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The theory of value and distribution and the problem of capital*

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The paper identifies as the root of the recent controversy in the theory of capital David Ricardo's finding that competitive prices and costs of production depend not only on the methods of production employed, but also on the wage rate (or rate of profits) and change with it. A consequence of this result, whose systematic elaboration we owe to Piero Sraffa, is that systems of production cannot generally be ordered monotonically with the rate of profits. Reswitching, capital reversing, price and quantity Wicksell effects, etc., are all rooted in this fact. It is argued that the rate of profits is not determined by the marginal productivity of capital and that the equality between the two in equilibrium must not be misinterpreted as implying a causal relationship leading from the latter to the former. Attempts to assess the empirical probability of reswitching, etc., in terms of input–output tables ought to be received with many reservations for both theoretical and data-related reasons. It is further argued that problems for marginalist theory already arise in a zero-profit framework, in which compound interest effects are ruled out. Hence the seemingly unobtrusive 'laws' of input demand and output supply are a much less reliable basis to stand on than is conventionally thought. The paper concludes with some remarks on the implications of the findings in the controversy for Keynes's theory of investment.

Keywords: capital theory, ceteris paribus clause, principle of substitution, David Ricardo, Piero Sraffa, value theory

JEL codes: B12, B51, C67, D24, D46, D57

1 INTRODUCTION

The problem of capital has been high on the agenda ever since the inception of systematic economic analysis at the time of the classical political economists. A major focus of their attention was how to deal with a multiplicity of produced means of production in a coherent way in an explanation of the generation of the social product, its sharing out amongst different claimants or social classes, and the exchange values of commodities formed in

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interdependent markets. The idea that in conditions of free competition – that is, the absence of significant barriers to entry into or exit from markets – there is a tendency towards a uniform rate of profits made the discussion centre on this rate and the set of relative prices supporting it. This approach had a significance not only for a given system of production at a particular moment in time, but also for a system of production moving through time, reflecting *inter alia* a growing population, a rising scarcity of natural resources of production, especially land, and technological and organizational progress. The problem of capital was therefore at the centre of an understanding of the static and dynamic properties of the economic system.

In this paper some of the issues mentioned will be dealt with. We start, in Section 2, with a brief account of how two major schools of thought, the classical and the marginalist schools, responded to the challenge the problem of capital poses. Section 3 begins by taking a closer look at what may arguably be taken to be the first clear statement of the problem in David Ricardo. He had understood that since competitive prices depend also on income distribution (real wages and the corresponding rate of profits), so does the magnitude of the capital stock employed in an economy, which consists of a set of heterogeneous means of production and means of subsistence of workers. Capital, Ricardo insisted, must be conceived of as a value magnitude that depends on income distribution. The paper then turns to Piero Sraffa (1960), who managed to reformulate the classical approach to the theory of value and distribution in a consistent way and solve many of the analytical difficulties Ricardo had struggled with. Section 4 provides a brief summary of the so-called Cambridge controversies in the theory of capital in the 1960s and 1970s, which turned around the problem of the choice of technique in an economic system with a positive (uniform) rate of profits and the effects of hypothetical variations of this rate on other variables of the system. Much of the debate focused on the possibilities of ‘reswitching of techniques’ and ‘reverse capital deepening’, which flew in the face of the received view of the working of the ‘principle of substitution’ in economics. Section 5 does away with a frequent misunderstanding concerning the equality between the general rate of profits and the marginal productivity of capital, appropriately defined, in conditions of economic equilibrium. Following Sraffa, we distinguish between ‘spurious “margins”’ and ‘the genuine article’ and argue that the aforementioned equality must *not* be interpreted as meaning that the marginal productivity of capital determines the rate of profits. Section 6 turns briefly to the aftermath of the Cambridge controversies. The attention focuses on some attempts to ascertain the empirical probability of reswitching and reverse capital deepening. It is argued that while these brought about important additions to the toolbox of empirical economics, because of the limitations of input–output tables they cannot settle the issue for good. Section 7 turns to the properties of a zero-profit (or interest) economy and summarizes some of the results derived by Arrigo Opocher and Ian Steedman (2015). It turns out that, even in this case – in which compound interest effects play no role – the conventional marginalist theory cannot be sustained in general. Section 8 draws the implication of the capital critique for Keynes’s concept of the marginal efficiency of the capital schedule. Section 9 provides some concluding observations.

2 THE PROBLEM OF CAPITAL IN ALTERNATIVE LONG-PERIOD THEORIES OF VALUE AND DISTRIBUTION

When we talk about ‘capital’ in this paper, following the British classical economists from Adam Smith to David Ricardo, we mean produced means of production, or capital goods or intermediate products, such as tools, machines, raw materials and the like, and possibly

also means of sustenance of workers (in the case in which wages happen to be paid *ante factum*). The reference is thus to a set of heterogeneous things, which in a capitalist economy are commodities traded in interdependent markets in which prices are formed. The attention focuses on the *long period* in which ‘natural prices’ or ‘prices of production’ prevail, which are seen to reflect the systematic, non-accidental and permanent forces at work as opposed to ‘market prices’, which reflect all kinds of factors, many of a short-lived or evanescent nature. In competitive conditions prices are seen to tend towards their centres of gravitation, which reflect costs of production plus a uniform rate of profits on capital invested. The questions the classical authors asked included: What role does capital play in explaining income distribution and especially the determination of the general rate of profits (and the rents of land), given real wages?¹ How does it affect the formation of competitive prices? What role does it play in the development and growth of the economic system?

For the purpose of this paper we may broadly distinguish between two kinds of approaches to the problem of value and distribution in a long-period framework. First, there is the classical *surplus* approach, which treats profits and wages *asymmetrically*: in determining the general rate of profits and relative prices for a given system of production, characterized by given gross output levels and given methods of production to produce them, it takes real wages as given, ascertained in another part of the theory, that is, the theory of capital accumulation and technological progress. Property incomes such as profits (and rents) are thus determined *residually*. Sraffa (1960) showed that for a given system of production the general rate of profits and relative prices may be consistently determined. Second, there is the marginalist or neoclassical *scarcity* approach, which treats profits and wages *symmetrically*: it determines the general rate of profits and real wages in terms of the marginal productivities of the factor services of capital and labour and takes as given the technical alternatives from which cost-minimizing producers can choose, the endowment of the economy with capital and labour and the preferences of agents. In order for the social product to be just exhausted by the claims of the owners of factors, technology must exhibit constant returns to scale because of Euler’s theorem. Such a condition is not implied by the classical approach.

The main questions asked are: What about the internal consistency of the two types of theory? If earlier authors have provided versions that are flawed, can the flaws be removed and consistent versions elaborated? In particular, can ‘capital’ be treated like some original factor of production (labour or land), whose ‘quantity’ can be given independently of, and prior to, the determination of the general rate of profits? While in the initial phase of the Cambridge controversies the attention focused on whether or not the marginalist concept of capital could generally be sustained, after this had convincingly been shown not to be the case, its advocates contended that the theory could nevertheless be accepted because it was able to explain the working of the economy reasonably well.

In the following section we first go back to the roots of the problem of capital as it surfaced in David Ricardo’s work. Then we turn to Piero Sraffa’s solution to the analytical difficulties Ricardo had encountered.

3 BACK TO THE ROOTS: RICARDO AND SRAFFA ON THE PROBLEM OF CAPITAL IN A POSITIVE PROFITS FRAMEWORK

The starting point of the following considerations is Ricardo’s discussion with John Ramsay McCulloch in their correspondence in the second half of 1823. In his letter of 21 August,

1. In the following we set aside for simplicity the problem of the scarcity of natural resources and rents; see therefore Kurz/Salvadori (1995: chs 10 and 12).

Ricardo asked McCulloch, ‘what means [do] you have of ascertaining the equal value of capitals?’ and answered himself:

[Any two] capitals are not the same *in kind* – what will employ one set of workmen, is not precisely the same as will employ another set, and if they themselves are produced in unequal times they are subject to the same fluctuations as other commodities. Till you have fixed the criterion by which we are to ascertain *value*, you can say nothing of equal capitals, for what is equal to day may be unequal in a year. (Ricardo 1951–1973, vol. IX: 360, emphases added)

Capitals consist of vectors of heterogeneous capital goods that can only be compared by using values, that is, prices. Prices, however, depend not only on the technical methods of production actually employed, which translate into dated quantities of labour expended in the production of different commodities, but also on income distribution, that is, on the real wage rate or the rate of profits. If, for example, the rate of profits changes, the wage rate will change too and so will (relative) prices and the values of capitals invested in the various lines of production. Ricardo’s formulation may be said to foreshadow Sraffa’s later criticism of the marginalist concept of capital as a magnitude that can be given prior to, and independently of, the determination of prices and the other distributive variable.

Before we take a brief look at Sraffa’s critical and constructive work in the 1940s, we may recall first his 1960 solution to Ricardo’s search for a consistent theory of value and distribution in the case in which wages are paid *post factum* and there is *free competition* involving a uniform rate of profits (see Kurz/Salvadori 1995: ch. 4).² We deal only with the simplest possible case, that is, that of single production with only basic commodities and no scarce natural resources. (For more general cases, including non-basics, fixed capital, scarce natural resources and joint production proper, see, for example, Kurz/Salvadori 1995). In this case, using matrix notation and setting gross output levels of the different commodities equal to unity, the system of price equations associated with a given system of production can be written as

$$\mathbf{p} = (1 + r)\mathbf{A}\mathbf{p} + w\mathbf{l}. \quad (1)$$

Here \mathbf{p} is the price vector, \mathbf{A} the matrix of material inputs, \mathbf{l} the vector of (homogeneous) direct labour inputs, r the rate of profits and w the wage rate. Fixing a standard of value (and of wages) in terms of the semi-positive vector \mathbf{d} implies

$$\mathbf{d}^T \mathbf{p} = 1. \quad (2)$$

System (1)–(2) determines \mathbf{p} for $-1 \leq r < R$, where R is the maximum rate of profits of the system of production under consideration corresponding to zero wages.³ From equations (1) and (2) the relationship between the rate of profits and the wage rate, or the w – r relationship, also known as the *wage curve*, can also be constructed.

We may now study how prices depend on income distribution, given the technique (\mathbf{A}, \mathbf{l}) actually used. Let $\dot{\mathbf{p}}$ denote the vector of derivatives of prices and \dot{w} the derivative of the wage rate with respect to r , respectively. Differentiating the above price equations gives

$$\dot{\mathbf{p}} = \mathbf{A}\mathbf{p} + (1 + r)\mathbf{A}\dot{\mathbf{p}} + \dot{w}\mathbf{l} \quad (3)$$

2. Ricardo assumed *ante factum* payment of wages, but the assumption concerning the timing of wage payments does not affect the substance of the argument.

3. With $w = 0$, the production equations become $\mathbf{p} = (1 + R)\mathbf{A}\mathbf{p}$ and one sees at a glance that R corresponds to the left-hand eigenvalue $\lambda = 1/(1 + R)$ of \mathbf{A} .

and

$$\mathbf{d}^T \dot{\mathbf{p}} = 0. \quad (4)$$

In the case in which $-1 \leq r < R$, equation (3) implies

$$\dot{\mathbf{p}} = [\mathbf{I} - (1 + r)\mathbf{A}]^{-1}(\dot{w}\mathbf{I} + \mathbf{A}\mathbf{p}), \quad (5)$$

and, as a consequence of equation (5),

$$\mathbf{d}^T [\mathbf{I} - (1 + r)\mathbf{A}]^{-1}(\dot{w}\mathbf{I} + \mathbf{A}\mathbf{p}) = 0, \quad (6)$$

that is,

$$\dot{w} = -\frac{\mathbf{d}^T [\mathbf{I} - (1 + r)\mathbf{A}]^{-1} \mathbf{A}\mathbf{p}}{\mathbf{d}^T [\mathbf{I} - (1 + r)\mathbf{A}]^{-1} \mathbf{I}} (< 0).^4 \quad (7)$$

From equations (6) and (7) it follows that

$$\dot{\mathbf{p}} = [\mathbf{I} - (1 + r)\mathbf{A}]^{-1} \left\{ \mathbf{A}\mathbf{p} - \frac{1}{\mathbf{d}^T [\mathbf{I} - (1 + r)\mathbf{A}]^{-1} \mathbf{I}} \mathbf{I} \mathbf{d}^T [\mathbf{I} - (1 + r)\mathbf{A}]^{-1} \mathbf{A}\mathbf{p} \right\}, \quad (8)$$

and finally that

$$\dot{\mathbf{p}} = (\mathbf{I} - \mathbf{p}\mathbf{d}^T) [\mathbf{I} - (1 + r)\mathbf{A}]^{-1} \mathbf{A}\mathbf{p}. \quad (9)$$

As equations (7) and (9) show, prices and the wage rate are differentiable functions of the rate of profits, given the system of production in use. Ricardo sought to establish this fact, and while we owe him important insights into the matter, he did not succeed in fully mastering it due to a lack of the tools needed.

We may now go a step further and discuss a choice-of-technique problem by assuming that with regard to commodity k there are two methods available to cost-minimizing producers, method α and method β , whereas with regard to all other commodities only a single method is known. The technique, or system of production, using method α is given by $(\mathbf{A}^\alpha, \mathbf{I}^\alpha)$, whereas the technique using method β is given by $(\mathbf{A}^\beta, \mathbf{I}^\beta)$. The two techniques will typically be associated with different maximum rates of profit, R^α and R^β (and different maximum wage rates corresponding to a zero rate of profits). With regard to each of the two techniques, we may then differentiate the corresponding price vector with respect to the rate of profits as in equation (9). Figure 1 plots the dependence of the price of commodity k in terms of the numéraire (2) on the rate of profits for all non-negative rates up until the maximum rate for technique α (black line) and for technique β (grey line). In the case depicted, $R^\alpha < R^\beta$, and the black line cuts the grey line twice, at $r = r_1$ and $r = r_2$. For $0 \leq r < r_1$ cost-minimizing behaviour will prompt producers to adopt method (and technique) β , at $r = r_1$ both methods (and techniques) are equi-profitable and exhibit the same prices for all commodities, for $r_1 < r < r_2$ method (and technique) α will be adopted, at $r = r_2$ both methods (and techniques) are again equi-profitable, and for $r_2 < r \leq R^\beta$ method (and technique) β will be adopted. (Technique α would yield rates of profit larger than R^α only at negative levels of the real wage rate.) The case under consideration illustrates the reswitching of a

4. It deserves to be emphasized that in the case of single production $\dot{w} < 0$ irrespective of the standard of value chosen; see Kurz/Salvadori (1995: ch. 4).

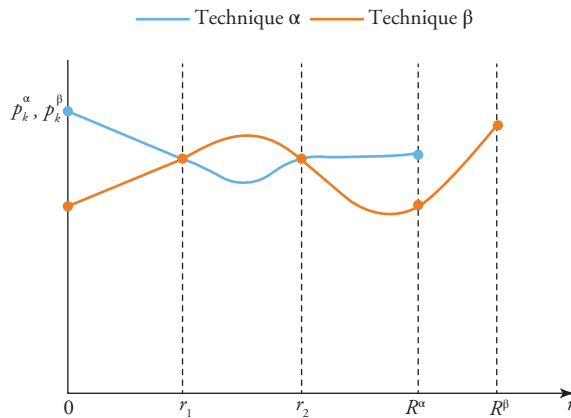


Figure 1 Choice of technique and non-monotonic ordering of technical alternatives

technique and exemplifies the fact that techniques α and β cannot be ordered monotonically with the rate of profits.

From a history of economic analysis point of view, the important point to be made is this: Ricardo's discovery that relative prices depend not only on technical conditions of production but also on the distribution of the product amongst different claimants, workers and capitalists, contains the seeds to the findings Sraffa elaborated, which fuelled the Cambridge controversies in the theory of capital. This is also the reason why Sraffa (1960: v) insisted modestly that what he had done was simply to go back to the 'standpoint ... of the old classical economists from Adam Smith to Ricardo, [which] has been submerged and forgotten since the advent of the "marginal" method'.

Let us now turn briefly to Sraffa's constructive and critical work that culminated in the publication of his 1960 book. Sraffa in the early 1940s, resuming his work after ten years dedicated to the task of bringing out the Ricardo edition (Ricardo 1951–1973), composed a few notes that substantiated Ricardo's above claim. In a note composed on 6 August 1942, entitled 'Measure of capital', Sraffa insisted that the quantity of capital employed cannot be measured in 'price', because its price varies with 'the variations in the proportional distribution of the product between wages and profits' (D3/12/16: 10).⁵ The term 'proportional distribution' echoes Ricardo's concept of 'proportional' wages, by which he was referring to the *share* of wages in the social product in the case in which wages did not just cover mere subsistence but workers participated in the sharing out of the surplus product.⁶ The difficulty besetting marginalist capital theory Sraffa then specified in the following terms:

If the quantity of capital, when measured in a variable standard, is proportional to the income of the capitalist, then the quantity of capital, measured in an invariable standard, is not proportional

5. The reference is to Sraffa's Papers at Trinity College, Cambridge, catalogued by Jonathan Smith, archivist.

6. In his book, Sraffa adopted Ricardo's concept, but as we have already noted instead of assuming wages paid *ante factum* he assumed *post factum* payment. He then developed his argument with the help of the Standard system and Standard commodity and established a linear relationship between the rate of profits r and proportional wages ω ,

(footnote continues opposite)

to the income of the capitalist; that is to say, the income divided by the rate of interest does *not* give the quantity of capital. (D3/12/16: 11, emphasis in original)

Hence Ricardo's search, far from representing an outmoded concern that is irrelevant with regard to modern theory, implicitly pointed towards a crucial stumbling block of the marginalist concept of capital: the 'quantity of capital', whose relative scarcity is supposed to reflect its marginal productivity, cannot be given independently of relative prices and the rate of profits. How, then, could the rate of profits be determined by marginalist theory? Ricardo's findings, if developed coherently, 'cannot be reconciled with *any* notion of capital as a measurable quantity independent of distribution and prices' (Sraffa 1960: 38; emphasis in original).

In a note drafted in August 1942, Sraffa elaborated on his previous argument. He enunciated the following requirement: 'What is demanded of a Model is that it should show a constant (constant with respect to variations of r) ratio between quantity of capital and quantity of product'. He concluded that marginalist authors, including Eugen von Böhm-Bawerk and Knut Wicksell, failed to accomplish the task:

The reason why B-B., Wicksell and Co fail to find an invariable measure of capital is their obsession with the marginal product theory of interest. For them a measure is satisfactory only if it suits the marg. prod. theory: naturally they fail to find any satisfactory. In the end W. confesses that the difficulties of a measure are 'insuperable', but always clings to, and in fact never has any doubts, about the marg. prod. It never occurs to him that it is the latter problem that is impossible and has to be given up. (D3/12/16: 14)

And on 17 February 1946 Sraffa emphasized that the conventional concept of capital bases its 'prestige ... on an extension of the uniform means of production' case and adds that this is 'the only case in which the price measure applies accurately' and so does 'also the ton measure (and any other)', for in this case capital is 'uniform in quality, e.g. wheat' (D3/12/16: 27). The *corn model* is required for the marginalist theory to hold true!

In his book, Sraffa (1960: 6) expresses his findings in a passage that leaves nothing to be desired and does away with the received concept of a 'given quantity of capital'. He writes:

This is because the surplus (or profit) must be distributed in proportion to the means of production (or capital) advanced in each industry; and such a proportion between two aggregates of heterogeneous goods (in other words, the rate of profits) cannot be determined before we know the prices of the goods. On the other hand, we cannot defer the allotment of the surplus till after the prices are known, for ... the prices cannot be determined before knowing the rate of profits. The result is that the distribution of the surplus must be determined through the same mechanism and at the same time as are the prices of commodities.

We can only wonder which course economics would have taken had Sraffa already published his findings in the second half of the 1940s, long before Gérard Debreu brought out his *Theory of Value* (1959). With the benefit of hindsight, Sraffa's work on the Ricardo edition (or, more specifically, the discovery of Ricardo's letters to James Mill in 1943, which postponed the completion of the edition a great deal and had a negative impact on the progress of Sraffa's constructive work) was clearly a boon, but it was also a curse.

(footnote 6 continued)

$$r = R(1 - \omega),$$

where R is the *Standard ratio* or *maximum rate of profits* and ω is the share of wages.

We now turn to the Cambridge controversies, the essence of which may be summarized in the following way.⁷

4 THE CAMBRIDGE CONTROVERSIES IN A NUTSHELL

The result, which at the time received the greatest attention, was the possibility of the *reswitching of techniques* (or systems of production), or RST for short. By this we mean that techniques cannot generally be ordered monotonically with the rate of profits (or rather the w/r ratio). Therefore the direction of change of 'input proportions' cannot be related unambiguously to changes in the distributive variables. This contradicts the marginalist *principle of substitution* as it is typically invoked in micro- and macroeconomics. According to this principle, an increase (decrease) of the wage rate relative to the rate of interest (or profits) prompts cost-minimizing producers to employ relatively less (more) of the factor of production, in this case labour, that has become relatively more (less) expensive. The conventional principle of substitution underlies the usual demand functions of factor services that are inversely elastic with regard to the factor price. With RST, the demand function need not be downward-sloping in its entire domain, but may exhibit rising segments. Therefore, a fall in the real wage rate need not always lead to an increase in labour employment, as marginalist theory typically maintains. The results of the capital controversy have occasionally been dubbed barren and irrelevant with respect to the 'real world' and economic policy issues. However, the result under consideration shows that this is not so. If in certain conditions employment can be increased by an increase rather than a decrease of real wages, then this turns the conventional preconception upside-down.

Reverse capital deepening, or *capital reversing* – RCD for short – means that the relationship between the capital–labour, K/L , or capital–output, K/Y , ratio and the r/w ratio is increasing rather than decreasing, as conventional marginalist theory maintains. This is to say that input proportions are not necessarily everywhere inversely related to 'factor price' proportions. RCD does not presuppose RST of wage curves contributing to the wage frontier (or outer envelope of all wage curves). The negative implication of RCD for conventional long-period marginalist theory can be seen when we confront a 'demand curve' for capital with a 'supply curve' of it (see, for the following, Kurz/Salvadori 1998). If the two happen to intersect only once at a level of the rate of profits (interest) at which the demand curve cuts the supply curve from below, the equilibrium is unstable. With perfect competition, conceived of, as it is in marginalist theory, as including the perfect flexibility of w and r , a deviation of r from the equilibrium value would imply that one of the two types of income, wages and profits, would disappear.

Consumption reversal, or CR, means that consumption per capita (that is, per unit of labour employed) c and the rate of interest r may be positively related to one another. This runs counter to the conventional neoclassical view, which postulates a negative relationship.

It is interesting to note that Knut Wicksell, who was well-read in Ricardo, sensed around the turn of the nineteenth century that the marginalist concept of capital was problematic. This was so, he argued, because it could only be given as a quantity of value and not as a physical quantity, although its relative scarcity and marginal productivity were defined in terms of the latter. A marginal change in its quantity was taken to affect its marginal productivity and therefore the rate of profits, but a change in the rate of profits also affected

7. See also Garegnani (1970; 1990), Harcourt (1972), Kalmbach (1972), Hagemann (1977), Schefold (1989), Kurz/Salvadori (1995: chap. 14) and Petri (2016).

relative prices and thus the value of the capital invested. In the Cambridge controversies it was Joan Robinson in particular who stressed the importance of Wicksell's findings. We distinguish between 'price Wicksell' and 'real Wicksell effects' (see Kurz/Salvadori 1995: 120 and 124). The negative versions of these contradicted conventional theory. A negative price Wicksell effect is obtained when the relationship between the capital–labour ratio and the rate of profits relative to a given technique is increasing for some r . A negative real Wicksell effect is obtained when at a switch point the technique adopted at higher levels of the rate of profits has a value of capital per head that is higher than that of the technique adopted for lower levels of the rate of profits.

Both advocates and critics of marginalist theory were taken by surprise when confronted with these results. While the critics welcomed them because they strengthened their position, advocates received them at first with disbelief and later frequently called them 'perverse', because in their theory there was no room for them.

What did the critique of marginalist theory amount to? At the deepest level it expresses a profound reservation with regard to the marginalist 'vision' of how the economy works, the kind of 'forces' it contemplates (in particular the preferences of autonomous agents) to the detriment of other forces (such as economic power), the individualistic methodology adopted and the analytical method used. More specifically, it implies an attack on the narrow and mistaken use of the *ceteris paribus* clause, based on the assumption that one can change the price of just one commodity or factor service at a time. However, this is impossible, because at least some other price(s) have to change as well. Therefore the results obtained using the *ceteris paribus* clause in the sense explained are bound to be misleading in general, not only quantitatively, but also qualitatively: they may postulate forms of relationships between economic variables that are opposite to those derived in a (more) general framework. Partial equilibrium analysis is said to be a highly problematic guide to economic policy recommendations.⁸

In the light of the capital theoretic findings the conventional microeconomic 'laws' of input demand and output supply turn out to be not valid in general. The conventional apparatus of demand-and-supply analysis proves to be much less solid than many economists are inclined to believe.

The implications of these 'negative' findings – negative only with regard to marginalist theory – reach far beyond the field of value and distribution, which is hardly surprising given the fact that the latter constitutes the centrepiece of economic analysis. The criticism has been carried over to other fields of economics, including international trade, growth and development, taxation and so on.

There have been numerous responses by authors, who count themselves as belonging to mainstream or neoclassical economics. Paul Samuelson admitted the correctness of the critique in his 'Summing up' paper (Samuelson 1966). He and Edwin Burmeister were particularly intrigued by the possibility of a positive relationship between consumption per capita and the rate of interest. This was seen to be the most striking of all 'perversities' established in the Cambridge controversies.

A first brief look at some of the responses of prominent advocates of marginalist economics gives the following picture (see also Section 6 below). In his Marshall Lectures given at the University of Cambridge, UK, Robert Lucas, not surprisingly, felt the need to ask who was right in the Cambridge controversies in the theory of capital. If, he surmised, the

8. It hardly needs to be stressed that any economic analysis is *per se* always partial in the sense that it cannot take into account all the elements that may play a role in the context under consideration. Here the question is whether important aspects are ignored that must not be, because they affect the result of the investigation in crucial ways.

controversy had been about whether capital consists of heterogeneous means of production, he graciously conceded that the Cambridge UK side had won the debate. As if the heterogeneity of capital goods could ever have been a matter of dispute! But then he surprisingly added that physical capital is to be treated as if it was homogeneous. He justified this radical turn by insisting that, like human capital, physical capital ‘is best viewed as a *force*, not directly observable, that we *postulate* in order to account in a *unified way* for certain things we *can* observe’ (Lucas 1988: 36, first three emphases added). One can only wonder whether there are any limits to imagination and what they are. If capital is not observable, how could its size ever be ascertained and its marginal productivity determined? Lucas pretended to address the capital theoretic problem besetting marginalist theory, but what he actually did was to gratuitously ignore it.

Andreu Mas-Colell’s (1989) response was rather different. He stressed that the relationship between the capital–labour ratio and the rate of return on capital can have almost any shape whatsoever. This implies that the ‘demand function’ for capital in terms of the rate of interest need not be downward-sloping at the (perhaps only) point at which it cuts a given ‘supply function’ of capital. The resulting equilibrium, while unique, would be unstable. We may ask, along with Alfred Marshall (1890), what is the explanatory power of an unstable equilibrium?⁹

As time went by, large parts of the profession began to simply ignore the results of the Cambridge controversies in the theory of capital. Today the knowledge about them is poor. Many colleagues do not even know what the controversies were all about, let alone what their results were and how these might affect their own work. This is not exactly a sign of the widespread view that the science of economics is a teleological process, an irresistible and triumphant march away from false ideas and perceptions towards true ones.

Before we turn to the aftermath of the Cambridge controversies, a confusion ought to be cleared up, which is encountered in the literature and wrongly takes the equality between the rate of profits (interest) and the marginal productivity of capital, appropriately defined in a multi-commodity framework, to mean that the former is determined by the latter.

5 BEWARE OF ‘SPURIOUS “MARGINS”’!

In the long-period equilibrium of a multi-commodity economy, the marginal productivity of capital, appropriately defined, equals the rate of profits. Some authors interpret this fact as confirming marginal productivity theory. Interestingly, Sraffa anticipated the kind of misunderstanding involved when he wrote in his book: ‘Caution is necessary ... to avoid mistaking spurious “margins” for the genuine article. Instances will be met in these pages which at first sight may seem indistinguishable from examples of marginal production; but *the sure sign of their spuriousness is the absence of the requisite kind of change*’

9. It deserves to be mentioned that, with the works of Sonnenschein, Mantel and Debreu in the 1970s, it has been firmly established that the only restrictions the usual assumptions on individual agents impose on aggregate excess demand do not suffice to show that the resulting equilibria are stable. On the basis of these assumptions one does not find an adjustment process that converges from arbitrary initial prices to equilibrium prices. From this, Debreu drew the conclusion that the problem is not tractable. It has also been shown that convergence presupposes that agents have access to an *infinite* amount of information. This contradicts the widespread view amongst neo-classical economists that the market economy is efficient and equilibrating despite the fact that individual agents are possessed of limited and highly dispersed knowledge only.

(Sraffa 1960: v, emphasis added). He added that it was ‘P. H. Wicksteed, the purist of marginal theory, who condemns such a use of the term “marginal” as a source of “dire confusion”’ (ibid.: v–vi). We shall see that in the view under scrutiny, the ‘requisite kind of change’ is indeed absent.¹⁰

Christian Bidard (2004), for example, stressed on the basis of a ‘differentiability hypothesis’ and Shephard’s lemma that the rate of profits and the marginal productivity of capital are equal to one another.¹¹ Clearly, for each commodity i , any input vector $(l_i, a_{i1}, a_{i2}, \dots, a_{in})$ satisfying a smooth and convex isoquant

$$F^i(1; l_i, a_{i1}, a_{i2}, \dots, a_{in}) = 0$$

is technically feasible and the smoothness and convexity properties imply that there is an infinite number of such vectors. In terms of this assumption, the following can immediately be established: For a *given* rate of profits r^* , there is a unique technique $(\mathbf{A}^*, \mathbf{I}^*)$ that pays the largest wage rate, whatever is the standard of value. This technique then satisfies conditions that can be interpreted as the equilibrium condition reflecting the equality between the marginal productivity of a composite input and the price of that input in terms of the output.

This fact cannot be disputed, and to the best of my knowledge has never been disputed by critics of marginalist theory starting from Sraffa’s contribution. The question is, what does this fact mean? The answer is obvious: The marginal conditions are simply a *logical implication* of cost minimization in cases in which there are no ‘jumps’ in input use. These conditions do not undermine or spell trouble for many important ‘negative’ results deriving from Sraffa’s analysis, as some commentators seem to think. These results can be obtained even in the case in which marginal conditions hold in equilibrium.

In short, the fact that the rate of profits equals the marginal productivity of capital, appropriately defined, must not come as a surprise.¹² It should especially not be mistaken to imply that the rate of profits *is determined* by the marginal productivity of capital. Since the rate of profits (or the real wage rate) has been treated as a known magnitude, a given or datum, income distribution is already fixed. The marginal equality under consideration therefore cannot be interpreted as reflecting a *causal relation* leading from the marginal productivity to the rate of profits. In Sraffa’s words, the absence of the ‘requisite kind of change’ is all too obvious. The question is not by how much total output Y will change due to an infinitesimal change in the ‘quantity of capital’ employed K and whether the marginal productivity of capital determines the general rate of profits as marginalist theory postulates, that is,

$$\frac{\partial Y}{\partial K} = r.$$

The question, rather, is which technique will cost-minimizing producers adopt, *given* the rate of profits (or the real wage rate). Therefore these equilibrium properties or equalities render no support whatsoever to the marginalist attempt to *explain* the rate of profits in terms of the ‘marginal productivity’ or ‘relative scarcity’ of a factor called ‘capital’. The

10. The following consideration summarizes an argument contained in Kurz/Salvadori (2010).

11. Burmeister/Dobell (1970: ch. 9) had already used the differentiability hypothesis and had explored its implications.

12. To conceive of the marginal productivity of capital as the increment of profits in monetary terms divided by the increment of the capital stock also in monetary terms, as occurs frequently in the literature, evades the issue and simply defines the marginal profitability of capital.

‘quantity’ of this factor cannot generally be conceived of as a magnitude that is independent of the rate of profits. As Pasinetti (1969: 529) stressed: ‘It is this idea which has been shown to be an illusion; for, in general, such a thing does not exist’.

Major representatives of marginalist theory, including Paul A. Samuelson, received the results of the Cambridge controversies in the theory of capital at first with disbelief. Once the logical possibility of phenomena such as RST, RCD and CR had been firmly established, the attention turned to the question of how likely they are in well-specified analytical circumstances and what is their empirical probability. In the following section I comment briefly on some of the works that contributed to these issues.

6 THE ‘ALL-IMPORTANT PRINCIPLE OF SUBSTITUTION’

RST and RCD contradict what Joseph A. Schumpeter, following in the footsteps of Alfred Marshall, had called the conventional view of the working of ‘the all-important principle of substitution’. This version postulates that methods of production can be ordered monotonically with regard to relative input or factor prices, which is reflected in decreasing or at most constant inputs per unit of output with respect to the price of an input (or factor service), that is,

$$\frac{\partial b_{uv}}{\partial e_v} \leq 0,$$

where b_{uv} is the amount of input v needed to produce one unit of product u and e_v is the price of one unit of input v . Not trusting the new findings, Samuelson asked his student David Levhari to demonstrate that RST was impossible and that systems of production can be ordered according to ‘degrees of mechanization’ (Levhari 1965). Encouraged and supported by Piero Sraffa, Luigi Pasinetti showed that Levhari’s claim could not be sustained (Pasinetti 1966). Levhari/Samuelson (1966) then frankly admitted that ‘The nonswitching theorem is false’, hence the title of their reply.¹³

Once the question of the possibility of RST, RCD and CR had been cleared, the attention turned to the probability of their occurrence. Advocates of marginalist theory were inclined to consider them as basically negligible and insisted that ‘exceptions’ of this kind cannot possibly endanger the basic validity of a theory that is meant to provide a simplified but broadly correct picture of reality (see, for example, Ferguson 1969). Some compared the phenomena to the case of ‘Giffen goods’ in consumer theory. Several critics of marginalist theory, on the other hand, also without any further theoretical or empirical substantiation, were inclined to stipulate that the phenomena under discussion are widespread and play a crucial role in shaping the actual behaviour of the economic system.

These were offhand responses. The first author who, to the best of my knowledge, sought to substantiate his claim that RST and RCD were empirically unimportant was Wilhelm Krelle (1977). He constructed wage curves from input–output data for different years and analysed the switch-points, if any, between the curves. To use input–output data appears to make perfect sense, since the phenomena under discussion refer to properties of the economic system as a whole and input–output tables are designed to capture precisely (some) such properties. It therefore does not come as a surprise that up until today

13. The switching of systems had, of course, not been disputed, as the title somewhat misleadingly suggests.

basically all empirical investigations of the questions we are concerned with have been carried out using input–output. While this may provide the best framework available, the question is whether it is good enough to answer satisfactorily what we are interested in.

Before I express my doubts in this regard, let me stress that they concern first and foremost the data available in input–output tables and the way they have been constructed rather than the sophisticated methods and algorithms developed and employed in the respective empirical studies. In fact, recent contributions have significantly upgraded the set of tools by means of which the issues under consideration can be tackled.¹⁴ Alas, there is no comparable improvement in the set of data available to the economist. It deserves also to be mentioned that, while in most studies cases of RST, RCD and CR turn out to be of rare occurrence, this does not imply that the critique of neoclassical theory put forward in the Cambridge controversies is invalidated. The authors mentioned are quite clear in this regard and stress that the Sraffa-based critique is solid. The attention has, however, shifted to other, albeit closely related phenomena, such as Wicksell effects and their impact on the economic system. Schefold (2013b) argues that the number of techniques that contribute to the wage frontier is rather small, which implies that marginalist theory grossly exaggerates substitution possibilities. Mariolis/Soklis (2010) advocate the use of the actual Supply and Use Tables, which correspond empirically to what joint production systems are in theory. In this case non-monotonic wage curves exist. This casts further doubt on the view that marginalist theory offers a good approximation of how actual economic systems behave. According to Zambelli (2018: 419), several of the theoretical results established in the 1960s and 1970s have been empirically confirmed. In particular, ‘the *surrogate* production function does not have the desired *neoclassical* properties’ (ibid.: 419, emphases in original). And: ‘The very notion of aggregate marginal productivity ... has no meaning’ (ibid.: 419).¹⁵ We owe him and his collaborators (see Zambelli et al. 2017) the elaboration of an algorithm that allows the computation of the wage frontier from any given set of methods of production. He also insists that the wage frontier is generally not linear (or close to linear).¹⁶

14. See, in particular, Han/Schefold (2006), Soklis (2011), Schefold (2013a), Mariolis/Tsoufidis (2014; 2016), Mariolis (2015), Shaikh (2016), Zambelli et al. (2017) and Zambelli (2018).

15. See also Shaikh’s (1974) early criticism of what he called the ‘humbug production function’ and Felipe/McCombie’s (2013) treatise on the unsustainability of macroeconomic production functions. (The term ‘aggregate’ production functions is misleading, because they have never been shown to be the outcome of consistent aggregation starting from microeconomic production processes.) The fact that such functions often give plausible statistical results, Felipe/McCombie stress, is due to the use of constant-price data instead of physical data, to which the theory refers, and the use of an accounting identity that relates the data in definitional terms. The function is therefore *not* a technical relationship between inputs and outputs at all and cannot be statistically refuted.

16. Schefold (2016) advocates the use of ‘random matrices’; on the concept of random matrices, see also Bródy (1997). These are meant to capture two unobtrusive facts, namely, first, that changes in material input–output coefficients are unpredictable, and, second, that labour coefficients are typically decreasing. Adding some further assumptions, randomization gives rise to quasi-linear wage curves. I am not clear what randomization is good for, *if* one is prepared to accept the idea that methods of production can be retrieved with sufficient accuracy from input–output tables. Why then randomize? Randomization implies a shift away from the ‘facts’ provided by input–output tables. It does not simply change the perspective from which one looks at a *given* system in order to disclose properties of it that would otherwise remain hidden (as in the case of Sraffa’s Standard commodity). Instead, randomization changes the properties of the original system and in fact generates a new one. On the differences between original and randomized systems, see also Mariolis (2015) and Mariolis/Tsoufidis (2016).

But can one rely on input–output tables in our context? Empirical economists have no choice: they are thrown back on the data provided by them for lack of better data. Can they expect to be given satisfactory answers to the questions they are interested in?¹⁷

The limitations of input–output tables are well known (see, for example, Kurz et al. 1998). Here it suffices to draw the attention to some of the difficulties that relate especially to the problems under consideration. An input–output table gives constant-price data. These are translated into an $n \times n$ input–output matrix \mathbf{A} that is taken to represent the technical coefficients of production subject to the following two bold assumptions: the (heterogeneous) commodities produced in a given industry all exhibit the same input proportions (industrial technology assumption) and there is only circulating capital (single production assumption). Not taking fixed capital (plant and equipment) into account is an especially daunting fact. Matrices of durable instruments of production are not available for many countries or only for a few years. This is a serious shortcoming not least because there is evidence that the fixed capital intensity of production is increasing over time. Would the inclusion of fixed capital affect the results? There is reason to presume that it would. Steedman (2020: 50) shows in terms of a simple corn-tractor model that ‘a sensible treatment of fixed capital can be decidedly damaging for familiar marginalist results’. He starts from Sraffa’s reference to ‘the remarkable effect that with a rise in the rate of profits the value of [an equi-proportionate stock of machines] rises relative to the original value of a new machine’ (Sraffa 1960: 70, emphasis in original). Once the assumption of radioactive decay (also entertained in some input–output studies) is replaced by a reasonable treatment of durable capital goods, it turns out that RST, RCD and CR can ‘easily’ occur. Apparently, the chosen analytical framework matters with regard to the results one gets. So does the available empirical set of data. It seems to me that the results derived with the help of an ‘experimental setup’ that takes into account only circulating capital and is subject to several other severe limitations, some of which will be mentioned in the following, ought to be received with great caution. The question that bothers me is this: Walking on shaky ground, can we really conclude with confidence that RST, RCD and CR are empirically of rare occurrence or even unimportant?

What does matrix \mathbf{A} (and the corresponding labour input vector) derived from an input–output table represent? It does *not* represent a single technique consisting of as many single-product processes as there are products, one process for each product. It, rather, represents an *aggregate* account of the quantitative structure of production observed *ex post* in an economy.¹⁸ Typically, *several* processes will be employed in the production of each and every product. Coefficients a_{ij} will therefore reflect not only the coefficients of production of all the processes employed in a given industry, but also the activity levels at which these processes have been operated. If in the production of the quantity Q_i of product i altogether m different linear processes happen to have been employed side by side whose coefficients of production are given by a_{ij}^k ($k = 1, 2, \dots, m$), and if process k has been operated at an activity level q_k , then

17. In the mid 1980s I engaged in such studies myself, but soon got frustrated because of the limitations input–output tables impose. I felt that the required translation of highly sophisticated theoretical concepts and propositions into empirical ‘facts’, and vice versa, was a mission impossible for me.

18. Since the dimension of tables and thus the number of industries is not changed for long periods of time, new goods and means of production are confounded with old ones. In the extreme, an industry in year T produces a completely different set of commodities than in year t ($T > t$) and uses mostly different means of production as inputs. But this is hidden by the fact that new products are subsumed under a received classification of industries.

$$a_{ij} = \frac{\sum_{k=1}^m a_{ij}^k q_k}{Q_i}.$$

Coefficients a_{ij} thus refer to fictitious processes and the technique made up of such processes is also fictitious.¹⁹ Applying the usual argument elaborated in the theory of the choice of technique, from all real methods of production effectively available in the economy for the n different products, *several* alternative techniques can be built up. To each of these corresponds a w - r curve. Using a common standard of value, all these curves can be plotted in a single w - r diagram. The diagram shows at a glance that in all probability not all techniques allow for positive rates of profit, given some non-negative levels of the real wage rate. Some of these curves will in all probability be completely dominated by one or several other curves. That is to say, the processes will typically yield differential rates of profit for any given level of the real wage rate; some profit rates may even be negative. Hence not all processes and techniques are actually eligible, a fact which the (only) w - r relationship constructed from an input-output table fails to reflect. In competitive conditions nobody would reinvest in processes exhibiting rates of profit that are lower than their competitors' and thereby secure their continued existence: obsolete processes would go out of business. The outer envelope of all effectively available techniques would give the *proper* wage frontier. It is made up of the best-practice techniques in the given circumstances corresponding to alternative levels of the real wage rate. How many cases of RST, RCD, CD and 'perverse' Wicksell effects will it display in any particular situation? We don't know.²⁰

Whilst with only circulating capital, on which empirical studies willy-nilly focus attention, obsolete processes can be expected to swiftly disappear from the picture, things are actually quite different because in reality there *is* fixed capital. At any moment in time the capital stock of an economy is made up of capital goods used in production processes of various vintages operated side by side in different industries. It is plausible to assume that a concern with cost minimization prompts firms to fully utilize the most efficient plant and equipment even in conditions of low levels of effective demand. As Sraffa (1960: 78) stressed:

19. Firms are typically multi-product firms. The allocation of a firm to an industry in input-output tables depends on its product mix (in value terms) and may change with it. Firms may therefore be part of one industry in the input-output table of a given year and part of another industry in the following year, even if their product mix has changed only slightly. (Think, for example, of firms like Siemens.) This may have a considerable impact on the technological characteristics of the various industries, both intertemporally and interspatially, even though relatively little has changed technologically.

20. What has been said about a_{ij} applies *cum grano salis* also to the labour input vector. The widespread practice of summing all hours of labour employed as if it were homogeneous labour and assuming a uniform real wage rate ignores the heterogeneity of labour and cannot capture important changes in the composition of the workforce, such as up- and deskilling, and in the cost structure of products. (In Section 3 above we also assumed for simplicity homogeneous labour. For a treatment of heterogeneous labour, see Kurz/Salvadori 1995: ch. 11.) The classical economists and Marx were very clear that heterogeneous labours had first to be made commensurable with one another in terms of the relative wages paid to the workers performing them. In the course of time, both the kinds of labour employed and the relative wages paid change; think, for example, of the changing importance of skilled and unskilled labour in recent times and the growing wage spread between them. Approaches that ignore the heterogeneity and changing heterogeneity of labour provide a distorted picture of reality.

Machines of an obsolete type which are still in use are similar to land in so far as they are employed as means of production, although not currently produced. ... [H]aving been in active use in the past, [they] have now been superseded but are worth employing for what they can get.

Wicksell spoke aptly of 'rent goods'. What an input–output table thus represents is not only a set of multiple processes of production actually in use in the different industries during a given year; it also reflects a particular stage in the diffusion of new processes of production and the fixed capital goods employed in them and the elimination of old processes and the corresponding fixed capital goods, and the levels of effective demand across industries and processes of production actually employed.

These considerations should suffice to alert one to the difficulties involved when using input–output tables. While the choice of technique literature whose results ought be assessed empirically refers to technical knowledge available to cost-minimizing agents at a given moment in time, an input–output table conveys the impression that there is only a single technique actually available and that it is being operated. By construction *there is no choice of technique* in a given year. A choice exists only across several years. In this perspective, there are as many alternatives as there are years, one for each year reflected by a w – r relationship computed from the input–output table relating to that year. Furthermore, if the techniques available in some other country are considered to be eligible alternatives in the home country, the choice set is increased accordingly.²¹ For example, Han/Schefold (2006) computed wage curves corresponding to pairs of input–output tables, using altogether 32 tables with 32 industries each. Zambelli et al. (2017) constructed wage curves for 30 countries for each year from 1995 to 2009. He and his co-authors also computed what they called the intertemporal wage–profit frontier. Wage–profit curves corresponding to later years typically tend to dominate those corresponding to earlier years for levels of the rate of profits close up to the maximum rate possible. This reflects, as we have argued, two effects: first, the diffusion of already known and more profitable processes to the detriment of less profitable ones and thus a movement towards the old wage frontier, and, second, the introduction of entirely new processes reflecting new technical and organizational knowledge, that is, technical progress, and thus the establishment of a new wage frontier.

The problem of technical change over time is thus confounded with the choice of technique at a particular point in time. Because of its dominantly labour-saving character technical progress typically increases the intersections of w – r curves corresponding to consecutive years with the w -axis, whereas their intersection with the r -axis does not appear to be affected all that much. It therefore should not come as a surprise that the w – r curves belonging to input–output tables of *different* years do not intersect many times, if at all. Hence *by construction*, due to the shift factor of technical progress, the 'probabilities' of RST, RCD and CR assessed in this way are bound to be small. But is this a compelling proof of their unimportance? I wonder. It seems to me that, for the reasons given, the chosen experimental set-up does not allow for a satisfactory answer to the question raised.

To conclude, while the discussion of the capital theoretic problems in the aftermath of the Cambridge controversies in the 1960s and 1970s have contributed to our understanding of the problems at hand, these are still far from being settled for good. This is not the fault of the economists that have engaged in them, to whom we owe the elaboration of important theoretical and empirical arguments and devices. It, rather, points towards the severe limitations of

21. The assumption that the entire technical knowledge available in the world as a whole is available *hic et nunc* in each and every country is difficult to sustain. Classical trade theory and contributions to 'new' trade theory insist that the transfer of knowledge is costly and the institutions and labour force of a country may not be prepared for it.

the empirical material available in terms of input–output tables. There is perhaps reason for optimism as regards future research, because in the era of what is called ‘data capitalism’ the information about actually available technical alternatives at a given moment in time can be expected to improve considerably. With the powerful analytical and computational tools forged during recent years, more solid answers can be expected to be forthcoming.

7 PROBLEMS OF MARGINALIST ECONOMICS IN A ZERO-PROFIT FRAMEWORK

It would be wrong to assume that the difficulties of marginalist capital theory, some of which have been discussed during the Cambridge controversies, are exclusively due to the assumption of a positive rate of interest (or profits) and the compound interest effects that come with it. This is definitely not the case, as Arrigo Opocher and Ian Steedman have made clear in a number of contributions and most recently in their book *Full Industry Equilibrium* (2015); see also the symposium dedicated to the book in *Metroeconomica* (2017).²² They show in terms of numerous cases regarding the given set of technical alternatives from which producers can choose that even if extra profits and extra losses are eliminated and the rate of interest is nil, the microeconomic ‘laws of input demand’ (Hicks 1939; Samuelson 1947), derived within a partial equilibrium framework, need not hold true. A change in the (service) price of a primary input may induce, for example, a qualitative change in input use, including produced inputs (capital goods) of various types.

More specifically, they establish the following results:

- In the case of just *two* inputs (primary or produced) or of an arbitrary number of only primary inputs no problem arises: the conventional laws of input demand correctly predict the substitution effects.
- With more than two inputs, both primary and produced, a parametric change in one input price entails a variety of compensating effects in other prices through cost and price adjustments across the economy.
- There is a fundamental difference between primary inputs and produced inputs: While the price of a primary input *either* increases *or* decreases relative to all other input prices, the price of a produced input increases relative to some input prices *and* decreases relative to others.
- This is the reason, why no ‘law of input demand’ can in general predict the qualitative change in produced input use, even if all pairs of inputs are Hicksian substitutes.
- It follows that a simple relationship between produced input use and produced input price (in terms of some numéraire), as is typically assumed in microeconomic textbooks and in empirical analyses, lacks any theoretical meaning.

It can happen, for example, that an increase in the wage rate is associated with an increase in the employment of labour per unit of output – a possibility reflected upon, for example, by Joseph A. Schumpeter (1916–1917), who, however, lacked the analytical means to establish this possibility and study the circumstances under which it occurs.

22. It is interesting to note that the book by Opocher and Steedman is firmly rooted in a predominantly Italian tradition of economic thought to which Sraffa contributed his famous 1925 and 1926 papers (Sraffa 1925; 1926). A main aim of these papers was to criticize the received *ceteris paribus* premise, which amounts to simply ignoring the interdependence of prices and income distribution.

At the industry level we thus get what is somewhat reminiscent of the ‘perverse’ phenomena discovered at the level of the economy as a whole and discussed in Section 4 above. Once again, the phenomena under consideration are perverse only if judged against the background of conventional economics that frequently ignores compensating price and income effects. If anything deserves the attribute ‘perverse’, then it is ignoring these effects. Yet once they are taken into account, which they ought to, the simple and seemingly unobtrusive ‘laws’ of input demand and output supply get violated.

In 1848 John Stuart Mill contended: ‘Happily, there is nothing in the laws of Value which remains for the present or any future writer to clear up; the theory of the subject is complete’ (Mill 1848 [1965]: 456). Opocher/Steedman (2015) show that even one and a half centuries later this is still not true.

8 KEYNES AND CAPITAL THEORY – AFTER MORE THAN 80 YEARS

Since the audience at the conference in which this paper was given was said to have consisted mainly of ‘Keynesians’ of various orientations, the chairperson of the session, Harald Hagemann, asked me to say a few words about the implications of the Cambridge controversies for Keynes’s theory. I am diligently rushing to comply with his request. When reading what follows, it turns out once more that Piero Sraffa’s contribution plays a central role in the argument. His impact on core parts of economics is truly remarkable.

Invited by Lionel Robbins, editor of *Economica*, to write a review article of Keynes’s *Treatise on Money* (1930), Friedrich August von Hayek (1931b) attacked Keynes for lacking a capital theoretic foundation. Such a foundation, Hayek insisted, was badly needed. He advised Keynes to adopt Eugen von Böhm-Bawerk’s theory of capital and interest as he himself had done in his book *Prices and Production* (Hayek 1931a).

Keynes did not follow Hayek’s advice. In chapter 17 of *The General Theory* (1936) he rather employed the concept of ‘commodity rates of interest’ which Sraffa (1932) had used in his criticism of Hayek. (The concept had originally been introduced by Irving Fisher, as Sraffa made clear.) Keynes, who was not familiar with the main building blocks of Hayek’s argument – Böhm-Bawerk’s capital theory, Ludwig von Mises’s monetary theory and Vilfredo Pareto’s general equilibrium theory – asked Sraffa to help him out of the impasse. This Sraffa did. Keynes then appears to have convinced himself, apparently without discussing the matter with Sraffa, that the concept of commodity rates could not only be put to critical use in responding to Hayek, but at the same time did provide the capital theoretic foundation Keynes was in need of. He therefore based his own analysis in *The General Theory* upon it or rather upon what he thought the concept meant. When Sraffa saw the book after it had come out, he expressed his strong disagreement with some of the ideas in it in annotations in chapter 17 of his personal copy and in two manuscript fragments he left in the copy. There is no evidence that he ever showed the annotations and fragments to Keynes. It was only after Sraffa had passed away and his papers and library had been catalogued and opened to the public that his critical stance towards parts of *The General Theory* became known.

In his annotations and fragments Sraffa criticized Keynes essentially for the following reasons:²³ (i) Keynes had used two contradictory definitions of the concept – Sraffa’s and an entirely new one according to which the own rate of an asset equals the sum of the asset’s yield, its carrying cost and its liquidity premium. However, Sraffa insisted, the concept is defined only with respect to an expected change of the price of an asset, that is, the

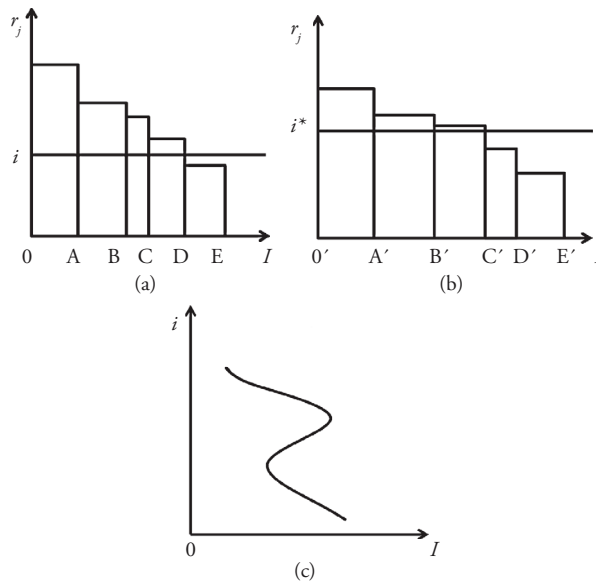
23. For a detailed discussion of Sraffa’s criticism, see Kurz (2000; 2015).

difference between its spot and future price. (ii) Keynes's choice of money as a standard of value had distorted his perspective. In an annotation on p. 227 in his copy of *The General Theory* Sraffa explained: 'The point is, that in the case of the rate of the article chosen as standard, *the effect upon it of the expected depreciation is concealed*' (emphasis added). Thus, an expected fall in the value of money, for example, implies a high 'money-rate of wheat interest' (Keynes's concept), which, alas, Keynes did not take into account. (iii) Keynes variously did not reason correctly and occasionally arrived at results that are the opposite of what a cogent argument implies. His contention that a fall in the money rate of interest is bounded from below because of liquidity preference cannot be sustained. (iv) According to Sraffa the liquidity preference schedule is but a peculiar exemplar of the conventional marginal utility curve, which he considered to be problematic. (v) Investment demand need not be inversely related to the money rate of interest. Sraffa concluded that the chapter was not well thought out, but a mess.

As regards item (v), Keynes's marginal efficiency of capital schedule, which expresses his view that investment demand is inversely related to the rate of interest, Sraffa objected: The schedule is simply a variant of the marginalist scarcity-cum-marginal productivity theory of capital, which, however, is difficult to sustain in general. Keynes derived it by starting from the same fallacy we have spotted at the beginning of this paper: that of believing to be able to change a single price or distributive variable at a time (here the rate of interest) and keeping all the other prices and distributive variables constant. Accordingly, Keynes's concept suffers from what Sraffa dubbed the 'stupid' *ceteris paribus* clause in a situation in which it must not be adopted. Once one takes into account the changes of other prices that necessarily accompany a change in the rate of interest, a cost element, these changes can be expected to have an impact on relative prices and thus on costs. This impact may (but need not) reverse the results reached by employing the *ceteris paribus* clause.

This can be illustrated with the help of the following figures.²⁴ Figure 2a gives the ranking of five investment projects in terms of their expected rates of return r_j ($j = 1, 2, \dots, 5$) and the volumes of investment associated with them (OA, AB, BC, etc.) when the money rate of interest equals i . In the situation depicted, four projects will be realized and the volume of total investment (and credit) demand will be given by OD. Figure 2b gives the case in which the rate of interest is higher, $i^* > i$. This involves, first, lower expected rates of return with regard to each project and, second, different prices and thus costs associated with the commodities needed in order to realize the projects. In the case depicted, some projects are more expensive in the new situation than they were in the old, for example $0'A' > 0A$ and $A'B' > AB$. (Some projects might be less expensive: $C'D' < CD$.) At the higher rate of interest now not only the fifth project (DE and D'E' respectively) is eliminated, as it was already at the lower rate, but also the fourth project (CD and C'D', respectively). But since the increase in the value of the first three projects as a consequence of the movement from i to i^* is larger than the value of the eliminated fourth project, the volume of total investment demand will be larger: $0'C' > 0D$. A relationship

24. For the following, see also Kurz (2012: sec. 5.4). We have already noted that Schumpeter had contemplated the possibility of non-conventional shapes of the labour demand or the investment demand schedule, but was unable to establish these possibilities in strictly analytical terms. One may wonder why he showed so much alertness in this regard, whereas Keynes did not. One reason might be that someone brought up with Walras's general equilibrium theory had perhaps a deeper grasp of the complex interdependencies involved than someone brought up with Marshall's partial equilibrium theory, which shied away from such complexities.



Source: Kurz (2012: 896).

Figure 2 Investment demand and the rate of interest

between investment demand and the rate of interest, as in Figure 2c, that is not downward-sloping throughout cannot therefore be ruled out.

Sraffa's objections to Keynes's concept of liquidity preference and his investment demand theory, it seems, were on the whole well taken: As recent developments show impressively, the money rate of interest has not been prevented from falling to even negative rates in real terms. And this fall did not spur investment activity and cause a tendency towards full employment again. In important respects Keynes was still a victim of 'habitual modes of thought and expression' (Keynes 1936: viii). He was right, though, in opposing the received doctrine that the rate of interest equilibrates investment and full employment savings.²⁵

9 CONCLUDING OBSERVATIONS

The arguably most important finding of the Cambridge controversies in the theory of capital was that the general rate of profits cannot be conceived as determined by the marginal productivity of capital. More generally, the marginal productivity theory of income distribution cannot be sustained and ought to be abandoned. This applies also to macroeconomic production functions. The findings show that the usual input demand and output supply functions postulated in microeconomic and macroeconomic theory cannot generally be sustained. RST, RCD, CR and negative price and real Wicksell effects

25. In recent discussions about the problem of secular stagnation even some scholars, who consider themselves as Keynesians of sorts, focus attention on this alleged role of the rate of interest. But why should the rate of interest be able to perform this role vis-à-vis a lack of effective demand reflected in substantial margins of underutilized productive capacity and unemployment in several countries?

may occur, and while there is still some controversy about their likelihood, there is no doubt that they call into question the validity of marginalist theory. In the preface to his book, Sraffa (1960: vi) wrote that although the propositions contained in it 'do not enter into any discussion of the marginal theory of value and distribution, they have nevertheless been designed to serve as the basis for a critique of that theory'. He added: 'If the foundation holds, the critique may be attempted later, either by the writer or by someone younger and better equipped for the task' (ibid.: vi). Since these lines were written, the critique has indeed (and in my judgement successfully) been attempted. The fact that many marginalist authors still ignore the capital theoretic findings does not support the view that the market for economic ideas is efficient. There are intellectual bubbles and some of them appear to be long-lived; hopefully they are not everlasting. A growing number of economists, several of whom used to belong to the mainstream or were close to it, have begun to deplore forms of intellectual capture in economics and some advocate a return to the approaches of the classical economists from Adam Smith to David Ricardo, Joseph A. Schumpeter and John Maynard Keynes. Policy recommendations based on conventional economics ought to be received, using a formulation by Adam Smith, 'with great precaution, and ought never to be adopted till after having been long and carefully examined, not only with the most scrupulous, but with the most suspicious attention' (Smith 1776 [1976]: WN I.xi.p.10).

To conclude, let me recall what Sraffa is recorded as having said in one of his interventions at the famous Corfu conference on 'The theory of capital' in September 1958, organized by the International Economic Association (Lutz/Hague 1961: 305–306). Sraffa insisted that

one should emphasize the distinction between two types of measurement. First, there was the one in which the statisticians were mainly interested. Second, there was measurement in theory. The statisticians' measures were only approximate and provided a suitable field for work in solving index number problems. The theoretical measures required absolute precision. Any imperfections in these theoretical measures were not merely upsetting, but knocked down the whole theoretical basis.

He added:

The definition in this case must be absolutely watertight, for with a given quantity of capital one had a certain rate of interest so that the quantity of capital was an essential part of the mechanism. One therefore had to keep the definition of capital separate from the needs of statistical measurement, which were quite different. The work of J. B. Clark, Böhm-Bawerk and others was intended to produce pure definitions of capital, as required by their theories, not as a guide to actual measurement. If we found contradictions, then these pointed to defects in the theory, and an inability to define measures of capital accurately. It was on this – the chief failing of capital theory – that we should concentrate rather than on problems of measurement.

But even when, by assumption, there is no problem of measurement of capital in modelling, the conventional marginalist view is not confirmed. As Freni (2017) has demonstrated in terms of a model with homogeneous capital, the presence of multiple primary factors of production may give rise to the same kind of complications that are encountered in systems with joint production.

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