BULLETIN OF POLITICAL ECONOMY
15:2 (2021): 147-162

Pierangelo Garegnani: economics with a critical orientation

HEINZ D. KURZ*

Abstract: In this paper we will focus on some of the problems in the theory of value and distribution that Sraffa and Garegnani have tackled in their path-breaking works. In particular, the focus will be first on the identification of the cost-minimizing system of production from a set of technical alternatives and its properties in terms of the general rate of profits and the set of relative prices corresponding to a given real wage rate. Next we will discuss briefly in highly abstract terms and in the context of an utterly simple one-good economy the process of the diffusion of new techniques and the gradual elimination of old techniques, which once were cost minimizing, but no longer are. The issue at hand is an aspect of what Schumpeter called "creative destruction." Finally, we will analyse the non-conventional (that is, non-marginalist) findings in capital theory put forward by Sraffa (1960) and further elaborated by Garegnani (1970, 1990 etc.). When their theoretical possibility had been firmly established, they were questioned on empirical grounds. The problem with this questioning is that it is far from clear, how it could convincingly be shown that some of the phenomena under scrutiny do, or do not, exist in the real world. After all, what is at issue is the behaviour of the economic system as a whole, and the data situation on the basis of which the question could possibly be decided is perhaps not up to the problem at hand. In this respect, we will point out some of the difficulties to investigate the situation in terms of data taken from input-output tables.

Keywords: Garegnani, Sraffa's price system, choice of techniques, creative destruction, capital theory, probability of reswitching and capital reversing, input-output tables.

JEL classification: B12, B13, D24, D57, E11, O33.

INTRODUCTION

Pierangelo Garegnani was a major economic theorist and historian of economic thought, who had an important impact on my way of seeing the

* University of Graz.

economic world and understanding the problems it was afflicted with. To him economic theory and its history were but two sides of a single coin, a view that is reminiscent of Georg Friedrich Wilhelm Hegel's dictum according to which philosophy is the history of philosophy. Garegnani was possessed of great intellectual power and an uncompromising dedication to his work, which in the tradition of Piero Sraffa propelled the revival and further elaboration of classical political economy. He was one of the deepest thinkers I encountered in economics. His work can be expected to have a lasting impact on the economic profession.

Garegnani defined his own work as economics with a "critical orientation". He thereby alluded to the fact that he was a critic of marginalist economics, on the one hand, and an admirer of classical and Karl Marx's political economy, on the other. However, admiring Marx's achievements did by no means amount to taking an uncritical stance towards his doctrines and propositions, as Garegnani's criticism of Marx's theory of (labour) value shows. What mattered in Garegnani's view becomes clear when he approvingly referred to Maffeo Pantaleoni's statement in *Erotemi di Economia* (1925: p. 158): "There are no 'schools' in economics, or, rather, there are only two, those who know economics and those who don't." Garegnani was, of course, keen to be a part of the former "school" and made every possible effort in this regard. An important task in this context was to identify views in economics that could not be sustained because they were based on erroneous or circular reasoning. A negative methodology played indeed an important role in Garegnani's work, as several of his works show impressively that are dedicated to a careful scrutiny of the contributions of major economists; see, in particular, the publication that grew out of his Cambridge PhD thesis (Garegnani 1960). Garegnani followed this path because in his judgment the state of affairs in economics in the second half of the twentieth century was not that most of its teachings were sound and only at the margin improvements were necessary and possible. In his view large parts of the main corpus of contemporary economics are problematic, because they were based on a theory of value and distribution that cannot be sustained. Theories whose substance he considered to be fundamentally sound had been abandoned because of the problematic form in which they had been handed down. The task was to develop versions of the theories that shed their weaknesses elaborate on their strengths. This Garegnani did with regard both to the classical surplus approach to the theory of value and distribution and the Keynesian theory of effective demand and capacity utilization.

RELATIVE PRICES, INCOME DISTRIBUTION AND THE CHOICE OF TECHNIQUE

Let us first have a brief look at David Ricardo's discussion with John Ramsay McCulloch in their correspondence in the second half of 1823 on the problem of capital. In his letter of 21 August, Ricardo asked McCulloch, "what means [do] you have of ascertaining the equal value of capitals?" and provided himself the answer:

> [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 Works IX: p. 360)

Capitals consist of bundles 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, as Ricardo had argued in his *Principles*. They depend also on the distribution of income, that is, on real wages (and the corresponding rate of profits). With a change in real wages, the rate of profits will change and so will relative prices and costs of production. A change in prices (and costs) will, however, generally affect the values of capitals invested in the various industries of the economy. While Ricardo was clearly not aware of all the intricacies of the relationship between relative prices and income distribution in systems of production, in which commodities are produced by means of commodities, his above formulation may be said to have alerted Sraffa to the need to investigate carefully these intricacies. The stunning result of his respective work implied that the marginalist concept of capital as a magnitude that can be ascertained prior to, and independently of, the determination of prices and the rate of profits cannot be sustained other than in exceedingly bold circumstances.

What is at stake can be illustrated within a Sraffian framework of the analysis in which wages are assumed to be paid post factum and there is free competition involving a uniform rate of profits (see Kurz and Salvadori 1995: chap. 4). For simplicity, it will be assumed that there is only single production, all commodities are basic commodities, that is, each one of them is needed directly or indirectly in the production of each and every commodity, and there are no scarce natural resources (such as land or

mineral deposits). (For more general cases, including non-basics, durable capital goods, scarce natural resources and joint production proper, see Kurz and Salvadori 1995). The system of production equations associated with a given system of production can then be written in familiar notation as

$$\mathbf{p} = (1 + r)\mathbf{Ap} + w\mathbf{l}, \tag{1}$$

with $\mathbf{p}$ as the price vector, $\mathbf{A}$ as the matrix of material inputs, $\mathbf{l}$ as the vector of (homogeneous) direct labour inputs, r as the general rate of profits and w as the wage rate. We then take the semi-positive vector $\mathbf{d}$ as the standard of value in terms of which wages and prices are measured, which implies

$$\mathbf{d}^T\mathbf{p} = 1. \tag{2}$$

The system consisting of equations (1) and (2) determines the price vector $\mathbf{p}$ for $-1 \leq r < R$, where R is the maximum rate of profits of the system of production under consideration corresponding to zero wages. In this case, the production equations become $\mathbf{p} = (1 + R)\mathbf{Ap}$ and one sees at a glance that R corresponds to the left-hand eigenvalue $\lambda = 1/(1 + R)$ of $\mathbf{A}$. 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 derived from equations (1) and (2) by solving (1) for $\mathbf{p}$ and plugging the result in (2).

We may now study how prices depend on income distribution, given the system of production actually in use ($\mathbf{A}$, $\mathbf{l}$). 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

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

and

$$\mathbf{d}^T\dot{\mathbf{p}} = 0. \tag{4}$$

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

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

and, because of equation (5),

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

that is,

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

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

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

and therefore that

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

Equations (7) and (9) conceive 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 could not satisfactorily solve the problem due to a lack of the mathematical tools needed.

Let us now discuss the choice-of-technique problem in the given framework. Assume 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 available. The technique using method α is given by $(\mathbf{A}^\alpha, \mathbf{l}^\alpha)$, whereas the technique using method β is given by $(\mathbf{A}^\beta, \mathbf{l}^\beta)$. The two techniques will typically have 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 illustrates the dependence of the price of commodity k in terms of the standard of value (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) b, 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) a 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 technique and exemplifies the fact that techniques α and β cannot be ordered monotonically with respect to the rate of profits. 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 technique and exemplifies the fact that techniques α and β cannot be ordered monotonically with the rate of profits; see also Kurz (2020).

From a history of economic analysis perspective, 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 sharing out of the product between 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."

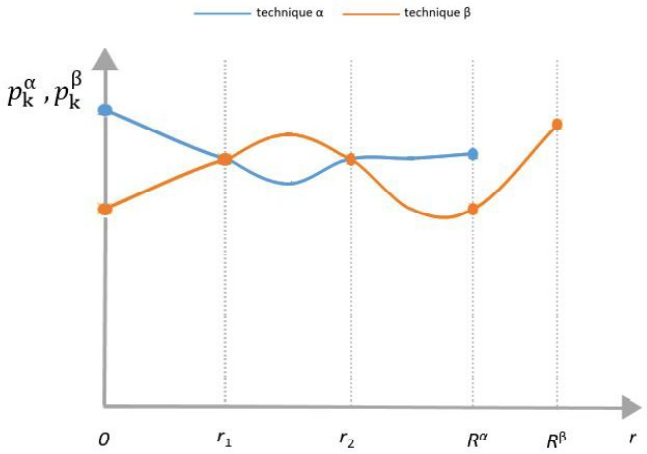

Fig. 1: *Choice of technique and non-monotonic ordering of technical alternatives*

Ricardo's early discussion draws the attention to a crucial stumbling block of the later marginalist concept of capital, conceived of as a "quantity" that could be given independently of relative prices and the distribution of the product, that is, the general rate of profits. How, then, could that "quantity" explain, and ascertain, the rate of profits in terms of the relative scarcity of capital, reflected in its marginal productivity? This is simply a case of circular reasoning. Put briefly, Ricardo's findings, if developed coherently, cannot be reconciled with the marginalist concept of capital (see Sraffa 1960: p. 38). We owe Garegnani a meticulous demonstration of this fact with regard to the contributions of major marginaist authors, first

in his history of thought master piece (Gargenani 1960) and then in numerous essays (see, in particular, Garegnani 1970). In them he debunked the conventional long-period versions of the theory, as they were advocated, among others, by William Stanley Jevons, Léon Walras, Eugen von Böhm-Bawerk, John Bates Clark, Knut Wicksell, Vilfredo Pareto and in parts of his work by John Hicks.

In the above, the focus was on the identification of the cost-minimizing system of production from a set of technical alternatives and its properties in terms of the general rate of profits and the set of relative prices corresponding to a given real wage rate. Next we discuss briefly in highly abstract terms and in the context of an utterly simple one-good economy the process of the diffusion of new techniques and the gradual elimination of old techniques, which once were cost minimizing, but no longer are. The issue at hand is an aspect of what Schumpeter called "creative destruction".

DIFFUSION DYNAMICS AND SELECTION PRESSURE

Up until now the focus was on long-period positions of the economic system, which are fully adjusted to the technical and organizational knowledge available at a particular place and time and the proportions in which the various products are "required for use" (Sraffa 1960: 43, n. 2). Hence, both the pre- and the post-innovation systems of production in conditions of free competition are ideally characterized by a given and constant uniform rate of profits across all firms and industries of the economy. This perspective implies, of course, an extreme abstraction that finds no equivalent in reality where differently productive firms and techniques coexist at any moment of time. The argument will revolve around the "selection pressure", a concept adopted from evolutionary theory, to which incumbent firms are exposed by a pioneer that has successfully introduced a new method of production. This pressure depends both on the form and the magnitude of technical progress.

We discuss the issues at hand in terms of the simplest model possible (see also Kurz 2017). We assume in addition that the general rate of profits will not change over time, whatever the technological changes experienced. This assumption reflects a "stylized fact" alluded to in much of recent contributions to the theory of economic growth. It is, of course not claimed here, that this is an actual fact, but postulating it simplifies the argument considerably and allows one to explain the story of the diffusion of new methods of production in a straightforward manner.

We assume that a single commodity is produced by means of itself and

labour (see Kurz and Salvadori 1995: chap. 2). Let a designate the amount of the commodity needed in its own production per unit of gross output and l the corresponding amount of direct labour. With the price of the commodity set equal to unity, all value magnitudes in the system are measured in terms of the commodity. We, therefore, have the following accounting equation per unit of gross output

$$1 = a + ra + wl = (1 + r)a + wl.$$

A unit of gross output is thus equal to reinvestment (a) plus profits (ra) plus wages (wl). Solving for the wage rate and assuming once again a given and constant (but positive) general rate of profits $r = r^*$, $0 < r^* < R = \frac{1-a}{a}$, we get

$$w = \frac{1-(1+r^*)a}{l}. \tag{10}$$

Equation (10) gives the wage curve in the one-commodity case. Figure 2 illustrates it with regard to the system of production from which the economy is supposed to start, represented by the blue wage curve. At the going general rate of profits r^* the corresponding real wage rate is given by w^*. The slope of the wage curve gives the capital-to-labour ratio or capital intensity, which here (and only here) is defined in purely physical terms. The intercept of the curve with the abscissa gives net output per unit of capital, $(1 - a)/a$, and the intercept with the ordinate net labour productivity, $(1 - a)/l$. While l is the direct labour coefficient, the vertically integrated labour coefficient (or labour value), v, is the solution of the following equation

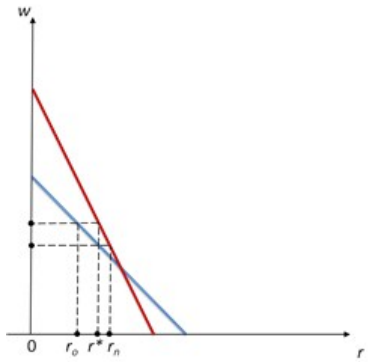

Fig. 2: Static incumbent firms can survive

Let us now distinguish between different forms of inventions: (i) direct labour saving inventions reduce coefficient l ($\Delta l < 0$) and involve a clockwise movement of the wage curve with its intercept with the abscissa as pivot; (ii) capital saving inventions reduce coefficient a ($\Delta a < 0$) and shift the curve outwards by at the same time reducing its slope; (iii) direct labour and capital saving inventions ($\Delta l < 0$ and $\Delta a < 0$) move the wage curve outwards; (iv) direct labour saving and more capital using inventions ($\Delta l < 0$ and $\Delta a > 0$) move the wage curve in such a way that its intercept with the abscissa moves closer to the origin, whereas its intercept with the ordinate moves further away from it; (v) more direct labour using and capital saving inventions ($\Delta l > 0$ and $\Delta a < 0$) are associated with the opposite movement of the wage curve.

Inventions (i)–(iii) obviously become innovations, because it is profitable to adopt them, irrespective of the level of the wage rate w^*. They reduce the total amount of labour needed per unit of output, v. In the case of forms (iv) and (v) things are slightly more complicated, because the new wage curve cuts (or, in the case of (v) may cut) the old one at some point. If the wage rate that can be read off at what is known as a switch point between the two curves is smaller (larger) than w^*, then in case (iv) the new method will (will not) be introduced; in case (v) the reverse applies. In these two cases, whether an invention will become an innovation depends also on income distribution (i.e. the initial wage or profit rate).

The magnitude of technical change depends on the difference between the production coefficients (a, l) corresponding to the new and the old method.

We may now illustrate the role of the form and magnitude of technical progress for the selection pressure that builds up during the diffusion process of the new method, which will be felt by incumbent firms. We consider just two cases; one concerns a *una tantum* technical progress of type (iv), the other one of type (iii). In Figure 2, the red wage curve relates to the new method. The pioneer who is able to introduce it at wage rate w^* pockets extra profits and yields a firm-specific profit rate equal to r_n, where $r_n > r^*$. Assuming that a firm's rate of accumulation is higher the higher is the firm-specific rate of profit, the pioneer's firm grows more swiftly than the firms of the competitors, which increases the weight of the new method at the cost of the old. According to the logic implied by a given and constant general rate of profits r^*, the wage rate is bound to rise. This rise compresses the profitability of incumbent firms still using the old method. In the case depicted, the system is taken to gravitate towards a new long-period position,

characterized by wage rate w^{**} corresponding to rate of profits r^{*}. Static firms that still happen to use the old method (and whose economic weight is vanishing) would at this wage rate still be profitable, although their rate of profits is down to r_o. They need not go out of business: they can continue to exist, and the reason for this is that the selection pressure exerted by the kind of technical progress under consideration is not strong enough.

Two observations ought to be added. First, whether an invention endangers the survival of existing firms that do not innovate depends not only on the kind and magnitude of technical progress, but may also depend on the level of the general rate of profits and the real wage rate associated with it in the initial situation. With regard to Figure 2, imagine that the original wage rate would be equal to w^{**}. As can easily be seen, in this case the wage rate in the post-technical change situation would be at a level that is incompatible with non-negative profitability of firms using the old method. Second, in the case in which there is a sequence of "small" technical changes, we may at any point in time find a whole population of firms that have survived up until then, exhibiting different efficiencies and yielding different profit rates. The size and composition of the population will change over time, reflecting the sequence of technical changes, one following upon the other, and the wage adjustment mechanism at work. While there is clearly a tendency towards a long-period position of the economic system, this does not mean that each and every single firm employs the most profitable method of production.

Figure 3 exemplifies form (iii) of technical change, which moves the wage curve outwards. In the case depicted, the selection pressure on incumbent firms will gradually become larger and larger and force them either to innovate themselves, to imitate or to go out of business. Incumbent firms that keep using the old method will start making losses as soon as the actual wage rate rises above a level higher than the maximum wage rate compatible with the old method. In the new long-period position of the economic system after it has fully absorbed the newly available technical knowledge, the wage rate will be equal to w'. At this wage rate the old method would yield its user losses that imply a negative rate of profit of r_o.

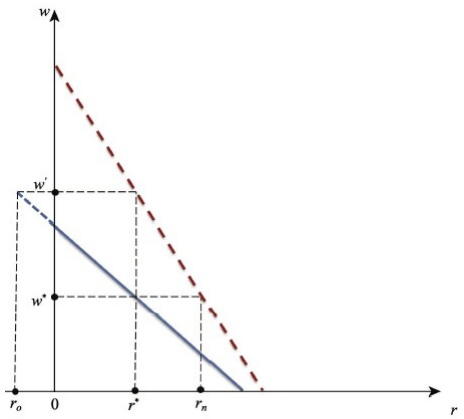

Fig. 3: Static incumbent firms cannot survive

We may conclude by saying that diffusion-driven dynamics are typically non-steady and may actually be highly unsteady. They follow sigmoid patterns, but typically not simple logistic curves. The process of creative destruction may, in the case of capital using and labour saving technical progress, engender in an initial phase, when the larger capital stock has to be built up, a net loss of jobs, i.e. technological unemployment, as Ricardo had argued in his famous chapter "On Machinery" (Ricardo *Works* I: chap. 31).

CAPITAL THEORY AND INPUT-OUTPUT ANALYSIS

The non-conventional (that is, non-marginalist) findings in capital theory put forward by Sraffa (1960) and further elaborated by Garegnani (1970, 1990 etc.) were first received with disbelief. When their theoretical possibility had been firmly established, they were questioned on empirical grounds. The problem with this questioning is that it is far from clear, how it could convincingly be shown that some of the phenomena under scrutiny do, or do not, exist in the real world. After all, what is at issue is the behaviour of the economic system as a whole, and the data situation on the basis of which the question could possibly be decided is perhaps not up to the problem at hand.

Here it suffices to comment briefly on attempts to investigate the situation in terms of data taken from input-output tables. To use input–output data appears to make perfect sense, since input–output tables are designed to capture precisely (some) properties relating to the economy as a whole and its subdivision in several industries. It therefore should not come as a surprise that basically all empirical investigations of the problems

have been carried out using input–output. While this may provide the best framework available, the question is: is it good enough to answer satisfactorily what we are interested in.

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 **A** that is taken to represent the technical coefficients of production subject to the following two *very* 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). (A similar observation applies to the labour input vector **l**, which assumes that labour is homogeneous, which it definitely is not.)

The considerations in the simple one-commodity framework in Section 3 have implicitly pointed already to some of the difficulties one faces when dealing with such data. What does matrix **A** and the corresponding labour input vector **l** 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. Typically, several processes will be employed in the production of each and every product, such as in the above model the coexistence, in various proportions, of "blue" and the "red" method. Coefficients *aij* 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 ($k = 1, 2, \ldots, m$), and if process k has been operated at an activity level q_k, then

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

Coefficients a_{ij} thus refer to *fictitious* processes and the technique made up of such processes is also ficticious.[2] 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 (just as in our simple case dealt with in Section 3). The diagram shows at a glance that not all techniques will allow for non-negative 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. Therefore the processes will typically yield differential rates of profit for any given level of the real wage rate, with some profit rates even being negative. However, according to the usual logic applied in the context under consideration, obsolete processes would swiftly 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 non-conventional phenomena will it display in any particular situation? We don't know. Which conclusions can be drawn from an empirical basis that by construction – that is, bold aggregation of incommensurables – confounds the specificities of all technical alternatives?

Finally, it ought to be recalled that matrices of durable instruments of production are not available for many countries or only for a few years. This is a serious shortcoming because there is overwhelming evidence that the fixed capital intensity of production is rising over time. To the problem of fixed capital we now turn briefly. Here we encounter another problem that is not dealt with at all or dealt with only in a cavalier fashion: the pattern and degree of its utilization.

FIXED CAPITAL, OBSOLESCENCE AND THE PATTERNS OF ITS UTILIZATION

Here it suffices to point out once again, but now with regard to durable capital goods, that these are heterogeneous both between and within industries, reflecting among other things the coexistence of different vintages of capital goods. The values of these capital goods depend on the magnitude of the general rate of profits. They also depend on the features of new methods of production that are introduced into the system of production and that revolutionize the entire system of pricing and income distribution. A main problem alluded to here is that of "moral obsolescence", as Karl Marx called it, that is, the devaluation of old capital goods due to innovations. This problem is entirely ignored in many current contributions. Ignoring it may be considered a sign of the problematic view of capital as a

homogeneous entity, which simply annihilates the specificity of its single items.

Not dealing with fixed capital (plant and equipment) in a compelling manner in input-output based studies is a daunting fact, not least because there is overwhelming evidence that the fixed capital intensity of production is rising over time. Would the inclusion of fixed capital affect the results? In all probability 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 the original). Once the assumption of radioactive decay (also entertained in some input–output studies) is replaced by a sensible treatment of fixed capital items, it turns out that non-conventional (that is non-marginalist) results can "easily" occur. The results obtained within a circulating capital framework is subject to severe limitations.

Whilst with only circulating capital, obsolete processes can be expected to swiftly disappear from the picture, things are quite different in the presence of 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, whereas obsolete items will only be operated if this is profitable, which depends inter alia on the briskness of effective dermand. As Sraffa (1960: p. 78) stressed:

> 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.

With regard to such items, Wicksell spoke of "rent goods". What an input–output table thus represents is not a set of processes of production actually in use and representing the technological frontier at a given moment of time. It rather 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.

It is obvious, as has been stated already in the above, that not all methods of production and fixed capital goods corresponding to them actually contribute to what has been called the "efficiency frontier" of the economy, given by the outer envelope of all wage curves associated with the different techniques that could be built up on the basis of all technical alternatives available in the system. In fact, many techniques reflecting older vintages of capital goods will not contribute even minute bits to the envelope. They are obsolete and can be expected to leave the system forever before long, getting replaced by new vintages that outcompete them. Bertram Schefold (2013) has drawn the attention to the fact that it is highly probable that the technological frontier at any moment of time is made up of only a small number of technical alternatives. This implies that the "all-important principle of substitution", as it is conventionally conceived of and revered by authors like Marshall and Schumpeter, is possessed of a much smaller explanatory power than is typically taken for granted, and if the choice of technique exhibits unconventional properties, it loses this explanatory power altogether.

CONCLUDING REMARKS

These above considerations point out some of the problems in the theory of value and distribution, capital and effective demand. These Sraffa and Garegnani have tackled in their path-breaking works. There is no doubt to me that they belong to the "school" of scholars that do know economics and have substantially deepened and widened our understanding of the problems at hand.

Notes

1. It deserves to be emphasized that in the case of single production $\dot{w} < 0$ irrespective of the standard of value chosen; see Kurz and Salvadori (1995: chap. 4). This does not necessarily hold true in joint production systems.
2. 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.

References

Garegnani, P. (1960), *Il Capitale nelle Teorie della Distribuzione*, Milan: Giuffrè.

Garegnani, P. (1970), "Heterogeneous capital, the production function and the theory of distribution", *Review of Economic Studies*, 37, pp. 407-436.

Garegnani, P. (1990), "Quantity of capital", in J. Eatwell, M. Milgate and P. Newman (eds), *Capital Theory*, London: Macmillan, pp. 1-78.

Kurz, H. D. (2012), "Obituary. Pierangelo Garegnani (1930-2011)," *European Journal*

of the History of Economic Thought 19(2), pp. 303-311.

Kurz, H. D. (2017), "Technical progress and the diffusion of innovations: Classical and Schumpeterian perspectives," *Frontiers of Economics in China*, 12(3), pp. 418-449.

Kurz, H. D. (2020), "The theory of value and distribution and the problem of capital, *European Journal of Economics and Economic Policies: Intervention*, 17(2), pp. 241-264.

Kurz, H. D. and Salvadori N. (1995), *Theory of Production. A Long-Period Analysis*, Cambridge, New York and Melbourne: Cambridge University Press. Revised paperback edition 1997.

Kurz, H. D., Dietzenbacher, E. and Lager, Ch. (eds) (1998), *Input–Output Analysis*, 3 vols. Cheltenham, UK and Lyme, NH: Edward Elgar Publishing.

Pantaleoni, V. (1925), *Erotemi di Economia*, vol. I, Bari: Laterza.

Ricardo D. (1951–1973), *The Works and Correspondence of David Ricardo*, Edited by P. Sraffa with the collaboration of M. H. Dobb, volumes I and IX, Cambridge, UK: Cambridge University Press.

Schefold, B. (2013), "Only a few techniques matter! On the number of curves on the wage frontier, in E. S. Levrero, A. Palumbo and A. Stirati (eds), *Sraffa and the Reconstruction of Economic Theory*, vol.1, *Theories of Value and Distribution*, Basingstoke, UK: Palgrave Macmillan, pp. 46-69.

Sraffa P. (1960), *Production of Commodities by Means of Commodities*, Cambridge, UK: Cambridge University Press.

Steedman, I. (2020), "Fixed capital in the corn-tractor model, *Metroeconomica*, 21(1), pp. 49-56.