

The Capital Controversy in Historical Perspective
[PROVISIONAL DRAFT: NOT FOR QUOTATION]

Gary Mongiovi
Economics & Finance Department
St John's University
Jamaica, NEW YORK 11439
USA
E-mail: *mongiovg@stjohns.edu*

The capital theory debate is generally interpreted as a technical controversy concerning the specification of capital in the neoclassical theory of growth and distribution. Most accounts of the Cambridge critique of orthodox capital theory traces the origins of the controversy back to Joan Robinson's 1953 essay on "The Production Function and the Theory of Capital". Although Piero Sraffa's *Production of Commodities by Means of Commodities* is accorded a central role in the controversy, the connection of the debate to Sraffa's larger project—the reconstruction of the theoretical approach of the classical political economists—is not well understood. It is only a slight oversimplification to say that while one side in the debate was acutely aware of this historical dimension, the other was concerned mainly with technical issues. But the technical dimensions of the problem themselves have a history that dates back to Ricardo, who encountered the problem of measuring capital in his attempt to explain the profit rate. Marx encountered the same problem, as did Walras and Wicksell on the neoclassical side. The problem was not fatal to Ricardo's theory, which does not require that the magnitude of capital be specified prior to the determination of prices and the profit rate; but its resolution in neoclassical theory requires a change in the object of analysis—that is, the abandonment of the long-period method of analysis in favor of models of intertemporal general equilibrium.

Classical economics and the traditional versions of the marginalist theory had the same analytical objective—to explain relative prices and the distribution of the social product in terms of the dominant forces that govern the operation of a market economy. Both approaches utilized the same method of analysis, the comparison of fully adjusted positions long-period positions characterized by uniformity of the profit rate in all lines of production. The logical appeal of this method derives from the idea that when there are no impediments to the movement of resources, capital will tend to flow from low profit rate sectors into high profit rate sectors until market prices and the composition of the capital stock are such as to enable each sector to earn the same rate of return. So long as rates of return are not equal there will be a tendency for the existing configuration of market prices and profit rates to change, that is, to move toward a configuration in which a single profit rate would prevail. The latter configuration is therefore conceived as a position of central gravitation toward which dominant and systematic market forces push the economy.

At the most fundamental level the classical and marginalist theories are distinguished by the categories of data which each takes as parametric in its analysis of value and distribution. Where the marginalist theory takes as its fundamental data preferences, technology and resource endowments, the classical analysis of value and distribution starts from the size and composition of the social product, the technical conditions of production, and the real wage (or in Sraffa's formulation, the profit rate).

The marginalist theory is grounded in two substitution mechanisms:

- (i) Technical substitution in production: as the price of an input falls, the economy will shift to methods of production that utilize that input more intensively.

- (ii) Commodity substitution in consumption: as a good becomes cheaper relative to other goods, owing for example to a decrease in the price of an input which it utilizes more intensively than other goods, agents will increase the proportion of that good in their consumption basket, thereby increasing the derived demand for the factors required to produce the good.

These substitution mechanisms are presumed to ensure that the demand for any input will be a monotonically decreasing function of its price—the wage rate for labor and the profit rate for capital. The upshot of the capital critique is that this presumption is not generally valid. It holds only under particular circumstances: (i) when there is only one capital good; and (ii) when all sectors utilize the various inputs in identical proportions (ironically, the same condition required to ensure that commodities exchange in proportion to the labor embodied in their production: the neoclassical theory of value & distribution and the so-called labor theory of value turn out to be special cases that hold under precisely the same assumptions!).

The marginalist theory that emerged in the 1870s was preceded by an altogether different approach to the analysis of value and distribution. The surplus approach of the old classical economists (Petty, Smith, Ricardo) and Marx had been, as Sraffa observes, “submerged and forgotten”, rather than confronted, criticized and then superseded by a more persuasive theory. The classical theory has sometimes been characterized as a primitive or incomplete version of marginalist theory (Marshall), or as a wrong-headed false start (Jevons). More recently it has been suggested that the classical theory represents a special case of marginalist theory in which the composition of the initial endowment of capital goods happens to coincide with the composition that would yield a uniform profit rate

(Bliss; Hahn). This interpretation, however, presupposes the legitimacy of a conception of equilibrium that is not itself characterized by the uniform profit rate condition; see below.

Sraffa's work indicates that, on the contrary, the classical theory constitutes a distinct analytical approach that is scientifically robust, and in important respects superior to neoclassical economics.

The central premise of the classical theory is that the distribution of the social product is regulated not by the forces of supply and demand, but by historical and institutional processes that reflect the interplay of class interests. The ratios at which commodities exchange were understood to depend upon the technical conditions of production and the distribution of the social product between labor and the owners of capital. A difficulty arises in connection with the determination of the profit rate, which the classicals regarded as the main influence on the rate of accumulation. They conceived the normal rate of profit as the ratio of the social surplus to the capital utilized in production. The social surplus is a residual obtained after deducting from the social product (i) the consumption goods required to sustain workers, and (ii) the means of production used up in the production process. The profit rate r might be conceived in the following terms:

$$(1) \quad r = [Q - (W+M)] / (W+M),$$

where Q is the social product; W is portion of the social product required to support the working class; and M represents the means of production required to produce Q . The denominator $(W+M)$ represents the amount of capital advanced at the start of the production period. A difficulty arises from the fact that the terms which comprise the right hand side of equation (1) are not scalars but vectors, collections of heterogeneous commodities. Before

the profit rate can be determined the elements of these vectors must be made commensurable.

An obvious procedure would be to weight each commodity element of Q , W and M by its long-period normal price. This solution, however, was not open to Ricardo, since the prices themselves depend upon the rate of return on capital, and therefore cannot be supposed to be known in order to calculate the profit rate. Ricardo thought he could get round the problem by supposing that commodities exchange approximately in proportion to the quantities of labor required to produce them; the profit rate could then be calculated as a ratio of quantities of labor-time. This solution is unsatisfactory, however, since, as Ricardo well understood, commodities do not generally exchange in proportion to quantities of embodied labor-time: labor values deviate from long-period normal prices in a systematic fashion, according to the degree in which different production processes utilize more or less labor relative to produced inputs. Ricardo appears to have been the first economist clearly to grasp that the impact of a change in distribution on relative prices depends upon the capital structures of the various sectors of the economy. Marx developed this insight further in his analysis of the connection between sectoral differences in the organic composition of capital and the pattern of price deviations from labor values. Sraffa's work showed that the effects of distribution changes on prices are far more complex than either Ricardo or Marx supposed. The puzzle vexed Ricardo until the end of his life. We now know that the solution requires the simultaneous determination of relative prices and the profit rate.

The failure of the classical economists to resolve the difficulties posed by the interdependence of prices and distribution partially explains why classical political

economy faded from the scene over the half-century that followed Ricardo's death. No doubt the decline was hastened by the misappropriation of Ricardo's labor value analysis by nineteenth century social reformers, who made it the basis of a claim that workers are entitled to the whole of the social product. Marx critiqued and elaborated Ricardo's ideas, and demonstrated the rich analytical potential of the surplus approach, but he was no more successful than Ricardo at reconciling his labor value analysis with prices conceived as long-period centers of gravitation. Nassau Senior and John Stuart Mill had already begun to nudge the discipline towards marginalism—Senior with his argument that interest is a reward for abstention from consumption, and Mill with the wages fund doctrine (which he later repudiated, but by then the damage was done) and with his assignment of a prominent role to utility in the explanation of economic behavior.

This same problem of the interdependence of prices and distribution emerges in neoclassical economics, but there it has more serious consequences. Thus the difficulties which capital posed for the classical economists have been surmounted. But they were surmountable in the first instance precisely because the classicals never deployed the capital stock as a parametric resource endowment in order to determine distribution: hence its aggregate value can be determined simultaneously with the profit rate. Marginalist analysis, on the other hand, does require that the endowment of capital be specified as a datum prior to the determination of the profit rate. The capital debates showed that the theory is incapable, in general, of specifying the endowment of capital in a way that permits the derivation of the substitution mechanisms which underlie price-elastic factor demand functions. Capital, then, is problematic not for the classical analysis revived by Sraffa, but only for the neoclassical theory of distribution.

Reswitching and capital reversing can occur because a commodity's price does not vary monotonically with the wage (or profit rate). Intuition might suggest that a decrease in the wage will cause the price of a commodity whose production requires a low proportion of labor to produced inputs to rise relative to the prices of goods whose production requires a higher proportion of labor to produced inputs. In fact, just the opposite response might occur, as Sraffa explains:

The reason for this seeming contradiction is that the means of production of an industry are themselves the product of one or more industries which may in their turn employ a still lower proportion of labour to means of production (and the same may be the case with these latter means of production; and so on); in that case, the price of the product . . . might *fall* in terms of its means of production [when the wage falls].

Underlying any production process are numerous layers of production located at successively more remote conceptual stages; the prices of the commodities which comprise the capital stock can therefore change in highly complex ways as the profit rate changes.

When the possibility of reswitching and capital reversing was brought to light, and the fact made clear that there are no logical grounds to rule them out, the initial, almost reflexive, line of defense taken by orthodox theorists was to express doubts about its empirical relevance. The early reactions to the capital critique combine an awareness that a serious blow had been struck with a quite natural inclination to discount the magnitude of the damage. Paul Samuelson, who has engaged the issues as directly as anyone on the marginalist side, forthrightly declared in his "Summing Up" of the debate that reswitching "can be called 'perverse' only in the sense that the conventional parables did not prepare us for it". But a few pages later he characterizes reswitching as a "pathology

[that] illuminates healthy physiology,” in effect retracting his concession. And he reinforces this defensive maneuver by suggesting that capital reversing is empirically insignificant.

This line of defense misses the point. The nineteenth century originators of the principle of factor substitution did not derive it from observation of empirical regularities; they constructed it by “deduction from postulates ... now generally admitted to be invalid,” as Garegnani notes. No economist has ever observed a factor demand function (or indeed any sort of demand function). What we observe are market phenomena, such as price–quantity couplets, that require explanation. Providing an explanation is complicated by the fact that observed magnitudes are conditioned by both accidental and systematic causes. It is the job of theory to identify and isolate the systematic causes—that is, to find the order in a highly complex reality. The basis for any theoretical proposition is the set of premises from which it is deduced; if the premises are unsound, so must be the theory built upon them, and we ought to look elsewhere for the regulating mechanism. Empirical evidence often runs counter to neoclassical propositions: declining real wages are not routinely associated with increases in the labor intensity of production; lower interest rates (as the makers of Japanese and US monetary policy have recently discovered) need not induce higher levels of capital spending. These observations are accommodated within neoclassical theory by the introduction of influences that interfere with the operation of the fundamental substitution mechanisms—price rigidities, information asymmetries and the like.

It is also worth noting that Samuelson assesses the relevance of capital reversing mainly in terms of the behaviour of the interest rate consequent upon a change in saving behaviour: a decrease in current consumption may entail a new steady-state equilibrium

in which the interest rate is lower rather than higher than initially. This was indeed unexpected in conventional theory, but its ramifications are rather more serious than Samuelson lets on. The conventional relation between consumption and the interest rate emerges from the operation of the substitution mechanisms that underlie the downward-sloping factor demand functions of the marginalist theory; it is the latter distribution theory that capital reversing undermines. The overall mainstream assessment of the outcome of the capital controversy is that its main points have been assimilated into neoclassical theory. Edwin Burmeister summarizes the upshot as follows: In steady-state models “some technical complications ... result from heterogeneous capital goods, but ... these complications [are] essentially trivial.... When one [studies] the dynamic properties of feasible paths, no paradoxes arise and the insights of neoclassical economics are left intact”.

The assimilation of these results has been accomplished by a radical shift in the method of analysis. The traditional method involving the comparison of long-period positions characterized by a uniform rate of profit in conditions of free competition, has been replaced by the study of intertemporal or temporary general equilibrium models that drop the uniform profit rate requirement. Such models are of limited applicability since there is no reason to think that the actual magnitudes of the economy will coincide with the short-period positions established by the model: the economy begins to move away from such a predicted temporary position, and towards the next predicted position, as soon as it is established. If actual and predicted magnitudes don't coincide, the latter has minimal practical significance, since it is neither observable itself, nor does it exert any systematic influence on the variables that *are* observable. Deviations between observed

and predicted magnitudes are routine and harmless in long-period analysis, but have serious consequences for intertemporal models: as the system moves further in time from its initial position, the impact of small, and inevitable, errors in the calculation of the temporary positions is likely to be amplified, causing the deviations between predicted and observed magnitudes to widen significantly over time.

These concerns might be adequate by themselves to undermine the marginalist claim that the capital critique has been answered. But it remains unclear that the modern axiomatic reformulations of the marginalist theory do in fact avoid capital-theoretic difficulties. The heterogeneous capital formulations of neoclassical theory require the equilibration of saving and investment via adjustments of interest rate, and there is no reason to suppose that this mechanism will operate as required in the face of the complex patterns of changes that interest rate variations can induce in the prices of capital goods. The traditional interest-elastic investment function is retained in heterogeneous capital models of general equilibrium. Bertram Schefold and Pierangelo Garegnani have argued that this mechanism is as vulnerable to the possibility of capital reversing in heterogeneous capital models as in the long-period neoclassical models at which the capital critique was initially directed.

The destructive implications of *Production of Commodities* exercised the ingenuity of economic theorists for two decades, until the early 1980s, when the topic dropped off the radar screens of most economists. The debate, it is fair to say, was not so much resolved as abandoned. On the neoclassical side the critique was evaded by the adoption of models of temporary and intertemporal general equilibrium. It is not surprising that the aspect of Sraffa's work that drew the most attention was the challenge

it posed to foundational elements of neoclassical theory that had come to be regarded as intuitively (if not empirically) evident—in particular the idea that when a factor’s price declines the economy will utilize it more intensively. Once the neoclassicals walked away from the capital theory debate the prospects for Sraffa’s constructive agenda receded.

Sraffa’s terseness did not help matters. In the Preface to *Production of Commodities* he is explicit about his critical purpose: “It is a peculiar feature of the set of propositions now published that, although they do not enter into any discussion of the marginal theory of value and distribution, they have nevertheless been designed to serve as a basis for a critique of that theory.” He alludes to a more constructive purpose when he identifies the framework of his Parts I and II, in which no changes in outputs or proportions are considered, as the “standpoint ... of the old classical economists from Adam Smith to Ricardo” (1960, p. vi), and in his Appendix D on “References to the Literature.” But these hints are, to say the least, faint, and most readers would have had to work hard to grasp their significance.

Sraffa’s reticence is all the more striking in light of what his manuscripts reveal about his intellectual activity during the 1920s, ‘30s and ‘40s. Paul Samuelson is fond of an anecdote in which Keynes, upon being told that Nicholas Kaldor had contracted athlete’s foot, responds: “I don’t believe it. Next you’ll be telling me Piero has writer’s cramp”. Samuelson’s playful jibe is off-target, however. Though Sraffa *published* relatively little over the decades since 1930, he in fact *wrote* hundreds of manuscript pages in preparation for *Production of Commodities*.

In addition to voluminous notes relating to the working-out of the mathematical and technical properties of the equation systems of *Production of Commodities*, the manuscripts contain an enormous number of documents (including lecture notes) on the character and evolution of classical political economy and its displacement by marginalist theory. Evidence from the manuscripts suggests that Sraffa's original plan was to publish a larger work that would present a fully-developed account of his interpretation of the classicals, and connect that interpretation to the analytics of his price equations and to his implicit critique of orthodox capital theory.

The implications of the capital controversy remain troubling for marginalism. No entrenched orthodoxy retreats at the first sign of trouble. Nor should it. Normal science derives much of its authority from an essentially conservative outlook, which ensures that the corpus of propositions comprising a science doesn't change without cogent justification according to criteria accepted by all of the discipline's practitioners. Theories are not abandoned until they are demonstrated to be unsound; new hypotheses are not embraced until they show themselves capable of resolving anomalies and resisting falsification. The procedures for evaluating competing theories are more likely to falter in the social sciences than in the natural sciences, partly because social processes are innately more complex than physical processes, but also because social scientists are less apt than physicists and chemists to be in full agreement among themselves regarding the evaluative criteria for accepting or rejecting theoretical propositions. In the case of the capital debates, I believe the defensive responses have failed to vindicate the marginalist position.

The results of the capital critique have not been fully appreciated or taken fully on board even by many economists who are critical of neoclassical orthodoxy. Joan Robinson, who is often credited with first bringing the capital theoretic problems of neoclassical theory to light in her 1953 RES paper, in the end judged both reswitching and the positive theory elaborated by Sraffa in 1960 to be of little practical relevance. Paul Davidson has characterized the capital critique as a “barren detour.” I wish to mention several respects in which the critique has been misrepresented or misunderstood. The misunderstandings appear to stem partly from a failure to connect the critique to its broad historical roots in classical political economy.

(1) At elementary levels of discussion, the reswitching issue is often explored in terms of a simple two sector model. The first sector produces a consumption good using labor and a machine; the second sector produces the machine using labor and the same machine. The following equations describe the relations that connect relative prices, the real wage and the profit rate:

$$p_c = p_m a_c (1+r) + w l_c$$

$$p_m = p_m a_m (1+r) + w l_m,$$

where p_c is the price of the consumption good; p_m is the price of the machine; a_c and a_m are the amounts of the machine required to produce a unit of the consumption good and a unit of the machine respectively; l_c and l_m are the amounts of labor required to produce a unit of the consumption good and a unit of the machine respectively; r is the profit rate; and w is the real wage. If the consumption good is taken as numeraire ($p_c = 1$), the system can be manipulated to derive a trade-off relationship between w and r in terms of the technical conditions of production:

$$w = \frac{1 - a_m(1+r)}{l_c + (l_m a_c - l_c a_m)(1+r)}.$$

The trade-off is generally nonlinear, and if two or more techniques are supposed to be available for the production of either good, the model can exhibit reswitching-like patterns. But note that the model contains a single basic good, the machine. By making the (non-basic) wage good the numeraire, the model assigns the sector that produces it an artificial role in the solution—a role that it could not have if the capital good were the numeraire. In the latter case, the equations would be written:

$$p_c = p_m a_c(1+r) + w l_c$$

$$1 = a_m(1+r) + w l_m,$$

and the w - r trade-off could be derived from the machine sector equation alone:

$$w = \frac{1 - a_m(1+r)}{l_m}.$$

Thus, the wage curve, which can be derived from the technical conditions of production of the machine sector, without reference to the wage good sector, is linear and there is no possibility of reswitching or capital reversing. In effect, the equations constitute a corn model that utilizes a commodity other than corn as the numeraire! The coefficients a_c and l_c of the non-basic sector play no role in determining distribution. Let the capital good be the numeraire. Pick a profit rate r^* on the linear wage curve. That gives a real wage w^* in terms of machines. Then the price of the consumption good will be given by $p_c^* = a_c(1 + r^*) + w^* l_c$. The number of consumption goods purchased by the real wage is w^*/p_c^* ; it's the same number we'd get off the non-linear wage curve if we'd adopted the wage good as numeraire.

One might argue that it seems odd to measure the real wage in terms of the capital good. True enough. But as regards the logic of capital reversing, the choice of numeraire is absolutely irrelevant. The model isn't really capturing reswitching or capital reversing, for the simple reason that neither of these phenomena can occur when there is only one capital good. They arise because, except for special cases, capital cannot be measured independently of distribution. The model is perhaps useful in conveying the intuition underlying reswitching, but it doesn't exhibit reswitching or capital reversing per se. The confusion

(2) The role of Joan Robinson's 1953 production function paper has been somewhat exaggerated. In that paper Robinson does indeed allude to the possibility of reswitching—as a “curiosum” to which she assigned little practical significance. She appears to accept much of conventional economic thinking that reswitching and capital reversing call into question: “[T]he problem which the production function professes to analyse, although it has been too puffed up by the attention paid to it, is a genuine problem.” We observe that developed countries tend to utilize techniques that are more mechanized than techniques in use in underdeveloped countries. “[I]t seems pretty clear that the main reason for this state of affairs is that capital in some sense is more plentiful in [developed countries] than in [underdeveloped countries].... We cannot abandon the production function without an effort to rescue the element of common sense that has been entangled in it”! Elsewhere in the same paper we find the rather surprising statement that “The neo-classical system is based on the postulate that, in the long run, the rate of real wages tends to be such that all available labour is employed. In spite of the atrocities

that have been committed in its name there is obviously a solid core of sense in this proposition.”

Robinson’s main complaint about the production function is that it rests upon a comparative static method of analysis—a theme which had been present in her work since at least the early 1940s and became even more prominent in her thinking in the last two decades of her life. She argues that “The ambiguity of the conception of a quantity of capital is connected with a profound methodological error, which makes the major part of neo-classical theory spurious.” That error involves the notion of equilibrium: “The equilibrium neo-classical theorist thinks of a position of equilibrium as a position towards which an economy is tending to move as time goes by. But it is impossible for a system to get into a position of equilibrium, for the very nature of equilibrium that the system is already in it, and has been in it for a certain length of past time.” This passage is immediately followed by some remarks that point out the crucial difference between space and time: in space one can move backwards, whereas one can only move forward in time. And a few pages later on: “In a world where unexpected events occur which alter values the points of view of the man of deeds, making investment decisions about the future, and the man of words making observations about the past, are irreconcilable, and all we can do is botch up some conventional method of measuring capital that will satisfy neither of them.” The 1953 paper is mainly concerned with this issue, and has very little to say about capital paradoxes.

This focus of Robinson’s 1953 paper may have contributed to the view, at least among non-mainstream economists, that the capital controversy is somehow concerned with the usefulness of equilibrium as an analytical device—a view put forth by Cohen &

Harcourt in their recent *Journal of Economic Perspectives* note on the capital debates. This view is often linked with the idea that the debates were fundamentally about the role of time in economic theory. “Capital is fundamentally intertwined with issues of time,” Cohen & Harcourt write, and then go on to cite Christopher Bliss’s cryptic observation that “One of the essential tasks of a theory of capital is ... to make clear why a purely static and timeless economic theory could not be adequate.” But I know of no one who thinks that “a purely static and timeless theory” could provide an “adequate” account of capitalist reality. Robinson liked to quote the philosopher Henri Bergson’s definition of time as a device to prevent everything from happening at once. (Space of course is a device to prevent everything from happening in Cambridge!) But Bergson’s definition is more clever than helpful. Of course no one thinks that everything happens at once—not even economists who don’t spend a lot of energy fretting about time or capital. The fact that Robinson and Bliss, and indeed every competent economist, agree on the need to move beyond static analysis suggests that something altogether different is at stake in the capital theory debates.

(3) The lack of attention to the historical background has also led the capital critique to be confused with the problem of capital aggregation in empirical models aimed at testing neoclassical growth theory. They are in fact two distinct issues that intersect at one juncture: the problem of the measurement of capital. In the case of the Cambridge debates the measurement of capital is problematic because the prices of capital goods change when distribution changes; in the standard production function literature on aggregation, the problem is whether economy-wide, sector-wide, or firm-level production functions can be constructed that exhibit the properties needed to

establish downward-sloping factor demand functions. The latter problem is in a sense misguided, since the capital critique undermines the substitution mechanisms that constitute the basis of those factor demand functions. But if one doesn't accept the Cambridge UK assessment of the capital controversy, or if one just wants to leave that issue to one side, the mainstream concerns about aggregation in models designed for empirical testing remain. So attention ought to be paid to whether, in a particular analytical context, the "measurement of capital" problem under discussion relates to the interdependence of prices & distribution (the problem that underpins the reswitching, or capital reversing, debate), or instead emerges from the need to utilize aggregates when engaging in empirical modeling and testing. Both problems can be present at once, of course, but they are not the same thing.

Similarly the assertion, by Christopher Bliss and others, that the aggregation problems associated with labor and land are comparable to those associated with capital, is misplaced: the claim exemplifies the muddling of the two kinds of measurement problems mentioned above. Capital is problematic because its endowment must be specified independently of distribution in order to determine the profit rate. This problem doesn't arise in connection with labor or land, though there may be other problems of aggregation involving them that must be resolved when constructing models designed for empirical testing.

After Thomas Kuhn, no one can claim that science is a "purely" rational exercise. Human psychology and ideology almost certainly play some role in how scientists decide which propositions to incorporate into, and which to exclude from, a science. And that role is not entirely ad hoc: certain results appear anomalous because they come into

conflict with our intuition, which itself is shaped partly by the results of science. How intuition is formed and how human beings respond to challenges to their intuition cannot help but influence the history and philosophy of science, especially economics. The resistance of mainstream economists to the results of the capital controversy was in large part due to the difficulty they had to reconcile these results with what their intuition suggested must be the case about how markets function.