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SIMULTANEOUS VALUATION EXTIRPATED

A Contribution to the Critique of the Neo-Ricardian Concept of Value

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ABSTRACT: The neo-Ricardian interpretation of Marx's concept of value is criticized. A one commodity, circulating capital model is presented which both reinstates the neglected intertemporal aspect of value magnitudes, and seriously challenges the neo-Ricardian's "refutation" of the law of the tendency of the rate of profit to fall. Much of the further significance of the argument is summarily stated as a conclusion.

Criticism of Marx's theory of accumulation began soon after the publication in 1894 of *Capital* III. The critics advanced two quite different arguments. Von Bortkiewicz [1907], one of the early critics, offered a straightforward rejection of Marx's theory.[1] However, for most of this century such criticisms largely went unremarked by writers on Marx's theory of accumulation. Thus, the preponderant objection to be found in the literature has been along a second line. These interpreters of Marx contended that among all (theoretically) conceivable patterns of accumulation, Marx had unjustifiably accorded priority of place to one, the tendency for the rate of profit to fall. They recognized that such criticism was far from definitive, for they more or less openly acknowledged the possibility that Marx had, nonetheless, made the correct choice.[2] Following the publication of Sraffa's *Production of Commodities by Means of Commodities* [1960], however, the original, more devastating angle of criticism was revived. Once again, Marx's theory of accumulation is flatly denied by critics. Marx's notion of the falling rate of profit is not, after all, even a logical possibility.

It is ironic that Sraffa's work can be used to arrive at a negative verdict on that of Marx, since *Production of Commodities by Means of Commodities* was devoted to a critique of neoclassical theory. It is customary to explain this peculiarity by reference to the revival of classical political economy which the publication of his text stimulated [Kregel, 1971:1-11]. After all Sraffa clearly saw the Ricardian basis of his critique of modern economics and especially of its price and distribution theory [1960:v-viii]. However, many of Sraffa's followers, the so-called neo-Ricardians, applied his analytic framework to a re-examination of the central propositions of Marx's *Capital*. In general, they begin by "correcting" Marx's procedure of transforming values into prices of production. They note that Marx forgot to transform the inputs and, in correcting him, they are forced to impute to him a concept of value which allows inputs to be transformed.[3] The neo-Ricardians then point out that these same prices of production can be computed – without any reference to values – directly from a knowledge of the techniques of production, once the real wage rate is specified [Steedman, 1977:48-9]. Thus, values, likewise obtained from the given physical or technical data, are deemed "at best, redundant." [Steedman, 1977:202] Indeed, in *Marx After Sraffa*, Steedman declares that insistence on the import of value magnitudes in economic analysis is "obscurantist" [1977:21, 48-9].

The neo-Ricardian solution to the Marxian transformation problem duplicates that of von Bortkiewicz. He had not only solved the transformation problem in a similar fashion, he had also formulated the modern rejection of Marx's law of the tendency of the rate of profit to fall [von Bortkiewicz:1907]. Von Bortkiewicz, like modern neo-Ricardians, pointed out that capitalists are entirely unaware of values or a value-based rate of profit. Rather, in deciding among alternative investment opportunities, capitalists reason in the "visible" magnitudes, in terms, that is, of the prices of production. The neo-Ricardians then argue that if competing capitalists attempt to maximize profits, the presumption in Marx, they will *not, ceteris paribus*, choose techniques of production which will lower their rates of profit. Because they individually bar the introduction of such techni-

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ques, the general rate of profit, as obtained from all of the techniques of production, likewise cannot fall. Thus, they conclude that by contradicting the assumption of profit maximization, Marx's law of the tendency of the rate of profit to fall is logically invalid.

In this paper, we take the necessary first step in criticizing this judgment of Marx's law. It will be argued that the problem lies not with his theory, but with the imposition on it of the neo-Ricardian conception of value. We simply show that, unlike the Marxian notion of value, that of the neo-Ricardians allows no meaningful intertemporal comparison of value magnitudes. We confront this issue in the simplest possible case: that in which all capital circulates and only one commodity is produced.[4] It is necessary to begin at this simplest level in order to map out the origins of the problem without interference from issues that emerge only in more complex cases. Perhaps it should be noted that the neo-Ricardian claim against Marx's law is made for *all* circulating capital models in which each process produces a single commodity. Thus, if even one relevant counter-demonstration is made, the claim suffers a severe blow.

The only further reminder we need make at this point is that despite the theoretical equivalence of value and price magnitudes in a neo-Ricardian one commodity model, we are agreed that capitalists indeed know nothing of "values." Moreover, quantities of the one commodity used for various ends – for example, as instruments and materials of production or as surplus product – bear the same relation to one another as would their prices, since all portions of the one product have a single price. Thus, the capitalists, owners of the one commodity, reason in physical terms, and although it cannot reasonably be said that they compete with one another, they are nonetheless profit maximizers. Therefore, capitalists will not select any technique of production which will lower the rate of profit which is visible to them. By reinserting Marx's ideas on the distinction between physical quantities and value magnitudes we are able to show that it is the *value* rate of profit which falls.

Briefly then, in the linear production model of the neo-Ricardians, a falling rate of profit is impossible. But within the context of a theory of the overaccumulation of capital, a falling rate of profit is not only possible but significant. We shall draw several implications from this change in point of view.

Simultaneous Valuation: The Denial of the Law

The central concept in Marx's law of the tendency of the rate of profit to fall is the notion of value. For Marx, the substance of value is abstract labor, which is both socially necessary and homogeneous [1967a:38-9]. The magnitude of value is thus determined

> by the quantity of the value-creating substance, the labour contained in the article. The quantity of labour is, however, measured by its duration, and labour-time in its turn finds its standard in weeks, days, and hours [1967a:38].

Marx then considers the form of value (exchange value) and money. However, because we are using a one commodity model, the category of exchange value cannot be developed,[5] since, strictly speaking, the exchange value of a commodity can only be expressed in another commodity [Marx 1967a:60]. As there exists only one commodity, there is no exchange value and no money. The one commodity is simply means of production, wage good, and surplus product. Therefore, it is the only means by which capitalists can measure profitability.

We first present Marx's notion of the falling rate of profit using the value magnitudes. We then recast that idea in material terms, so that capitalist investment decisions can be considered. Let us initially denote the three portions of the product of period t as follows (a list of variables appears at the end of this article):

c_t = constant capital, the value of the means of production consumed.

v_t = variable capital, the value of labor power.

s_t = surplus value, the amount of time labor power works over and above its own value.

Thus, assuming the value of the constant capital is transferred to the output of each period, the value of the gross product in the period is

$$w_t = c_t + v_t + s_t.$$

Each variable is a specified quantity of labor time and we assume that all capital, constant and variable, turns over in the given period of production. The rate of profit is given by the formula

$$\pi_t = s_t/(c_t + v_t) \tag{1}$$

We shall refer to π_t as the "value rate of profit" since value magnitudes are used in computing it. We assume that in each period techniques of production are uniform, of course, for all capitalists, although they change from period to period as productivity increases.

The model of accumulation[6] is as follows:

1. In the value model, c_1, v_1, s_1 and, therefore, their sum, w_1, are given data.
2. For the sake of simplicity, $v_t + s_t = L$, where L is a constant amount of living labor time; it is the magnitude of value produced by the employed labor force. Workers are paid at the end of the production period.

3. Because productivity increases with the accumulation of capital, and the real wage is assumed constant, the variable capital required for the purchase of the labor power declines. Let d_t, $-1 < d_t < 0$, be its rate of change from period t to period t + 1. That is,
   $v_{t+1} = (1 + d_t)v_t$.
4. The rule for constant capital growth is given by
   $c_t = (1 + a)c_{t-1}$ where a is positive and constant. Clearly, even with declining v_t, the constancy of L implies that at some time, the amount of value needed for the growth of constant capital will not have been produced in the previous period.[7]
5. We assume that accumulation is possible for at least one period, that is, $s_1 > ac_1$ and that capitalists might consume an insignificant amount of the commodity.
6. Any amount of surplus value not required for the expansion of constant capital in the ensuing period presumably is used by the capitalists for personal consumption. Therefore, in this model, there is no "problem of effective demand" – as long as the accumulation of capital can continue.

TABLE 1
The Value Model

Period	c +	v +	s =	w
1	c_1	v_1	s_1	w_1
2	$(1+a)c_1$	$(1+d_1)v_1$	$s_1 - d_1v_1$	$w_1 + ac_1 = w_2$
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
t	$(1+a)^{t-1}c_1$	$(1+d_1)\ldots(1+d_{t-1})v_1$	$s_{t-1} - d_{t-1}v_{t-1}$	$w_{t-1} + ac_{t-1} = w_t$
t+1	$(1+a)\,c_t$	$(1+d_t)v_t$	$s_t - d_tv_t$	$w_t + ac_t = w_{t+1}$

As capital accumulates, the value rate of profit tends to fall; that is, $\pi_{t+1} < \pi_t$. The reasoning starts from the idea that from period to period c grows faster than s. In terms of the above model, $\pi_{t+1} < \pi_t$ if and only if d_t satisfies[8]

$$-d_t < a(s_t/v_t)(c_t/w_t) \qquad (2)$$

In our model this is the same thing as: if and only if the rate of growth of surplus value, g_s, is less than the rate of growth of the value of output, g_w. That is,

$$g_{s_{t+1}} = (s_{t+1} - s_t)/s_t = -d_tv_t/s_t < ac_t/w_t = (w_{t+1} - w_t)/w_t = g_{w_{t+1}}.$$

At this point, we can consider the neo-Ricardian challenge to Marx. We all agree that values are not the immediate basis for capitalists' decision making. Instead, in the one commodity model decisions are based on comparisons of quantities of the one commodity. To make these comparisons, we must translate the accumulation model into material terms.

For the moment, we adopt the neo-Ricardian notion of value – the time it takes to produce the commodity under the newly prevailing technique. Thus, in any period t, the material ratios of portions of the product are in exact proportion to the corresponding value ratios. As the proportions between means of production, c_{m_t}, real wages, v_{m_t}, and surplus product, s_{m_t}, are given by the proportions of c_t, v_t, and s_t, Table 1, the amounts of the three parts of the product and the quantity of material output, w_{m_t}, can be computed from a knowledge of the given, constant real wage v_m. Thus, to make the conversion we need only multiply each value magnitude by (v_m/v_t), since $v_{m_t} = v_m$ for all periods.

TABLE 2
The Neo-Ricardian Material Model Corresponding to Table 1

Period	c_m +	v_m +	s_m =	w_m
1	$c_1(v_m/v_1)$	$v_1(v_m/v_1)$	$s_1(v_m/v_1)$	$w_1(v_m/v_1)$
2	$c_2(v_m/v_2)$	$v_2(v_m/v_2)$	$s_2(v_m/v_2)$	$w_2(v_m/v_2)$
.	.	.	.	.
.	.	.	.	.
.	.	.	.	.
t	$c_t(v_m/v_t)$	$v_t(v_m/v_t)$	$s_t(v_m/v_t)$	$w_t(v_m/v_t)$
t+1	$c_{t+1}(v_m/v_{t+1})$	$v_{t+1}(v_m/v_{t+1})$	$s_{t+1}(v_m/v_{t+1})$	$w_{t+1}(v_m/v_{t+1})$

$$\pi_t = s_t/(c_t + v_t) = \frac{s_t(v_m/v_t)}{c_t(v_m/v_t) + v_t(v_m/v_t)} = s_{m_t}/(c_{m_t} + v_m)$$

Thus, in the neo-Ricardian presentation, the rate of profit is the same whether calculated using values or calculated using quantities of commodities. Capitalists can compute the equivalent of the value rate of profit because they have knowledge of the material inputs and outputs of the process. According to neo-Ricardians, capitalists will adopt a new technique only if

$$\pi_{t+1} \geq \pi_t.$$

Therefore, Marx's proposition – that as capital accumulates $\pi_t > \pi_{t+1}$ – is invalid.

We have here constructed a neo-Ricardian refutation of Marx's law for the case of a one commodity model. But we should note that this basic formulation remains, to a large extent, the same in more complex models. That is, the idea that a capitalist would see that investments which lower the overall rate of profit are not in his interest is the central counter-proposition in the neo-Ricardians' n-commodity version of the argument.[9]

Valuation as Process

An alternative view of value. Can Marx be so easily dismissed? It should be noted that the neo-Ricardian treatment of the falling rate of profit turns on a particular view of the process of value preservation and value creation. In this conception, the value of commodities used as means of production in a period is determined simultaneously with the value of the output of that period. Yet when we observe that the means of production used in period t were produced in period t-1, the neo-Ricardian determination of their value seems suspect. There would be no need to consider this if the conditions of production did not change from period to period.

However, in Marx's idea of the accumulation of capital the techniques of production change as productivity increases. Since increases in productivity are here assumed to occur on a regular basis, we are consistent with Marx in treating the value of means of production as fully preserved in the output of a period.[10]

Let us explore this notion in some detail. In period t-1, $c_{m_{t-1}}$ and L are combined in a process of production to produce $w_{m_{t-1}}$. Now a portion of this output, say x, where $0 < x < 1$, is used for consumption and the other portion, 1-x, is used as means of production in the next period, t. Thus $(1\text{-}x)w_{m_{t-1}} = c_{m_t}$. We illustrate this below.

$$
\begin{array}{l}
[c_{m_{t-1}}, L] \longrightarrow w_{m_{t-1}} \dashrightarrow x \bullet w_{m_{t-1}} \\
\qquad\qquad\qquad\quad \searrow \\
\qquad\qquad\qquad\qquad [(1-x)w_{m_{t-1}} \text{ or } c_{m_t}, L] \rightarrow w_{m_t}
\end{array}
$$

The symbol "$\longrightarrow$" means "production results in." The symbol "$- - \rightarrow$" indicates how the output $w_{m_{t-1}}$ is used *after* production. The point is that c_{m_t} — means of production in period t — has a value which is determined in period t-1. In turn, c_{m_t} is used in the production of w_{m_t}.

The neo-Ricardians would have us believe that the value of c_{m_t} is determined in t itself. That is, according to them, c_{m_t} is unknown until production takes place in period t and, after production takes place, the unit value is given by $L/(w_{m_t} - c_{m_t})$. Given that labor productivity is increasing it is never clear when values actually change. Each period of production contains the information necessary for the computation of the unit value as inputs and outputs are simultaneously valued. Instead of observing the connection between one period of production and the next, the neo-Ricardians view the accumulation process as little more than a sequence of discrete cases in which production takes place.

Let us instead consider how this process can be viewed consistently with Marx's notion of value creation. Given that in each period productivity increases, the unit value of the commodity falls, and hence, at the conclusion of the production process a larger quantity of the commodity is necessary to represent a given amount of value. In other words, the value magnitude, c_t, is embodied in a *smaller* number of commodity units at the start than it is at the end of the period. If we express the quantity of means of production *used* in period t as $c^*_{m_t}$, its value, c_t, is preserved in the value of output by an amount of the commodity which we continue to denote by c_{m_t}.[11]

Recall that c_{m_t} is the amount of the means of production neo-Ricardians see as an input. With simultaneous determination of the values of commodity inputs and outputs, they fail to recognize the fall in the unit value of the commodity that takes place within and as a result of the process of production. Thus they cannot begin to comprehend that the value magnitude, c_t, is embodied in a quantity of commodity output larger than the input quantity of means of production in which it was originally embodied.

Let z_{m_t} be given by $z_{m_t} = c_{m_t} - c^*_{m_t} > 0$. z_{m_t} is the difference between the amount of the commodity needed at the end of the production process in order to preserve the value of the means of production *and* the amount of material actually used in production.

Let c_t^* be the value of that quantity of commodity-*output* from period t which is equal in amount to $c^*_{m_t}$, the quantity of means of production used in t. Clearly, c^*_t is *less* than c_t, the value advanced and embodied in the means of production used in period t because of the increase in productivity. If $z_t = c_t - c^*_t$, then z_t is the value of z_{m_t}. Indeed, the greater the increase in productivity in period t, the greater the decrease in the unit value of the commodity, and the greater is z_t.

At first glance, it may seem that v_t must be treated like c_t insofar as both are part of the value advanced in period t. However, the nature of the advance of v_t differs from that of c_t. We have seen that at the beginning of the production process of period t, c_t must be present in the form of material goods, $c^*_{m_t}$. On the contrary, capitalists merely commit themselves to paying workers "chits" or pieces of paper with a "social"[12] worth of so many units of the one commodity which is yet to be produced. After production takes place in t, capitalists then give workers the chits. However, these means of payment are never at rest in the hands of capitalists and hence, to them, the chits appear as an element of cost, "tied up" or advanced. The value of the variable capital, v_t, advanced in this fashion is the amount of time needed to produce the equivalent in value of v_{m_t}. Thus, unlike the value of constant capital, that of variable capital advanced in t is determined by production in t and not in t-1.

At this point, an example of the difference between production of values and production of use-values will underscore our criticism of the neo-Ricardians. Let us say that capitalists have 100 bushels of corn to be used as seed ($c^*_{m_t}$) and hire 10 workers who agree to work 10 hours each for a wage per worker of 2 bushels of corn (v_{m_t} = 20). Payment is to be made in the form of "chits" after the work is finished.

If (1) the 100 bushels of corn took 100 hours (c_t) to produce and if (2) the 2-bushel wage chits are in "circulation," having been paid for work performed in the previous period, then capitalists calculate that they have advanced 120 bushels of corn.

Now let us say that the 10 workers produce a gross output (w_{m_t}) of 400 bushels of corn. The wage chits have now returned to the capitalists and payment is made to the workers. The capitalists calculate their return: on an investment of 120 bushels of corn they have made a profit (p_{m_t}) of 400-120 = 280 bushels of corn. Thus to the capitalists, the rate of profit is 280/120 or 233.33...%:

$$\pi^*_{m_t} = p_{m_t}/(c^*_{m_t} + v_{m_t}) = 280/120 = 2.3333.$$

If we consider the same process in terms of value, the seed-corn had a value, c_t, prior to production of 100 hours; the living labor added is another 100 hours. The value of the gross product (w_t) of 400 bushels of corn represents an expenditure of 200 hours of labor. Preservation of the value of the seed-corn (c_t) requires an amount of corn (c_{m_t}) which represents 100 hours of labor (c_t) or 200 bushels of corn produced in t. The variable capital advanced (v_t)—equivalent in value to 20 bushels of corn (v_m)—has a value, therefore, of 10 hours. Surplus labor (s_t) is 100-10 = 90 hours; this is embodied in 180 bushels of corn (s_{m_t}). The rate of profit calculated using these value magnitudes in the formula, given above as equation (1), is

$$\pi_t = s_t/(c_t + v_t) = 90/(100+10) = 9/11 = 0.8181$$

considerably less than the rate of profit computed by capitalists.

The difference in the rates of profit arises from the revaluation of seed-corn in the process of production. Before the process, each bushel of corn had a value magnitude of 1 hour; after production that magnitude is halved. Thus, the value magnitude embodied in the 100 bushels advanced is preserved in 200 bushels of the output. The difference in the amount of corn advanced as constant capital and the amount needed after production for the preservation of the value magnitude advanced, has been labeled z_{m_t}. Its value, z_t, captures the devaluation of means of production due to increasing productivity. Because capitalists know nothing of values, they cannot see this loss of value and, in a one commodity model,[13] they simply include z_{m_t} in their profits, returns above costs. Their rate of profit is thus

$$\pi^*_{m_t} = p_{m_t}/(c^*_{m_t} + v_{m_t}) = (s_{m_t} + z_{m_t})/(c^*_{m_t} + v_{m_t}).$$

An alternative view of the rate of profit. Clearly, the "visible" rate of profit, $\pi^*_{m_t}$, of period t is not the rate of profit, π_t, computed on the basis of values. Thus, under some conditions, the former could conceivably rise as the latter falls. We shall not be concerned with all possible cases for changes in productivity nor with all cases in which the visible rate of profit, $\pi^*_{m_t}$, rises as the value rate of profit π_t, falls. To demonstrate the possibility of this divergence, it is sufficient merely to identify a subset of such conditions.

In each period the gross amount of the commodity produced can be computed by using the unit value implied by the given real wage, v_{m_t}, and the value, v_t. We follow the neo-Ricardians in assuming that the given real wage is constant. However, since the means of production consumed in period t were produced in period t-1, we must assume c^*_{m1}, which corresponds to the value of the constant capital, c_1, to be given at the outset of the value scheme in Table 1. The only condition on the choice of c^*_{m1} is that $c_1/c^*_{m1} \geq v_1/v_m$. This merely ensures that productivity is not falling as we begin our model.

1. c^*_{m1} and v_m are given positive amounts of material product. To simplify matters, we assume that $c^*_{m1} = (v_m/v_1)c_1$, or therefore that $z_{m1} = 0$. Thus, the divergence between the material and the value rates of profit is not assumed at the start but only emerges as accumulation takes place.
2. $v_{m_t} = v_m$, following the neo-Ricardian assumption of a constant real wage.
3. Therefore, $w_{m_t} = (v_m/v_t)w_t$ and $s_{m_t} = (v_m/v_t)s_t$. Note that s_{m_t} and w_{m_t} are the same amounts of material the neo-Ricardians would calculate from the given values.
4. $c^*_{m_t} = c_t(w_{m_{t-1}}/w_{t-1})$ for t = 2, 3,.... That is, the value of constant capital in period t is embodied in an amount of material which was produced (and therefore "valued") in t-1. Note that $c^*_{m_t} = c_t(v_m/v_{t-1})$ for t = 2, 3,..., but not necessarily for t = 1.
5. Recall from the value model that $v_t/v_{t-1} = (1 + d_{t-1})$ for t = 2, 3,..., with $-1 < d_{t-1} < 0$. We make the following change in notation: $v_{t-1}/v_t = (1 + b_t)$ for t = 2, 3,...and $b_t > 0$. Thus, $-d_{t-1} = b_t/(1+b_t)$ for each t = 2, 3,....Clearly, b_t is less than the proportional rate of increase in gross product from period t-1 to period t.[14]
6. By definition, $z_{m_t} = w_{m_t} - (c^*_{m_t} + v_m + s_{m_t})$. With the notation indicated in (5) above, z_{m_t} can be reformulated as $z_{m_t} = [b_t/(1+b_t)]c_t(v_m/v_t)$. The assumption on c^*_{m1} in (1) above is, therefore, that $b_t = 0$. Thereafter, b_t is defined in (5) above.

The model is summarized in Table 3.

TABLE 3
The Alternative Scheme of Material Production Corresponding to Table 1 Values

Period	c^*_m +	z_m +	v_m +	s_m =	w_m
1	$c^*_{m_1} = (v_m/v_1)c_1$	0	v_m	$(v_m/v_1)s_1$	$(v_m/v_1)w_1$
2	$c_2(v_m/v_1)$	$[b_2/(1+b_2)]c_2(v_m/v_2)$	v_m	$(v_m/v_2)s_2$	$(v_m/v_1)w_2$
.	.	.	.	.	.
.	.	.	.	.	.
.	.	.	.	.	.
t	$c_t[v_m/(v_{t-1})]$	$[b_t/(1+b_t)]c_t(v_m/v_t)$	v_m	$(v_m/v_t)s_t$	$(v_m/v_t)w_t$

If we recall that a is the proportional rate of growth of constant capital in value terms and if, in the model of Table 3, $b_t > b_{t-1} > \ldots > b_2 \geq a$, it can be shown (and the reader is encouraged to see Appendix 2) that $\pi^*_{m_t} > \pi^*_{m_{t-1}}$. That is, the visible rate of profit rises. Thus it is *possible* that capitalists *will* invest so that the value rate of profit falls. The result holds because a falling value rate of profit is compatible with a rising visible rate of profit. In other words, the value model of Table 1, in which the value rate of profit falls, is the value counterpart of the material model of Table 3, in which the visible rate of profit rises.

In this context, let us again consider the neo-Ricardian notion of value. If we take the material schema of Table 3 as the starting point and convert the material quantities to neo-Ricardian values, the value rate of profit would be exactly the same as that visible to capitalists. For neo-Ricardians, the living labor, L, is embodied in the material net product ($v_{m_t} + s_{m_t} + z_{m_t}$). The unit value of a commodity, u_t, is thus given by $L/(v_{m_t} + s_{m_t} + z_{m_t})$. All material quantities of a period are converted into values by multiplying by the unit value just calculated. Since, for neo-Ricardians z_{m_t} is a part of the net product, like the capitalists, they view it as a portion of profit. Their value rate of profit would thus be

$$\pi_t = (u_t s_{m_t} + u_t z_{m_t})/(u_t c^*_{m_t} + u_t v_{m_t}),$$

which of course is the same as

$$\pi^*_{m_t} = (s_{m_t} + z_{m_t})/(c^*_{m_t} + v_{m_t}).$$

"Value" thus becomes a "redundant" category.

Mere redundancy is not, however, the full extent of the problem. That is, were a neo-Ricardian to calculate value magnitudes from the amounts of material given in Table 3, the resulting schema would not only show an ever-increasing "value" rate of profit but also an ever-decreasing amount of constant capital required in production. Thus, as the amount of surplus value approaches the total of living labor, the neo-Ricardian "value" schema fails to anticipate that the surplus value produced in one period may not be sufficient to meet the constant capital requirement of the ensuing period. The system therefore appears eternal, with no symptoms of an impending shortage of surplus value. Value analysis is not simply redundant; it should be judged deceptive!

Because the neo-Ricardians simultaneously value the inputs and outputs of a single period of production, the change in the value of the means of production during a period simply vanishes. The dual nature of the capitalist process of production – production of material output and creation of value – is altogether neglected. The one-dimensional world of the capitalist is the "essence" of neo-Ricardian "science."

Additional Remarks

Throughout this paper we have focused on the failure of neo-Ricardian analysis to grasp the intertemporal aspect of Marxian values. Given the pervasive use of this interpretation of Marx, we would be remiss if we did not indicate the further significance of this point.

First, as we noted in the beginning, many have viewed Marx's law of the tendency of the rate of profit to fall as an arbitrary selection of a particular pattern of accumulation. Briefly, the dominant line of criticism argues that if capitalists mechanize in order to check increases in real wages – and if Marx's law is to hold – a necessary condition is that the ratio of constant capital to living labor must rise. However, it is generally deemed arbitrary to maintain that this occurs.

We cannot fully respond to this criticism here but note that it presupposes the neo-Ricardian notion of value. That is, to say that the ratio of the value of constant capital to living labor rises is to mean, in this view, that the ratio $c^*_{m_t}/(z_{m_t} + v_{m_t} + s_{m_t})$ grows, since $c^*_{m_t}$ is seen as the material counterpart of the value of constant capital *after*, as well as before, production takes place. The value added to constant capital is thus understood to be embodied in the material quantities z_{m_t}, v_{m_t}, and s_{m_t}. Marx's law is interpreted as nothing more than the assertion that technical change in capitalism necessarily implies a greater *material* amount of means of production per unit of output. Unfortunately, attempts to defend Marx too often accept this view of technical change. From our model, however, we see that a *decrease* in the material amount of the means of production per unit of output is compatible with a fall in the *value* rate of profit. Hence, defenders of Marx often argue needlessly that capitalists do not employ "capital-saving" techniques, as they are commonly called. Rather, these defenders ought to try to show that as a *decrease* in the amount of means of production per unit of output takes place, the aggregate of means of production increases. As capitalists attempt to "save capital" in this manner, a greater proportion of the output of one period is used as means of production in the next period. This paper certainly has not demonstrated the necessity for this greater proportion; rather, it has simply assumed it. However, we have hopefully given defenders of Marx firmer ground upon which to stand.

Second, given the material accumulation pattern of Table 3 and the corresponding values of Table 1, the relevance of empirical studies of the visible rate of profit is called into question. Clearly, that rate of profit rises. Very often, such studies are used to question the notion of the falling rate of profit. However, now that we know that a visible rate of profit can move in a direction opposite to that of the value rate of profit, we should seriously begin to question such misguided efforts to disprove Marx's law. To be sure, efforts to prove Marx correct in this fashion must likewise be seen as suspect.

Third, we can now see why Marx never asserts that the course of capitalist crises is directly attributable to the falling rate of profit. Since a falling value rate of profit is compatible with a rising visible rate of profit, the system could seemingly go on indefinitely. Yet, in the value model of Table 1 and its material counterpart in Table 3, there must come a time, t, when the amount of surplus value, as well as the amount of "profit," is not enough for the expansion of capital in period t + 1. The timing of this "crisis of overproduction" clearly depends not only upon the intitial values of c_1, v_1 and s_1 and the real wage but also upon the rate of accumulation *a* and the pattern of the growth rate of output as indicated by b_t.[15]

Fourth, we can *begin* to see why Marx refers to the "law of the tendency of the rate of profit to fall" as a tendency. Insofar as a crisis of overaccumulation causes a revaluation of constant capital, some portion of the value of the means of production would be destroyed. In such cases, the value rate of profit would tend to rise, rather than fall. In a more complex model, the visible rate of profit may tend to fall prior to a crisis of "overaccumulation." In other words, the visible rate of profit may approach the value rate of profit either before or during any crisis of overaccumulation.

Finally, within this paper we have by no means shown that Marx's notion of the accumulation process is correct. Indeed, we have not attempted an exposition of that process, as we have only taken up the category of value around which it is formed. This paper has merely demonstrated that the meaning of value hitherto used to reject (and often to defend) Marx's law of the tendency of the rate of profit to fall is foreign to Marx. Having freed the concept of value from the timeless world of the neo-Ricardians, the task remains to develop that category and to restate Marx's notion of the accumulation of capital. Only then could his arguments be seriously evaluated.

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NOTES

1. Van Parijs has briefly traced the origins of the rejection mentioned here [1980:14].
2. For example, Sweezy has questioned for years the validity of the law. The basic problems Sweezy uncovers are presented in an article [1974] critical of Marxists who uphold its validity.
3. This familiar idea is cogently summarized by Steedman [1977:31-3].
4. We abstract from recent attempts to incorporate fixed capital into the criticism of Marx. cf. Roemer [1979] as well as Alberro and Persky [1979]. We are implicitly disagreeing with attempts to defend Marx by incorporating fixed capital into the model since such attempts ignore what we consider the fundamental nature of the problem. cf. Shaikh [1978].
5. As we focus on the "magnitude of value," we are not concerned to show the manner in which value appears to capitalists. This is permissible since we are merely clarifying the neo-Ricardians' neglect of intertemporality in value magnitudes and some possible ramifications thereof.
6. We should recall that Marx never presented a model which showed the reproduction of the entire system as new techniques of production are introduced. Hence, our model is a modified version of one used by Grossmann [1929:119] in his attempt at presenting Marx's law.
7. To simplify matters we have assumed that *a* is positive and constant. We are implicitly assuming that a growing proportion of the output of period t-1 is used as means of production in period t and that, sooner or later, the demand for means of production exceeds the surplus output of the previous period. Thus, by assigning *a* a positive and constant value we assume a model in which capital generates a crisis of "overaccumulation." This crisis would occur even if real wages fell to nothing.
8. See Appendix 1 for the proof of statement (2).
9. The usual manner in which the neo-Ricardians proceed is to observe what happens to the general rate of profit when a given capitalist, producing a basic commodity, adopts a technique which increases his rate of profit. They show that the general rate of profit cannot fall; cf. Okishio [1961]. We assume that all capitalists invest simultaneously and then show, obversely, that were the general rate of profit to fall, individual capitalists would be forced to choose techniques which immediately reduce their individual profit rates.
10. According to Marx [1967a:404], when changes in the value of the means of production are anticipated, their value is transferred to the value of the output, since this "moral depreciation" is a portion of the value of the means of production.To be sure, for Marx [1967a:209-10], anticipation of the change in the value of the means of production may, at times, be impossible. In which cases, the value of the means of production is not completely preserved in the value of the output. In our model, productivity changes are assumed to occur on a regular basis. We thereby assume that the change in value of the means of production is anticipated and hence that their value is completely preserved in the value of the output. The manner in which capitalists anticipate such changes cannot be dealt with in our model as the process involves Marx's notion of the "form of value" which, again, cannot be treated in a one-commodity model.

In this context it is interesting to consider Samuelson's characterization of the manner in which neo-Ricardians transform values into prices of production. He states, "Contemplate two alternative and discordant systems. Write down one. Now transform by taking an eraser and rubbing it out. Then fill in the other one. Voilà! You have completed your transformation algorithm" [1971:400]. What Samuelson does not notice is that as neo-Ricardians write down a set of values they have already made use of their "eraser" to avoid confronting the manner in which changes in value take place during a period of production. It is hardly surprising that Samuelson never considers this, as this would accord to the production process a significance which is foreign to most of neoclassical economics and to the time involved. Thus, we find the neo-Ricardians in peculiar agreement with neoclassical economists in constructing economic models which abstract from the passage of time.

11. Note that using this notation, $c_{m_{t-1}}$ and c_{m_t} now become $c^*_{m_{t-1}}$ and $c^*_{m_t}$, respectively.

12. In an n-commodity model variable capital would of course be in terms of the money commodity. In this discussion, however, payment can only be in terms of a nonproduced promise of goods, since, on the one hand, the real wage is assumed given and constant, and, on the other hand, the only apparent measure of worth is the one commodity produced. The "chits" circulate as "money" because they are legal tender.

13. In more complex models exchange value would have to be considered, and capitalists may not include all of z_{m_t} in their profit calculations.

14. See Appendix 2, item 3.b.

15. See Appendix 3 for a proof of this.

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APPENDIX 1
The Value Schema

The Model

1. The data and assumptions of the model of accumulation:
   a) Data: c_1, v_1, s_1, and their sum, w_1.
   b) $c_t = (1 + a)c_{t-1}$, where $a > 0$ is a constant.
   c) $s_t + v_t = L > 0$, a constant labor force.
   The two assumptions, b) and c), imply a constant proportional rate of growth of capital per worker.
   d) $v_t = (1 + d_{t-1}) \cdot v_{t-1}$, where $-1 < d_{t-1} < 0$ for all $t \geq 1$. That is, with productivity increases, the variable capital diminishes.

2. Some useful results of the assumptions:
   a) $v_t = (1 + d_{t-1}) \cdot (1 + d_{t-2}) \ldots (1 + d_1) \cdot v_1$.
   b) $s_t = s_{t-1} - d_{t-1}v_{t-1}$.

The Falling Value Rate of Profit

3. The condition that the value rate of profit fall is a condition on d_t and, by implication, on the rate of productivity increases.
   Show: $\pi_{t+1} < \pi_t$ if and only if d_t satisfies $-d_t < a(s_t/v_t)(c_t/w_t)$ for $-1 < d_t < 0$ and for each $t = 1,2,3,\ldots$.
   a) By definition $\pi_{t+1} = \dfrac{(s_{t+1})/(v_{t+1})}{[(c_{t+1})/(v_{t+1})] + 1}$
   b) And from the above relations,
   $\pi_{t+1} = \dfrac{(s_t - d_tv_t)/(1 + d_t)\, v_t}{[(1 + a)c_t/(1 + d_t)v_t] + 1}$
   c) $\pi_{t+1} < \pi_t$ if and only if
   $[1/(1 + d_t)][(s_t/v_t) - d_t][(c_t/v_t) + 1]$
   $< (s_t/v_t)[1/(1 + d_t)][(1 + a)(c_t/v_t) + (1 + d_t)]$
   by cross-multiplication of the formulae for π_{t+1} and π_t.
   d) The above inequality holds if
   $(s_t/v_t)(c_t/v_t) - d_t(c_t/v_t) + s_t/v_t - d_t < (s_t/v_t)(1 + a)(c_t/v_t) + s_t/v_t + (s_t/v_t)d_t$;
   therefore
   $-(d_t/v_t)(c_t + v_t + s_t) < a\,(s_tc_t/v_tv_t)$;
   therefore
   $-d_t(w_t) < a(s_t/v_t)c_t$;
   therefore
   $-d_t < a(s_tc_t/v_tw_t)$.

4. The condition in 3. is equivalent to the condition that
   $g_{\pi+1} \equiv \Delta s_{t+1}/s_t \equiv (s_{t+1} - s_t)/s_t = -d_tv_t/s_t$ [from 2.b)]
   $< a(c_t/w_t)$ [from 3.d)]
   Now,
   $a(c_t/w_t) = (w_{t+1} - w_t)/w_t = g_{w_t+1}$.
   That is, the value rate of profit falls if and only if
   $g_{s_t+1} < g_{w_t+1}$.
   Note that the more rapid the rate of accumulation, the more likely it is that this condition holds and, therefore, that the value rate of profit falls.

APPENDIX 2
The Alternative Material Schema

The Model

1. The data of the model and the assumptions claimed by the

neo-Ricardians (which are assumed to hold in this model as well):

a) Data: $c^*_{m_1}$ and $v_{m_t} = v_m$ for each $t = 1,2,3,\ldots$, where v_m is the constant, given real wage.

b) $w_{m_t} = (v_m/v_t)w_t$ for each $t = 1, 2, \ldots$

c) $s_{m_t} = (v_m/v_t)s_t$ for each $t = 1, 2, \ldots$

d) Notation: $v_{t-1}/v_t = 1/(1 + d_{t-1}) = 1 + b_t$ for each $t = 2,3,\ldots$

Note that $-d_{t-1} = b_t/(1 + b_t)$ and that $b_t > 0$, where d_{t-1} is taken from the value schema.

Thus, $s_t = s_{t-1} + [b_t/(1 + b_t)]v_{t-1}$.

2. The distinctive features of the model:

a) $c^*_{m_t} \equiv c_t(w_{m_{t-1}}/w_{t-1}) = c_t(v_m/v_{t-1})$ for $t = 2, 3, \ldots$

b) $z_{m_t} = w_{m_t} - (c^*_{m_t} + v_{m_t} + s_{m_t})$ for all t.

c) The capitalists' "visible" rate of profit, $\pi^*_{m_t} = (s_{m_t} + z_{m_t})/(c^*_{m_t} + v_{m_t})$ is the rate of profit of this schema.

3. Some useful results of the model:

a) $v_t = [1/(1 + b_t)(1 + b_{t-1})\ldots(1 + b_2)]\, v_1$, to use the new notation.

b) The rate of growth of gross output is defined by:

$$g_{w_{m_t}} \equiv$$

$$\frac{w_{m_t} - w_{m_{t-1}}}{w_{m_{t-1}}} = \frac{w_{m_t}}{w_{m_{t-1}}} - 1 = \frac{(v_m/v_t)w_t}{(v_m/v_{t-1})w_{t-1}} - 1$$

$$= [(v_{t-1})w_t/v_t(w_{t-1})] - 1 > b_t.$$

c) $z_{m_t} = w_{m_t} - (c^*_{m_t} + v_{m_t} + s_{m_t})$

$= (v_m/v_t)[w_t - (c_t v_t/v_{t-1} + v_t + s_t)]$

$= (v_m/v_t)\{w_t - [c_t/(1+b_t) + v_t + s_t]\} = (v_m/v_t)c_t b_t/(1+b_t)$

The Rising Material Rate of Profit

4. Given our assumption that the real wage is constant, $\pi^*_{m_t} = (s_{m_t} + z_{m_t})/(c^*_{m_t} + v_m)$.

The task is to show that on the condition that $b_t > b_{t-1} > \ldots b_2 \geq a$, we have $\pi^*_{m_t} > \pi^*_{m_{t-1}}$ for each $t = 2,3,\ldots$. The proof follows in steps a) – g) below.

a) Now recall the expressions for s_{m_t}, z_{m_t}, $c^*_{m_t}$ and recall that $w_{m_t}/w_t = v_m/v_t$ for each t.

b) Then

$$\pi^*_{m_t} = \frac{(v_m/v_t)[s_t + c_t b_t/(1+b_t)]}{c_t(v_m/v_{t-1}) + v_m} = \frac{(v_m/v_t)[s_t + c_t b_t/(1+b_t)](1+b_t)}{[c_t + (1+b_t)v_t]v_m/v_t}$$

$$= \frac{\{s_{t-1} + [b_t/(1 + b_t)]v_{t-1} + [b_t/(1 + b_t)]c_t\} \quad (1 + b_t)}{(1 + a)\,c_{t-1} + v_{t-1}}$$

c) Since $b_t > b_{t-1}$ and $c_t > c_{t-1}$, we have

$$\pi^*_{m_t} > \frac{\{s_{t-1} + [b_{t-1}/(1+b_{t-1})]v_{t-1} + [b_{t-1}/(1+b_{t-1})]c_{t-1}\}(1+b_{t-1})}{(1+a)c_{t-1} + v_{t-1}} \cdot \frac{v_m/v_{t-1}}{v_m/v_{t-1}}$$

d) So that

$$\pi^*_{m_t} > \frac{\{s_{t-1} + [b_{t-1}/(1 + b_{t-1})]c_{t-1}\}/(v_m/v_{t-1})}{[1/(1 + b_{t-1})][(1 + a)\,c_{t-1} + v_{t-1}](v_m/v_{t-1})}$$

$$= \frac{s_{m_{t-1}} + z_{m_{t-1}}}{[1/(1+b_{t-1})][c^*_{m_{t-1}}(1+a) + v_m]} > \frac{s_{m_{t-1}} + z_{m_{t-1}}}{[(1+a)/(1+b_{t-1})][c^*_{m_{t-1}} + v_m]}$$

e) $\pi^*_{m_t} > \pi^*_{m_{t-1}}(1 + b_{t-1})/(1 + a)$ [from c) and d) above].

f) Thus, if $b_2 \geq a$ and $b_{t-1} > b_2$, then $(1 + b_{t-1})/(1 + a) > (1 + b_2)/(1 + a) \geq 1$.

g) Therefore, $\pi^*_{m_t} > \pi^*_{m_{t-1}}$ for each $t = 2,3,\ldots$

Q.E.D.

Note that with $c^*_{m_1} = c_{m_1}$, $z_{m_1} = 0$. Therefore, $b_1 = 0$ is such that $b_2 > b_1$ and the result holds for the increase in productivity from period 1 to period 2, as well as for all subsequent periods during which accumulation continues to be (economically) sustainable.

Compatibility Requirement

We have argued in the paper that there exist conditions of capital accumulation under which the material rate of profit rises as the value rate of profit declines. In Appendix 1 we proved – given initial value magnitudes and the rate of accumulation – that the value rate of profit falls from period t to period t + 1 if and only if d_t, the "speed" of decline of the variable capital from period t − 1 to period t, satisfies

$$-d_t < a\,(s_t/v_t)(c_t/w_t).$$

Although we have not (yet) succeeded in our attempt to find *necessary* conditions for a rising material rate of profit, we have nonetheless just shown a *sufficient* condition in the proof given in this Appendix. We now restate the condition in terms of the d-sequence in order to make clear that a falling value rate of profit is compatible with a rising material rate of profit.

From the above proof, if $b_{t+1} > b_t > \ldots > b_2 \geq a$, then $\pi^*_{m_t} > \pi^*_{m_{t-1}}$ for each $t = 2, 3\ldots$. For a rising material rate of profit from period t to period t+1 it is sufficient that $b_{t+1} > b_t \geq a$. This condition can be condensed and restated in terms of the d's of Appendix 1 in order to make our reasoning explicit:

$$b_{t+1} = -d_t/(1 + d_t) > a$$

or

$$-d_t > a(1 + d_t).$$

Clearly such d_t for $-1 < d_t < 0$ exist, given any $a > 0$.

We need, then, to have d_t simultaneously satisfy both inequalities, or

$$a\,(1 + d_t) < -d_t < a\,(s_t/v_t)(c_t/w_t).$$

This mainly requires that

$$(1 + d_t) < (s_t/v_t)(c_t/w_t).$$

As s_t/v_t increases rapidly as time passes – and as the real number line is dense – it is an easy matter to find d_t, $-1 < d_t < 0$ – an entire sequence of d's, in fact – such that this inequality might hold not only between periods t and t + 1 but from period 1 throughout. The reader is encouraged to satisfy him/herself of this.

This is all that we need for the argument of the paper for it illustrates that both sets of conditions may hold at once.

APPENDIX 3
The Overaccumulation of Capital

In order to assure that the material or "visible" rate of profit rises, we have made $b_t > b_{t-1} > \ldots b_2 \geq a$. In this case, $d_{t-1} = -b_t/(1 + b_t)$ traces out a declining sequence of d's. For the sake of simplicity, however, we first present a time of "break-down" in a value accumulation model in which $d_t = d_1$ throughout. We then consider the directly relevant case of a declining sequence d_t by comparing it with this simpler case, finding this rather indirect approach easier to reason about than the more complex case which is of interest to us. Thus, the presentation is in two parts.

1. The case where $d_t = d_1$ for all periods of time.

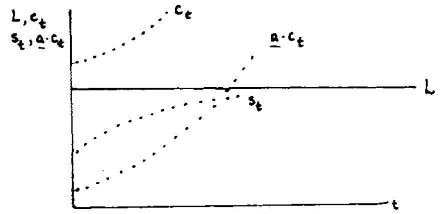
a) From Appendix 1, the condition on d_1 for a falling value rate of profit from period 1 to period 2, is

$$-d_1 < a\,(s_1/v_1)(c_1/w_1).$$

We assume that this condition is satisfied.

b) Then, since s_t/v_t and c_t/w_t increase over time, $-d_1 = -d_t < a\,(s_1/v_1)(c_1/w_1) < a\,(s_t/v_t)(c_t/w_t)$ and the value rate of profit falls from period to period, without end.

c) In this case, $v_t = (1 + d_1)^{t-1}v_1$ is an exponential sequence which declines monotonically and is asymptotic to zero.
d) Therefore, $s_t = L - v_t$ increases monotonically and is asymptotic to L. That is, L is the least upper bound of the s-sequence over time.
e) Recall that $c_t = (1 + a)^{t-1}c_1$, where $a > 0$ is the constant rate of accumulation of capital. Then c_t is an exponential sequence, increasing monotonically and without bound over time.
f) Then (and this is the conclusion which is of use to us in 2. below), there exists some period of time, say t_B, during which the surplus value created is not enough to meet the requirements of capital accumulation into the next period. That is, $s_{t_B} < ac_{t_B}$.
g) We summarize graphically, plotting amounts of surplus value and of investment requirements as point-values over an interval of time.



The assumption is that, initially, accumulation is possible. That is, $s_1 \geq ac_1$.

2. As we are interested only in those cases for which the value rate of profit continually falls and, simultaneously, the material or "visible" rate of profit rises, we make the necessary restrictive assumptions. Namely, we assume that d_t, for $-1 < d_t < 0$, is a monotonically decreasing sequence of numbers for which
$$-d_1 < a\,(s_1/v_1)(c_1/w_1)\,.$$
Moreover, $-d_t < a\,(s_t/v_t)(c_t/w_t)$ for any time t. This is nothing more than the necessary and sufficient condition for a fall in the value rate of profit between any pair of consecutive periods of production t and t + 1 (see Appendix).

3. For economic sense, we have restricted d_t to $-1 < d_t < 0$. Recall that, by definition, $b_t = -d_{t-1}/(1+d_{t-1}) > 0$, and note that if d_t is a monotonically decreasing sequence, b_t is monotonically increasing. However, as the d-sequence approaches its lower bound of negative one, the b_t sequence "explodes." Hence, at some time $t = t^*$, we can find some $b_{t^*} \geq a$ for any rate of accumulation $a > 0$. This moment, t^*, may thus be understood to mark the start of "period 2" of the illustrations given in the body of the paper and in the generalized model of Appendix 2. A glance at Appendix 2 will reveal that – on the assumptions of this part – the material rate of profit *must* rise, even if only after many periods. We thus take t = 1 to be $t^* - 1$ and begin our discussion from this period, in all instances in which the value rate of profit continually falls. We thus have contiguous periods of production during which the falling rate of profit is accompanied by increases in the material rate of profit.
a) Thus, in this case, as in part 1 above, $v_t = (1 + d_{t-1})(1 + d_{t-2})\ldots(1 + d_1)v_1$ is a monotonically decreasing sequence of values which is asymptotic to zero. Term for term, this sequence is *smaller* than the v-sequence of part 1.
b) Therefore, the s-sequence is monotonically increasing, asymptotic to L, although term for term *greater* than the s-sequence of part 1.
c) As c_t is the same in this case as in part 1 and as the s-sequence is term-for-term greater than the s-sequence in part 1, t_B comes later. That is, there must exist a period, t_B, during which the surplus-value produced, s_t, is insufficient to cover the investment requirement, ac_{t_B}, i.e., $s_{t_B} < ac_{t_B}$.
d) Moreover, since the investment in value terms which is required to maintain the rate of accumulation cannot be met with the surplus value produced, the physical investment required also cannot be met from the surplus product produced. To see this, recall that accumulation requires replacement plus net investment. At the end of period t_B, the replacement of capital value requires $c_{m_{t_B}} = c^*_{m_{t_B}} + z_{m_{t_B}}$ in physical product because this is the amount of material output which has a value equal to the constant capital value advanced (and used up) for the period. (That is, $c_{m_{t_B}} = c_{t_B}\,(v_m/v_{t_B})$, where v_m/v_{t_B} is the material per unit of value at the close of the production process.) (Thus, $s_{m_{t_B}} = s_{t_B}(v_m/v_{t_B}) < ac_{m_{t_B}}$ whenever $s_{t_B} < ac_{t_B}$.)

Glossary of Symbols

(Listed in order of appearance)

- t period of production; t = 1, 2, 3….
- c_t constant capital; the value of the means of production at the start of period t.
- v_t variable capital; the value of labor power.
- s_t surplus value; the amount of time labor power works over and above its own value.
- w_t the value of the gross product of period t; $w_t = c_t + v_t + s_t$.
- π_t the value rate of profit; $\pi_t = s_t/(c_t + v_t)$.
- L the total living labor time in any period; a constant.
- d_t the (negative) rate of change of variable capital from period t to period t + 1.
- a the proportional rate of growth of constant capital; the rate of accumulation.
- g a proportional rate of growth between consecutive periods; e.g. $g_{w_{t+1}} = \dfrac{w_{t+1} - w_t}{w_t}$
- c_{m_t} the portion of output of period t which has value c_t.
- v_{m_t} $= v_m$ the real wage of period t, having a value v_t, held constant throughout.
- s_{m_t} the surplus product of period t, having a value s_t.
- w_{m_t} the gross product of period t; $w_{m_t} = c_{m_t} + v_{m_t} + s_{m_t}$.
- x the fraction of commodity output devoted to consumption.
- $c^*_{m_t}$ the material quantity of means of production used in period t. For neo-Ricardians, $c_{m_t} = c^*_{m_t}$.
- z_{m_t} $= c_{m_t} - c^*_{m_t} \geq 0$; an amount of commodity-output of period t.
- c^*_t the value of that portion of output of period t equal in quantity to $c^*_{m_t}$.
- z_t the value of z_{m_t}; $z_t = c_t - c^*_t$.
- p_{m_t} $= s_{m_t} + z_{m_t}$; the apparent "profit" of period t.
- $\pi^*_{m_t}$ the material or "visible" rate of profit; $\pi^*_{m_t} = \dfrac{p_{m_t}}{c^*_{m_t} + v_{m_t}}$.
- b_t $= -d_{t-1}/(1 + d_{t-1}) > 0$ is defined for t = 2, 3,….
- u_t the unit value of the commodity after production in period t.