Organic Composition of Capital

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The distinction between labour value transferred and labour value added is crucial to Marx's theory of value. For the capitalist system as a whole, the abstract labour-time previously materialized in machinery and materials (c) merely reappears in the total product. The capital expended for the purchase of c is therefore constant-in-value. On the other hand, whereas the capital expended for the engagement of workers is determined by the labour value of their means of consumption (v), their actual employment results in a quanriry of abstract labour-time (I) which is generally different from v. Thus capital expended for the purchase of labour-power is intrinsically variable-in-value. Indeed, the secret of capitalist production is contained precisely in this variability, since surplus value ($s = l - v$) only exists to the extent that I is greater than v. It follows from this that for any given total capital expended ($c + v$), its *composition* between c and v is the utmost importance, because only v expands total capital value from $c + l$ to $c + l = c + v + s$ (Marx, 1867, pp. 421, 571).

The ratio c/v, the *value composition*, is the immediate measure of the composition of capital. But since c represents the value of machines and materials and v the value of labour-power, the (vectors of) technical proportions in which various machines and materials combine with labour (the *technical composition* of capital) clearly stand behind the value composition c/v (Marx, 1863, ch. 33; and Marx, 1894, ch. 45). That is to say, the technical composition is the inner measure of the composition of capital. Similarly, since $c + v$ materializes itself as c + I, we can view the ratio c/l as the outer measure of the composition of capital the *materialized* composition of capital (Marx, 1894, ch. 8). At a more concrete level each of the above value-measures acquires a corresponding price counterpart, and each element of any price/value pair is in turn differentiated into stock/flow measures. We shall see that that distinctions can play an important role at times. None the less, because the value relations are so fundamental to the basic argument, we will concentrate our attention on this level.

It is evident that the technical, value and materialized compositions of capital are intrinsically related. Indeed, it was one of Marx's central claims that the *movements* of all three are dominated by one overriding force: the mechanization of labour process, which is 'the distinguishing historic feature' of the capitalist mode of production.

To see how this works, we begin by reducing the technical composition vector to a scalar measure TC by valuing the current vector elements at time t in terms of the unit values of means of production in some base year $t_,$. Suppressing the current time subscript t, let k^j = the jth means of production per worker, λ_1, λ_2 = indexes of the unit values of means of production and wage goods respectively, w = an index of the real wage per worker, h = the number of hours worked by each worker, all at time t; while λ_{j_0}, λ_{i_0} = the unit values of means of production and wage goods, respectively, and v_0 = a constant representing the labour value of a unit of labour-power, all in the base year t_0. Then

$$k = [k_j] = \text{the technical composition}$$

$$= \text{a vector of means of production per worker} \tag{1}$$

$$TC = \text{a scalar measure of the technical composition of capital}$$

$$= \sum \lambda_{j_0} k_j. \tag{2}$$

Next. note that $c/v = c'/v'$ and $c/l = c'/h$, where c' and v' are per worker, and h is th length of the working day. Then

$$c' \equiv \sum_j \lambda_j k_j = \left[\frac{\sum_j \lambda_j k_j}{\sum \lambda_{j_0} k_j} \right] \sum_j \lambda_{j_0} k_j = \lambda_1 TC$$

where λ_1 = the term in brackets = an index of the current unit value of means of production. Similarly,

$$v' \equiv \sum_i \lambda_i w_i = \left[\frac{\sum_i \lambda_i w_i}{\sum \lambda_{i_0} w_i} \right] \left[\frac{\sum_i \lambda_{i_0} w_i}{\sum \lambda_{i_0} w_{i_0}} \right] \left[\sum_i \lambda_{i_0} w_{i_0} \right] = \lambda_2 w v_0$$

where the terms in brackets are respectively:

I, = an index of the current unit value of means of production

w = an index of the real wage

v_0 = the base year value of labour-power

$$c/v = (TC/v_0)(\lambda_1/\lambda_2)(1/w) \tag{3}$$

$$c/l = (TC/v_0)(\lambda_1)(v_0/h). \tag{4}$$

Now, according to Marx's argument, mechanization is a continual process of increasing the productivity of labour through the use of ever greater quantities of machines and materials per worker. In a mathematical sense, this means a secular rise in most but not necessarily all of the elements of the technical composition vector (which will itself grow in dimension). It is therefore easy to see why the technical composition measure TC will tend to rise secularly, and why, other things being equal, this in turn will transmit an upward tendency to both c/v and c/l through their common term TC/v_0 (equations (3)–(4)). Because this latter term is both the direct gauge of the effect of a rising technical composition on c/v and c/l and also itself a constant-value measure of the current year's value composition, Marx calls it the organic composition of capital (Fine and Harris, 1976; Shaikh, 1978: Weeks, 1981). Accordingly, we write

$$\mathrm{OC} = TC/v_0 = \text{the organic composition of capital} \tag{5}$$

The organic composition OC is evidently the critical link between the technical composition and the value and materialized compositions. But since the latter two have other determinants as well, we need to consider the specific influence of these other factors. In this regard, Marx argues that these other factors act as counter-tendencies which may slow down, but do not negate, the basic upward trend produced by the tendency toward a rising technical composition of capital (Rosdolsky, 1977, part V, appendix).

Consider the above expression for the value composition c/v (equation (3)). Here, we see that in addition to the organic composition OC, it depends also on the ratio λ_1/λ_2, and on the real wage w. But the former factor will serve primarily to create fluctuations around the basic trend produced by the rising organic composition, because the diffusion of technical change will tend to confine the variations in λ_1/λ_2 within a fairly narrow range. Therefore, it is only a secularly rising real wage which can cause the trend of the value composition to lag systematically behind that of the organic composition (though at the same time it accelerates the growth of organic composition by enhancing the scope of mechanization) (Marx, 1867, ch. 15). The trend of the organic composition is thus an upper bound to that of the value composition. A corresponding lower bound can then be found by noting that the value composition is related to the materialized composition through the rate of surplus value:

$$c/v = (c/l)(l/v) = (c/l)[(v+s)/v] = (c/l)(1 + s/v). \tag{6}$$

On the question of the rate of surplus value, Marx argued that workers could not generally capture all of the gains in productivity achieved through mechanization, so that over time real wages would normally rise more slowly than productivity and the rate of surplus value would tend to rise (Rosdolsky, 1977). In the equation (6) above, this in turn immediately implies that the trend of c/l will be the lower bound to that of c/v.

This brings us to the trend of c/l itself. Here, the central theme of Marx's argument is that for individual capitalists the principal purpose of mechanization is to lower their unit production costs and thereby raise their profitability. But the gain of reduced units (flow) costs generally carries with it a corresponding requirement of the increased *capitalization* of production, i.e. a corresponding increase in the scale of investment required per unit of output (and hence in unit fixed costs). This familiar tradeoff between unit variable and unit fixed costs (Pratten, 1971, pp. 30667; Weston and Brigham, 1982, pp. 14557) turns out to be a sufficient condition for the rise in the organic composition OC to dominate the falling unit value of means of production (λ_1), so that the net result is a secularly rising c/l (Shaikh, 1978, pp. 239-40). And once it has been established that c/l rises over time, it follows from our earlier discussion concerning equation (6) that c/v also rise secularly. We can therefore say that under the conditions Marx sees as characteristic of capitalist industrialization, the resulting mechanization and capitalization of production expresses itself in a rising technical and hence organic composition OC, a less rapidly rising materialized composition c/l, and a value composition c/v which rises more slowly than the organic composition but more rapidly than the materialized composition.

All of this brings us to the implications of levels and movements of the various measures of the composition of capital. Marx distinguishes three major domains in which these factors are of critical importance. First, there is the domain of price/value relations, in which he uses the inter-industrial dispersion of organic compositions in any given period to derive the principal difference between prices of production and prices proportional to labour values, Here, the cross-sectional dispersion in organic compositions is initially taken to reflect the underlying variations in (the vectors of) technical compositions. Marx notes (but does not pursue) the fact that his results would undoubtedly be somewhat modified by the additional complications which arise when one distinguishes the dispersion of value compositions from that of the technical compositions, and the further dispersion of the price (transformed) compositions from that of the value (untransformed) compositions (Marx, 1894, chs 9, 45). Much of the subsequent debate surrounding the relations between values and prices of production (the Transformation Problem) has in fact centred around the complexity of the latter set of differences, with the dominant position being that such considerations effectively negate Marx's original formulations (Steedman, 1977, chs l-2). Yet recent work shows that the empirical differences between Marx's prices of production and the conventional (Bortkiewicz-Sraffa) 'correct' ones are generally very small, that both are good predictors of actual market prices (as are labour values also, all with R^2's between 93-6 per cent), and that there are sound mathematical reasons why the basic value categories dominate the overall results – as Marx quite correctly perceived from the start (Shaikh, 1984; Ochoa, 1984).

The second domain in which the composition of capital plays a central role is in the maintenance of a reserve army of labour. Marx points out that while the accumulation of total capital c + v increases the demand for labour, the attendant growth in the value composition of capital c/v in turn decreases the demand for labour. Where the net effect is negative, the reserve army grows. And where it is positive, the resulting shrinkage in the reserve army eventually puts pressure on the labour market and accelerates the growth in real wages. This rise in real wages then slows down accumulation on one hand, while on the other it accelerates the pace of mechanization and hence the growth of c/v. In this way, the growth of the value composition automatically adjusts so as to maintain a reserve army of labour. When capitalism is viewed on the world scale, this phenomenon assumes great significance.

The third, and perhaps most important application of the concept of the composition of capital arises in connection with what Marx calls 'one of the most striking phenomena of modern production', which is the tendency of the rate of profit to fall. The central variable in this case is the stock/flow materialized composition of capital C/l, because any sustained rise in C/l can be shown to give rise to an actual falling rate of profit, no matter how fast the rate of surplus is *rising*. Writing the rate of profit r in terms of s, v, $l = v + s$, and C = total (constant and circulating) capital advanced, we get

$$r = \frac{s}{C} = \frac{s/v}{C/v} = \frac{s/v}{(C/l)(l/v)} = \frac{s/v}{1 + (s/v)} \frac{1}{(C/l)} \tag{7}$$

It is evident from equation (7) that as the rate of surplus value rises, the term $s/l = (s/v)/(1 + s/v)$ rises at an ever decreasing rate, since in the limit it approaches 1. Thus, no matter how fast the rate of surplus value rises, the rate of profit eventually falls at a rate asymptotic to the rate of fall of l/C (Rosdolsky, 1977, chs. 16. 17, 26 and part V, appendix).

But the matter does not end there, because this issue recently sparked a fresh round of debates. On one side was an argument based on the (essentially neoclassical) theory of perfect competition, in which capitalists are assumed to invest in new methods only if these raise their own rate of profit, on the grounds that they would otherwise prefer to continue using their existing plant and equipment; and on the opposite side. an argument based on Marx's notion of competition-as-war, in which capitalists are driven to invest in those methods which lower their unit production costs, because the first ones to do so can cut prices and thereby expand their total profits through larger market shares. In the former case, the result is that the general rate of profit will necessarily rise, other things being equal; in the latter, the general rate of profit will tend to fall (as outlined above), provided that the new methods generally embody higher unit fixed costs.

In the original debates, the focus was on the differing implications of two apparently contradictory investment criteria; profit rate maximizing versus unit cost minimizing (profit margin maximizing). However, a subsequent contribution by Nakatani effectively dissolved this apparent opposition by showing that *both criteria are equivalent to selecting the highest projected rate of profit.* The principal difference then arises from the fact that in the case of perfect competition it is assumed that firms neither anticipate nor engage in price-cutting behaviour, while in the cases of competition-as-war, firms are assumed to necessarily do both (Nakatani, 1979). With this step, the issue reverts back to the two opposing conceptions ofcapitalism which lie behind these different notions ofcompetition.

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