whatever that job may be. But it may be of interest to clarify the extent to which this assumption equilibrates away traditional problems of economic theory, Marxist or not.

1.2 *The rule of transformation*

Formally, the rule of transformation (1) amounts to assuming relations between physical goods and labour, such that with each unit of a good appearing in (Q) we can associate a quantity of (homogeneous) labour. We call the number of hours of labour associated with each good its value. What are the relations which allow for the mapping of heterogeneous goods into the labour space (one-dimensional by assumption)?

Whatever else may be required, a precondition for the determination of values is the idea of a binary relation between goods and labour; to each unit of a physical good is to correspond a definite quantity of labour. For simple linear models, there usually are some assumptions which help ensure such a correspondence. Granted those, there is still a difficulty. In (Q), labour is not only associated with physical output (to the right of the '$\rightarrow$' symbolizing production), but also with physical inputs (to the left of '$\rightarrow$'). To establish a binary relation between goods and labour, one has to get rid of the (usually, heterogeneous) inputs. The first step in the determination of values could be taken by eliminating physical inputs in the form of a calculation of net output. The net output of each process is then associated with the living labour expended in this process in terms of a binary *relation of embodiment,* which may be presented in the following way

(2) $l_i L \dashrightarrow i$

(where '$\dashrightarrow$' stands for the relation 'is embodied in'). Before

discussing the characteristics of this relation, the difficulty of arriving at it should be pointed out. With the exception of extremely simplified cases, it is not possible to calculate net output unless one has previously transformed physical inputs into values. For example, in row 2 of (Q), the iron inputs cannot simply be subtracted from the gross output of gold in order to single out the relation of embodiment between labour (expended in period t) and net output of gold (appearing in period t+1). On the one hand, physical inputs and outputs have to be transformed into values in order to establish the required binary relation between labour and physical goods. On the other hand, this binary relation is a presupposition of the transformation. To escape the circularity lurking here, there seems to be none other than the resort to the customary device of simultaneous determination.

Using this device involves some opportunity costs. What started out as an attempt to pinpoint the relation constitutive for the association of values and physical goods (at the locus of production, where living labour results in net output), turns into a general assumption that all goods are to be considered as nothing but embodied labour on the same terms, regardless of the period of production in which they were produced, regardless of their place and function in the system. The distinction between living labour and labour already embodied in inputs is lost on the way, because in calculating values, we first have to establish a correspondence between gross output and total amounts of labour, embodied and living, before we can impute the existence of net output to the expenditure of living labour in each branch of production, thus singling out the relation of embodiment *in actu*. This relation (and the idea of value creation traditionally associated with it) turns out to be a construct, inconsistently derived and, certainly, not in any way observable.

That the correspondence between physical goods and labour established with the idea of embodied labour is one between gross output and total amounts of labour, living and embodied, can be illustrated with figure 1.

Using Steedman's example, we can depict the production activities in (Q) as combinations of iron (i) and labour (L), where q_i, q_g, and q_c are the iron, gold and corn producing activities. From (Q), we know the outputs produced in each industry. As it turns out, we only need to know the iron output (given by OA) to determine the aggregate values produced in all three industries (of course, this is due to the nature of the example used). Drawing a line from A through q_i to where it intercepts the L-axis (at point B), the distance OB will give the value of iron-output. The parallels to AB through q_g and q_c intercept the L-axis at points
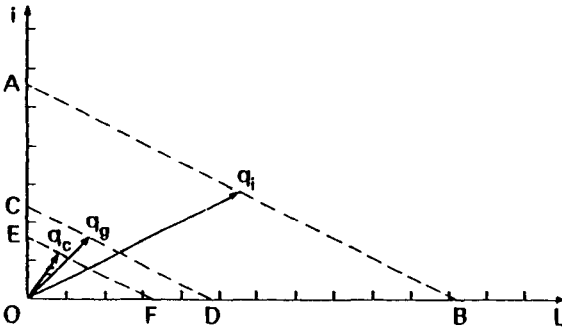
D and F, respectively, so that the values of gold and corn outputs are given by OD and OF, respectively. To determine unit values, we divide the values of outputs by the numbers of units produced.

From the figure, we can see that the idea of a genetic relation between labour and goods which is associated with the concept of embodied labour and which seems to provide for the underpinnings of a rule of transformation is metaphysical. Take the line AB to be the locus of all combinations (i,L) which yield output OA. The value of this output is defined by the one combination (0,112), where it is produced by labour alone. In general, physical output is viewed as the result of one of a definable manifold of possible combinations of physical inputs and labour. Values are determined by the one combination where all physical input quantities are zero and output is produced by labour alone.

This definition of values is based on the implicit notion that it is possible to theoretically treat conditions of production *as if* they were malleable. The notion is metaphysical — and it is also inconsistent with the initial argument according to which physical conditions of production are given as 'objective data', as the firm basis of all theoretical reasoning.

Reliance on the relation of embodiment alone does not justify the use of a rule of transformation à la Steedman. Understanding values as quantities of embodied labour does not open a way to derive values from physical conditions of production, the real wage and capitalist propensities. Maybe there are other ways to accomplish this derivation, but unless these are presented explicitly, there are no reasons for accepting Steedman's claim (A3).

Steedman's framework leaves enough room for speculation, however. Maybe reliance on the idea of reproduction as a unity of production, exchange and distribution can help in the derivation of values? Quite clearly, one of the shortcomings of the relation

of embodiment is that it may give us an idea how labour is transformed into goods, but it does not give us an idea why goods should be transformed into labour (or be presented as so many quantities of labour). Maybe relations of exchange are constitutive of the association of values and goods, as Marx and the classical political economists would have it?

Contrary to the impression created by Steedman, assumptions on the nature of exchange relations are crucial for his derivation of values, too. They are not made explicit, since they are part of a general reference to economies in equilibrium.

1.3 Exchange

The briefest way to indicate the role of exchange analysis is taken if we reconsider the issue of the evaluation of physical inputs. How can it be accomplished in an economically meaningful way while maintaining a central role for the concept of embodied labour?

A simple procedure would be the following: first, we introduce an assumption that all physical inputs (and labour, for that matter) are acquired by exchange. Thus, exchange values are already associated with inputs when they "enter" production. Then, we stipulate a *rule of exchange* to determine exchange values quantitatively, say,

(3) $i \, \tau \frac{l_i}{l_j} j \ (i \neq j)$

(where 'τ' stands for the relation 'is exchanged with') stating that goods are exchanged according to the quantities of labour embodied in them.

The result is a *formally* complete argument which can provide for a dual foundation of a rule of transformation à la Steedman, if we neglect some additional complications for a moment. On the one hand, we have the relation of embodiment *in actu*, which can be interpreted as a *rule of value creation*. On the other hand, we have a *rule of exchange* which takes care of the evaluation of produced inputs by establishing an indirect link to the relation of embodiment.

Some of the additional complications are familiar. The most obvious one involves the neutralization of time and changes in time and it is usually accomplished by (implicit) reference to systems in a steady-state. A second complication involves the role of living labour as an input under an aspect quite different from the ones considered so far. How is the role of an input under the disposition of those agents who control production (capitalists) ascribed to those agents who perform living labour (workers)? A shorthand answer to this question is provided by

introducing the concept of the real wage and treating quantities of living labour as equivalent to quantities of real wage goods which, in turn, are considered as quantities of embodied labour. This involves an asymmetry in the treatment of living labour. As a functioning input, it is counted simply in terms of hours. As an input to be acquired by *exchange*, it is counted to be equivalent to the (lesser amount of) labour embodied in the wage good bundle. Of course, there is the familiar idea of labour power as a commodity to avoid the apparent inconsistency implied in such a double role of living labour. But my point here is simply to stress again the need for exchange analysis as a prerequisite for the derivation of values. As soon as we make use of the concepts of capital, wages, surplus, etc., we do rely on some rule of exchange (as (3), and an appropriate modification of such a rule to cover those exchange transactions which involve the acquisition of living labour as an input).

Once this need for a rule of exchange is recognized, we have to analyse the nature of the exchange relations depicted by such a rule. Rule (3) does complement relations of embodiment between labour and goods in such a way that relations of equivalence between goods and goods in exchange are guaranteed. The existence of equivalence relations between goods in exchange implies a state of equilibrium of the exchange system complementing the system of production.

This can be seen by examining the implications of the transitivity of exchange relations posited with the assumption of equivalence.[4] Using Steedman's iron, gold and corn producing economy as an example again, transitivity of exchange relations implies that, if we observe

$i \tau 2g$

and

$c \tau 4g$

we are justified to conclude that

$i \tau \frac{1}{2}c$

without any further reference to observation, conditions of production, or whatever. Economically, this means that exchange transactions, although presumably subject to free contract among pairs of independent private agents, are completely interdependent and are so, moreover, in a way which will guarantee that no gains can be made by indirect trading. Obviously, assuming exchange relations to be transitive amounts to assuming away a whole rats' nest of traditional problems of exchange analysis concerned with

explaining why agents should or could behave in ways which result in a state of equilibrium of the exchange system. But this is not all. A state of equilibrium of an exchange system defined in terms of equivalence relations between goods traded is one thing. The way in which such an exchange system is related to a system of production is another thing. However, with the use of a rule of exchange (3), the problem of compatibility between exchange and production is eliminated because the use of embodied labour-times as determinants of exchange ratios not only ensures the transitivity of exchange relations, but also their strict dependence on conditions of production.

Exchange relations are thus defined to be equilibrium relations not only with respect to the mutual consistency of exchange transactions themselves, but also with respect to their compatibility with conditions of production. Viewed in terms of an economy of thought, labour values are miraculous constructs because they help to solve these two problems in one stroke. A minimum number of propositions, namely, a rule of value creation, based on the idea of embodied labour, and a rule of exchange, is sufficient to portray the functioning of a self-reproducing economy (if we neglect issues of distribution). Viewed in terms of explaining the actual functioning of a capitalist economy, the miracle is a flop, of course. The white rabbit gets into the hat by assuming an interdependence between production and exchange defined in terms of an equilibrium state, with no questions asked on how such an equilibrium may be possible. For example, why would agents exchange according to labour-times embodied in their goods? How can they even know what those labour times are?

Questions of this nature are entirely absent from Steedman's discussion of the labour theory of value. What he finds to be deficient in that theory, as he presents it, is not its being deeply rooted in equilibrium conceptions. Rather, his concern is one in terms of economy of thought. Labour values may be sufficient to determine a 'unity' of production and exchange, but they are not powerful enough also to solve the one major problem of distribution, an equilibrium rule of equal rewards for capitalist exertions. Thus, to extend the miraculous achievement associated with labour values such that not only a production-and-exchange, but a production-exchange-and-distribution equilibrium may be determined in one stroke, Steedman proposes to substitute prices of production for labour values.

2 Prices of production

Turning to Steedman's argument (A2), the issue is whether the

(uniform) rate of profit and prices of production can be derived from physical conditions of production, the real wage and the capitalist drive to accumulate. Before considering the transformation to (Q) into a price system (P), the issue of exploitation has to be taken up. The source of what is traditionally called the 'transformation problem' can thus be located. Again I will make use of Steedman's examples.

2.1 Real wages and exploitation

By assuming that real wages are lower than net output, Steedman posits in physical terms what is called exploitation in the value framework. If wages are equal for equal periods of work, a modified listing of inputs and outputs results from substituting real wage goods for entries of living labour:

(Q_e)		i	c		i	g	c
	i	28	3.5	→	56	—	—
	g	16	1	→	—	48	—
	c	12	.5	→	—	—	8
		56	5	→	56	48	8

There is a surplus product of 48g and 3c. Labour has disappeared, so there is no apparent reason why one should transform (Q_e) into a value system by mapping heterogeneous goods into the labour-'space'. In effect, there are good reasons against doing this, because the assumption of a real wage implies the need to modify the rule of exchange (3), which is constitutive of the value system (along with the rule of value creation). To assume a given real wage is nothing but an assumption on the nature of those exchange transactions which serve to acquire living labour to be realized in production.

While these transactions are of a quite complicated nature, because they usually involve an exchange of promises (to pay a specified amount of money on the part of the capitalist, to work a specified amount of hours on the part of the worker), the real wage assumption serves to reduce this complexity by positing that a given amount of living labour will be exchanged against a given amount of goods, specificable in kind. In the simple value framework suggested by Steedman, the assumption of a real wage would translate into a special rule of exchange for those transactions involving disposition over living labour, such that a unit of living labour (L') would always exchange against less than a unit of embodied labour;

(3') $L' \tau aL$ (a<1)

(In Steedman's example, a=1/4, while the additional restriction imposed by the real wage assumption, that living labour can be exchanged only against corn, cannot be portrayed in value terms, of course.)

The introduction of such a special rule raises some questions with respect to its consistency with the general rule of exchange (3) and, in turn, with the rule of transformation (1). Claiming equivalence relations between labour and goods (as embodied labour) is not easily compatible with rule (3′), where the explicit distinction between living and embodied labour and a differentiation with respect to their quantitative weight in exchange is used to make plausible the transformation of embodied labour (in the form of wage goods owned by capitalists) into living labour (as expended by workers in exchange for wage goods).

Leaving aside these issues, we simply take note of the point that the assumption of a real wage implies a special rule of exchange. At the same time, it settles one and, presumably, the most important part of the distributional problem by determining labour's share of the net product. There is an open question of how the surplus product is distributed among capitalists. But, again, there is no apparent reason for the expectation that the rules of value creation and exchange constitutive of the value system will imply a rule of distribution which is satisfactory for all agents involved.

(V_e)	C	V		W	S	S/C+V
i	56	14	→	112	42	.6
g	32	4	→	48	12	.33
c	24	2	→	32	6	.23
	112	20	→	192	60	.45

(C,V,W,S are constant, variable capital, value of output, surplus value; to avoid confusion, S/C+V is called the rate of valorization.)

2.2 *Distributional equilibrium*

(V_e) illuminates two points. First, rule (3′) for the exchange of living and embodied labour is not satisfactory for workers. Second, a rule of distribution based on the imputation of net output to the expenditure of living labour is not satisfactory for all those capitalists who use relatively small amounts of living labour compared to other inputs.

It is always tempting to speculate on the potential results of widespread social dissatisfaction. In our case, *workers* would insist on the abolition of rule (3′), demanding that there be only one general rule of exchange (3) involving no distinction between

living and embodied labour. Certainly, workers would see no point in objecting to the imputation of net output to their labour. Alas, we know that workers are structurally disadvantaged in capitalist systems, so this is an empty speculation. Turning to *capitalists,* they would have no objections against rule (3´), but otherwise they are in an awkward position because they are in different positions. The iron producer would insist on continuing the game according to the rules played out in (V_e). But the gold and, more so, the corn producer would turn into believers in equity, take the iron producer to the side-line and threaten him with a mysterious weapon called *competition.* Without ever having to use that weapon, they succeed in convincing the iron producer that rules of value creation are arbitrary and rules of exchange are nonsense, exchanges being subject to free contract. The iron producer turns into an equally true believer in equity among capitalists. Together, they decide to forget about (V_e) and take a fresh look at (Q_e).

After some deliberations, they succeed in translating their moral beliefs into an assumption of *'equal difficulty of production'*[5] in all branches. The new rates of exchange are to be determined such that the surplus product is distributed as if it were a reward for overcoming this 'equal difficulty of production'. In this spirit, they rewrite (Q_e), fearlessly overcoming logical difficulties:

$$(Q_p) \quad x(28i + 3.5c) = 56i$$
$$x(16i + \quad 1c) = 48g$$
$$x(12i + 0.5c) = \quad 8c$$

Agreeing that all rates of exchange are to be fixed in unit terms of one of the goods traded, capitalists maintain that $L'\ \tau\ 0.0625c$ and find that

$i\ \tau\ 0.3947c$
$i\ \tau\ 1.7042g$
$c\ \tau\ 4.2958g.$

The effect of these terms of trade will be an equal rate of reward for all, $x-1 = 0.5208$. Happy with these results, capitalists decide to act accordingly and to consult regularly in the future whether changes in conditions of production or in workers' attitudes would require adjustments.

Returning from speculations to the real world of economic theory, we face the hard facts of the transformation problem.

2.3 *The real transformation*

Marx, to whom the dubious honour of having created the trans-

formation problem is attributed, clearly recognized that (V_e) is in a state of disequilibrium as far as capitalists are concerned. Given their lower rates of valorization, the gold and corn producers would strive to become iron producers, too. If there was no mechanism to hold them in their respective branches of production, and if there was no way to change the rule of exchange (3), the most likely outcome of (V_e) would indeed be an economy of iron producers. Obviously, such an economy would not be feasible, so Marx was willing to concede that rule (3) was a softer spot in his argument than he had assumed before and that there would be some mechanism operative in exchanges which would satisfy capitalists to stay in their proper places. Unfortunately, Marx was willing to speculate about the new rules of exchange and distribution before ever specifying the mechanism which would bring them about.[6] So he became hopelessly entangled, mainly because he was not radical enough to sacrifice not only rule (3), but also the rule of value creation which imputes the increase in social wealth to the expenditure of living labour.

Steedman, as others before him, is sufficiently radical to take this step. His argument (A2) suggests that, right from the start, Marx should have based the theory of a capitalist economy on the recognition of a rule of distribution among capitalists. The rule is that the rate of profit is uniform in equilibrium. The underlying idea is that capitalists will demand equal rewards for equal efforts, where the efforts are measured by the respective outlays of capital. The Sraffian problem involved is that the measure itself cannot be independent of the rate of profit, because the only consistent measure of capital outlays is given by the exchange ratios among goods and labour functioning as inputs. These exchange ratios are not independent of the rate of profit, so they all have to be determined simultaneously. For Steedman, these considerations point to the need to return to the description of production conditions and wages in physical terms, as the empirical starting-point of economic reasoning.

(Q) is transformed into (pp. 45f.)

(P) i: $(1 + r)(28p_i + 56w) = 56p_i$
       g: $(1 + r)(16p_i + 16w) = 48$
       c: $(1 + r)(12p_i + 8w) = 8p_c$
with $80w = 5p_c; p_g = 1.$

The unknowns are the rate of profit, r, the money wage, w, and the iron and corn prices, p_i, p_c. They are easily determined, and Steedman draws the far-reaching conclusion that one can 'derive from the physical picture of the economy a coherent theory of

profits and prices' (p. 48). In considering this claim, one should not be misled by the simplicity of the examples or by the normalization used here — with gold prices being somewhat out of fashion nowadays. Also, I do not want to discuss whether the term 'theory' is a somewhat inflated label for the demonstration that the adoption of an equilibrium rule of distribution for capitalists enables one to derive prices, etc., from physical conditions of production, etc.

However, I do want to take a second look at the transformation from (Q) to (P).

2.4 *Prices and exchange*

According to conventional wisdom embodied in economic theory, a price is a positive or zero number associated with each commodity. Steedman's solutions to (P) thus allow us to associate the numbers 1.7052 with iron, 4.2960 with corn, 0.2685 with labour, 1.0000 with gold (the last association being given by definition). Of course, from a theory of prices we expect to learn something about the economic significance and the rules of such association. Steedman, staying as close to Marx as he can, suggests that we follow Marx and 'treat gold as the money commodity, so that the price of a commodity is the quantity of gold with which it exchanges' (p. 45). The numbers calculated have the following significance:

$$i \tau 1.7052g$$
$$c \tau 4.2960g$$
$$g \tau g$$
$$L' \tau 0.2685g.$$

In general, we have exchange transactions described by

(4) $i \tau p_i M$ and
(5) $L' \tau w M$

(where M is money, leaving aside whether gold, paper currency or shells serve as money). Thus, (P) is a monetary picture of (Q). The transformation of (Q) into (P) rests on the assumption that relations (4) and (5) depict necessary and ubiquitous transactions. Steedman suggests this much: 'It is to be taken as read throughout that the exchange of commodities takes place via the medium of money' (p. 19). The goods and labour described in (Q) are presented in (P) according to their capacity to attract money in exchange. At the same time, the rate of increase in monetary wealth achieved by production is expressed by the rate of profit.

Introducing money seems to solve the problem of selecting a dimension into which heterogeneous goods and labour can be mapped. The selection seems to be less arbitrary than the one of labour, underlying (V), because it reflects characteristics of actual capitalist economies. However, the realism of assumptions is a bad substitute for theoretical argument. The argument which is lacking in Steedman is one on why goods should be exchanged against money and where money would originate. Whereas labour in (V) is an element of (Q), money in (P) has to be introduced exogenously, even if one of the goods from (Q) serves as money. Despite the assumption of ubiquitous buying and selling, money has no necessary function in (P), except to make plausible the accounting convention which serves the theoretician to calculate prices. Money does not serve as a medium of exchange, a means of payment or a store of value. Analytically, the monetary economy (P) is indistinguishable from the barter economy (Q_p).

Actually, this is not surprising. The determinability of the unknowns in (P) rests on assumptions which make money superfluous, except in its property as an accounting device. The reasoning underlying the transformation of (Q) into (P) is approximately the following: First, we have to bring the heterogeneous ensemble of goods and labour in (Q) into a form accessible to algebraic operations. This is accomplished by assuming that every good and every kind of labour have a price. To determine prices quantitatively, it is not sufficient to think of every entry in (Q) in terms of a price tag attached to it. One has to assume prices to be equilibrium prices, with the physical changes occurring in (Q) through production — the increase in material wealth — being captured by a uniform rate of profit. That the price system is taken to be in a state of equilibrium is evident, on the one hand, from the implicit assumption of uniform prices for uniform goods. On the other hand, the mode of calculation of prices demonstrates that exchange relations are assumed to be equivalence relations in the formal sense. Otherwise it would not be possible to determine, for example, the price of one good from the knowledge of the prices of other goods and the rate of profit.

The possibility to determine prices is tied to the assumption of an equilibrium of the price system which, in turn, reflects the mutual compatibility of production, exchange, and distribution conditions. Since processes of convergence towards equilibrium, in which money could play a role, are not considered, and money is not essential for defining the mutual compatibility of production, exchange, and distribution conditions, money is indeed superfluous for the determination of prices, which, as numbers, describe barter arrangements under an accounting convention.

Maybe I am overemphasizing a trivial point, but it should be clear that neither the theory of value nor the theory of prices and profits as presented by Steedman have anything to do with a theory of a monetary economy. Less trivially, it is even questionable whether conceptions of an economy so deeply rooted in equilibrium notions as both the value and the price-of-production systems can serve as a starting-point for such a theory. If one separates the theory of prices and profits as proposed by Steedman from all ill-founded connotations with a theory of a monetary economy, the results of the transformation of (Q) into (P) are very limited. The possibility is demonstrated of constructing, for any economy described in physical terms and given standard assumptions, an exchange system which will ensure a distribution according to the fiction of an 'equal difficulty of production'. Why one should do this is another question.[7]

3 Conclusion

I think Steedman's arguments (A2 and A3) are not sufficient to support his claim that Marx's value reasoning must be abandoned. Whatever may be right or wrong with Marx, the Sraffa-based critique can 'be met head on' (p. 25), because it rests on questionable and often implicit assumptions and, most importantly, on a redefinition of some traditional problems of economic theory. The redefinition occurs when it is assumed that descriptions of self-reproducing economies in physical terms can be used as the starting point of theoretical reasoning. Implicit assumptions abound when it is assumed that one can transform these descriptions into equational systems in either value or price terms. The transformations are tied to assumptions of equilibrium, as shown by the need to adopt a rule of exchange or a rule of distribution among capitalists. Relying on equilibrium assumptions leads Steedman along the well-trodden path of dichotomizing economic theory into one branch, where money is a veil and prices can be determined, and another branch, where money plays some role and everything else is quite uncertain.

To conclude, I think Steedman's arguments must be accepted on logical grounds only if the decisions underlying the modelling of capitalist economies are *not* a matter of logic. I would prefer to think that they are, at least, if there can be a consensus about the central features of the economy to be explained. Certainly, one of these features is the co-ordination of production decisions on markets through the exchange of commodities and money. A theory of prices and profits which has no place for money and assumes that production activities are co-ordinated provides for

very fragile leverage against a theory of value whose, literally, first objective is to account for the necessity of money in commodity producing systems. Steedman is right to label Marxists 'obscurantist' and 'evasive'. But sometimes it is better to be wrong for the right reasons than to be right for the wrong reasons.

Appendix

A tax in kind on labour employed

The following example is intended to demonstrate that the problem of distribution (equal rates of return on capital outlays) solved by the derivation of prices of production by reference to the *deus ex machina* of competition can also be solved by reference to the *deus ex machina* of the state. The significance of this alternative solution lies in the fact that all exchanges conducted after state intervention can take place according to the values associated with each good. The uniform rate of return on capital outlays is equal to Marx's rate of profit.

Economically, this alternative solution is nonsense, but so is the familiar one, unless the processes leading to the equilibrium state of the prices of production regime can be specified. In other words, unless there is a theory of competition, the prices of production derived in linear models of production have as much explanatory value as the activity of counting unknowns and equations.

Using Steedman's example of a simple iron, gold, and corn producing economy and reducing it to its implicit status of a barter economy, the state would intervene in the following way:

Since the net output of each industry is imputed to the living labour employed, the tax rate is fixed with respect to these amounts of labour, such that total surplus value is absorbed in kind by the state. The surplus product is then redistributed according to each industry's share of total capital outlays (measured in values). The resulting rates of valorization (η) are equal for all capitals. Capitalists can then engage in the barter activities necessary to ensure the simple reproduction of the economy, using values to determine exchange ratios.

Given (Q) and (V) as above, the net output in each industry is imputed to the living labour employed. A tax rate of 75 per cent on the product imputed to each hour of living labour will absorb portions of gross output 21i, 12g, and 1.5c, such that the after-tax-before-redistribution state of the economy is as follows:

(Q′)	i	g	c	(V′)
i:	35	—	—	70
g:	—	36	—	36
c:	—	—	6.5	26
state:	21	12	1.5	60

After redistribution, the account for the state has disappeared again and the economy looks as follows:

(Q″)	i	g	c	(V″)
i:	46.13	6.36	0.8	101.82
g:	5.67	39.24	0.4	52.18
c:	4.2	2.4	6.8	38

In other words, the state has redistributed the surplus product according to each industry's share of total capital outlays (measured in values). Capitalists are considered as shareholders in a common enterprise. Dividends are paid out in kind, such that the rate of valorization is equal ($\eta = 0.45$). Considering the reproduction requirements, we can now tabulate deficits to determine the necessary barter transactions (c_L is the corn required for real wages):

Deficits:	i	c_L
i:	+18.13	−2.7
g:	−10.33	−0.6
c:	− 7.8	+6.3

Barter will lead to the following 'final' state of the economy:

(Q*)	i	c_L	c_K	g
i.	28	3.5	1	27.82
g:	16	1	1	12.18
c:	12	0.5	1	8

(where c_K is the corn consumed by capitalists). The corresponding values are

(V*)	C	V	S_d	$\eta(= S_d/C+V)$
i:	56	14	31.82	0.45
g:	32	4	16.18	0.45
c:	24	2	12	0.46

(where C, V, S_d are constant and variable capital and surplus value acquired through redistribution). Apparently, the tax authorities made a slight error through rounding, so that agriculture receives a little subsidy.

The example demonstrates that it is possible to construct a redistribution mechanism such that there is a distributional

equilibrium and exchange transactions are governed by values. Of course, introducing the state and taxation bears all the marks of an *ad hoc* assumption. But precisely this is the point. As long as the assumption of (perfect, unlimited?) competition underlying the standard derivation of prices of production remains an *ad hoc* assumption, other assumptions of the same methodological status can be substituted for it. This will be true until a theory of competition is elaborated which supports the results derived in the comparative statics framework of linear models of production.

Notes

*Thanks to Ulrich Krause and Johannes Berger for comments and criticisms. Remaining errors are my own, of course.

1. NLB, London 1977. All page references in the paper refer to this text. To avoid misunderstanding I want to emphasize that the argument following is at no point intended to present Marx's theory of value. As to Steedman's arguments, I take them to be representative of a school of thought.
2. Cf. Georgescu-Roegen (1979) for a well-informed complaint on the 'prevailing arithmomania' in economics.
3. (V) does not appear in Steedman in this form, because he immediately introduces the distinction between variable capital and surplus value.
4. Cf. Krause (1979) for an analysis of the conditions of transitivity with regard to Marx's 'forms of value'.
5. Cf. Benetti/Cartelier (1980, p. 97).
6. To reverse the order of chs 9 and 10 in Marx (1972) may illustrate this point.
7. Cf. Appendix.

References

Benetti, C. and Cartelier, J. (1980) *Marchands, salariat et capitalistes*, Maspero, Paris.
Georgescu-Roegen, N. (1979) Methods in Economic Science, *Journal of Economic Issues*, vol. 13/2, pp. 317–28.

Krause, U. (1979) *Geld und abstrakte Arbeit*, Campus, Frankfurt.
Marx, K. (1972) *Capital*, vol. 3, Lawrence & Wishart, London.
Steedman, I. (1977) *Marx after Sraffa*, NLB, London.