1 Resources, producibility and economic dynamics: a framework

Mauro L. Baranzini, Claudia Rotondi and Roberto Scazzieri

1. Introduction

1.1 Resources in political economy

The evolving relationship between the ownership and utilization of non-produced resources, the distribution of national income and wealth, and the formation and investment of capital funds within and across countries is a central feature in the structural dynamics of the world economy. Important features of that relationship have been a central focus of the theory of economic dynamics since Thomas Robert Malthus's (1815a, 1815b), Edward West's (1815) and David Ricardo's (1817) analysis of *decreasing returns* due to the emergence of scarcities and complementarities between productive inputs (which implies that the utilization of any given technique requires the maintenance of given proportions between those inputs). In Malthus's, West's and Ricardo's pioneering work, decreasing returns at the level of production units (such as the single productive establishment or the aggregate of production processes using a given non-produced resource) are associated with system-wise effects due to the interplay of (i) constraints due to the limited availability of non-produced and appropriable resources; (ii) the saving and accumulation behaviour of individuals and socio-economic groups; and (iii) income distribution between types of income (such as wages, profits and rents) as well as between socio-economic groups (such as workers, capitalists and rentiers).

Subsequent contributions took up and developed the classical economists' insights into those issues by exploring (i) the manifold dimensions of non-producibility and scarcity in a dynamic setting (Jevons, 1865; Quadrio Curzio, 1975; Leontief, Carter and Petri, 1977; Duchin and Lange, 1994); (ii) the opportunities generated by the discovery and utilization of new resource bases (Rosenberg, 1982; Wrigley, 1962, 1988, 2010); (iii) the determination of prices, income distribution and rents in the case of production systems constrained by non-produced resources (Sraffa, 1960; Quadrio Curzio, 1967); and (iv) the accumulation behaviour of socio-economic groups in economic systems subject to manifold types of resource constraints

and corresponding structural dynamics (Pasinetti, 1960; Baranzini, 1991; Baranzini and Scazzieri, 1990, 1997; Landesmann and Scazzieri, 2009).

The above interplay of constraints, opportunities and saving-accumulation behaviour may sometime trigger a tendency towards *decreasing returns*, and sometime reverse this tendency and lead to *increasing returns*.

Production linkages between sectors dependent on different resource bases are essential in determining to what extent technical progress will be effective; that is, in determining the actual influence of technical innovation at the level of individual establishments or industries on the growth and employment performance of the whole economic system. In particular, technical innovation at the level of single establishments, establishment networks or industries could be associated with technological retardation at the level of the economic system as a whole (due to mismatches between different production activities, or between sets of production activities). On the other hand, changes in the relative weight of given processes could be associated with technological improvement even in the absence of technical innovation (due to changes of proportions between production processes allowing a better coordination of production activities). This may lead to decreasing or increasing returns depending on the efficiency order or on the 'rentability order' of processes that use non-produced resources. The latter case (increasing returns) may arise from the utilization of 'residual' means of production that had previously gone out of use due to a change in production technology and/or in the rentability order of processes using a scarce resource (Quadrio Curzio, 1967, 1975, 1980, 1986, 1987, 1990; Quadrio Curzio and Pellizzari, 1999; Scazzieri, 2014; see also Section 5 in this chapter).

The structural theory of non-produced resources calls attention to the existence of long-term constraints that are at work underneath the surface of markets and ultimately shape the global and long-term patterns of growth, distribution and accumulation. This theory thus alerts us about critical features of economic dynamics that would otherwise go unnoticed. This research tradition is rich both in terms of analytical modelling and in terms of empirical and historical investigations. Building on classical contributions (Malthus, Ricardo and Jevons), this line of investigation has addressed the role of resource constraints in an interindustry framework and has more recently emphasized the importance of resource pooling and resource bottlenecks in stimulating technical change, and also in inducing processes of *selective* saving formation across the world economy, as shown by the recent emergence of sovereign funds.

A central feature of the structural tradition in the study of resource-induced economic dynamics is the attention to the influence of changing resource constraints on the compositional dynamics of the economic system, quite independently of the behavioural propensities of individual agents or groups.

In short, the structural approach emphasizes the *direct* influence of resource constraints on the structure and long-term dynamics of the economic system, mainly through the elimination of technological alternatives from the set of feasible production possibilities (*technology contraction*), and the generation of new opportunities through technological interrelatedness associated with the switch to a new resource base (*technology expansion*) as pointed out by Scazzieri (1982, 1993). In either case, resource availability and resource dynamics work *directly* on the structural and material side of the production system, rather than indirectly through their influence on agents' choices and prices (see also Baranzini and Scazzieri, 1986; Scazzieri, 1993; Landesmann and Scazzieri, 2009; as well as Silva and Teixeira, 2008).

This argument calls attention to the existence of critical, if seldom acknowledged, thresholds along the dynamic path of any given economic system, due to both the utilization of non-produced resources and changes in which resources are used across different time periods. The existence of those thresholds may thwart the economic system from one dynamic path to another. This possibility highlights the important role of economic (structural) policy in stimulating or slowing down the pace of resource-induced structural transformation (that is, structural transformation induced by constraints on resource availability and by the switch from one resource base to another).

1.2 Aim of the volume

The aim of this volume is to present a comprehensive assessment of the structural economic analysis of non-produced and appropriable resources from the point of view of long-term dynamics and within a political economy framework.

The multi-sectoral approach to production and structural dynamics provides the analytical framework for most contributions in the volume. However, a feature that distinguishes this volume from the greatest part of the multi-sectoral modelling literature (as discussed, for instance, in Leontief, 1941, 1951; Pasinetti, 1965, 1977, 1981) is the central role assigned to a multi-sectoral, resource-constrained economy, in which inter-sectoral relationships are characterized by complementarity or limited substitutability. In this economy, material bottlenecks and technological linkages are central factors explaining the course of economic dynamics and the structural transformations associated with it. The utilization of non-produced resources under technological or organizational complementarity (or limited substitutability) brings about the possibility of decreasing returns as the economic system hits scarcities of different types. In particular, the resource-based theory of structural dynamics highlights the conditions under which decreasing returns of the intensive or extensive type may occur. In either case, the production structure

of the economic system consists of a set of interdependent processes in which processes using non-produced resources make use of different 'types' of the same resource, or of different techniques with the same resource type.

The overall production structure may be represented either by a single *global technology* or by many *combined technologies*. The former approach unifies the techniques using non-produced resources and gives a synthetic view of production interdependencies within the single period, while the latter approach keeps those techniques distinct even if it keeps track of their interconnection across different periods. With a global technology the one-to-one correspondence between commodities and processes is dropped and special technical coefficients ('splitting coefficients') are introduced to allow for the delivery of the same commodity by different processes (Quadrio Curzio, 1987, 1990; Quadrio Curzio and Pelizzari, 1999). Under binding resource constraints, a global technology allows identification of the conditions under which technical complementarities bring about decreasing returns as the scale of the overall process is increased. On the other hand, the consideration of combined technologies emphasizes the dynamic complementarities leading to increasing returns when technical change allows a better utilization of residuals (see above) (Quadrio Curzio, 1975, 1986, 1990; Quadrio Curzio and Pellizzari, 1999; see also Quadrio Curzio, 1987). Whenever this is the case, it is possible to explain structural change as a response of the economic system to the existence of triggers (such as population dynamics or institutional transformation) working their way through technological or organizational complementarities and bottlenecks.

Decreasing returns lead to the successive activation of inferior techniques, and thus to the utilization of a global technology at any given time (say, multiple qualities of mineral ore, multiple types of agricultural land, etc.). Similarly, increasing returns are associated with the activation of combined technologies allowing a better utilization of the complementarities between those very techniques. In either case, paths of uneven dynamics of a purely structural character are generated. Four features of those paths are especially important[1]:

1. *complementarities and bottlenecks* work underneath the surface of markets and become primarily visible *in the long run*;
2. *technological interrelatedness* is central in generating patterns of uneven evolution and structural change;
3. *alternative time horizons* may be associated with different criteria for the ranking of the technical opportunities available at any given time

[1] See Quadrio Curzio (1975, 1986, 1990, 1996), Quadrio Curzio and Pellizzari (1999), Scazzieri (1982, 1993, 2014), Marengo and Scazzieri (2014).

(so that alternative paths of structural change may be highlighted depending on which time horizon is adopted);

4. *technological distribution* (with the formation of structural rents) becomes visible independently of the functional, social and personal distributions of income. This type of distribution may affect the choice of techniques and be in turn affected by the course of structural dynamics.

2. Resources, producibility and scarcity

Since the late 1950s, discussions among academic economists have focused on topics that, in spite of their apparent technical nature, are controversial above all because of their being rooted in different ways of looking at the 'scope and method of economics science'.[2] This is particularly true for the three phases of the 'Cambridge controversies' (Cambridge being both Cambridge, England, and Cambridge, Mass., United States) that flared up in the second half of the twentieth century: the first concerning the measure of the productivity increases (Luigi L. Pasinetti and Nicholas Kaldor *versus* Robert Solow and colleagues); the second on the distribution of income and rate of profits determination (Nicholas Kaldor, Luigi L. Pasinetti, Joan Robinson, Pierangelo Garegnani, John Eatwell, Richard F. Kahn and Geoffrey Harcourt *versus* Paul A. Samuelson, Franco Modigliani, James E. Meade and Christopher J. Bliss); the third on capital theory, i.e. capital reversing and reswitching (Pierangelo Garegnani, Luigi L. Pasinetti, Piero Sraffa, Joan Robinson *versus* Paul A. - Samuelson and David Levhari). To this we may add the controversy of the life-cycle *versus* intergenerational capital stock (Franco Modigliani and his pupils *versus* Laurence Kotlikoff, Larry Summers, Mauro Baranzini and others). Partly because of the debates caused by these and still other controversies, but also as the result of the publication of *Production of Commodities by Means of Commodities* by Piero Sraffa (1960), as well as Arrow and Debreu's 'Existence of an Equilibrium for a Competitive Economy', *Econometrica* (1954), Christopher C. Bliss's *Capital Theory and the Distribution of Income* (1975), and a few other milestones of economic theory, there has been a revival of interest in the object and method of economics, such as our science had not seen since the publication of *The Nature and Significance of Economic*

[2] This argument refers to a dichotomy initially put forward by Sir John Hicks and Luigi L. Pasinetti; see the later argument in this section. See also the reviews by Baranzini (1979) and Lutfalla (1983). In his contribution to the *Essays in Honour of Luigi Pasinetti*, Quadrio Curzio (1993, p. 247) discusses the 'object and method of economics' and maintains that the most specific elements of economic reality, in particular, production and exchange, represent 'the archetypes of any economic reality'.

Science by Lord Robbins (1932) and *The Political Element in the Development of Economic Theory* by Gunnar Myrdal (1953).[3]

A new way of looking at the evolution of economic ideas slowly emerged in the 1970s, mainly based on statements of Sir John Hicks and Luigi Pasinetti. Alberto Quadrio Curzio and Roberto Scazzieri[4] were the first to study the implications of such a proposal and its application to the documentation of a particular period in the history of economic analysis and economic history, especially in their Introduction to the four volumes on the leading economists since David Ricardo (Quadrio Curzio and Scazzieri, 1977–1982). Hicks and Pasinetti had in fact suggested that is no longer possible to see the development of economic theory as a linear evolutionary process from the Mercantilists to contemporary economics. A number of alternative 'paradigms' characterize the past and present situation of our science, and both John Hicks (1976) and Luigi Pasinetti (1964/5) seem to agree on a fundamental distinction between the theories centred on the analysis of the production phenomena and the theories centred on the analysis of exchange. Hicks, in order to emphasize the distinction, labels 'political economy' as the first group of theories, and 'catallactics' the second. This is how Quadrio Curzio and Scazzieri (1986, p. 378) discuss the exchange paradigm:

> The fundamental idea of exchange was the first to be developed systematically. It was present in the studies of money and value between the sixteenth and the seventeenth centuries, and it dominated the minds of the Mercantilists, who applied it to the study of trade relations between states. The principle of the maximization of national wealth constitutes an early expression of such an idea. With the early Marginalists, the fundamental idea of exchange was applied to individual behaviour for the maximization of utility; in later marginalism, it was applied to the behaviour of producers and consumers for the maximization of profit and utility. Finally, this fundamental idea was used for the determination of the 'welfare' of society as a whole. Step by step, the fundamental idea of exchange gains precision and articulation, with the concepts of 'scarcity' of resources with respect to ends, of 'efficiency' in the use of given resources, of 'one-wayness' of production from 'primitive' factors of production to products. This fundamental idea is finally crystallized in the principle that every economic problem can be reduced to the mathematical problem of maximizing an objective function subject to scarcity constraints.

On the production paradigm they write:

> The history of the fundamental idea of production is no less complex. Already with English political arithmetic (William Petty and others), with Quesnay and other Physiocrats, the central problem of political economy had been identified in the process

[3] Myrdal's book was first published in Swedish in 1930 and translated into German two years later.

[4] In particular we may mention the five volumes of *Protagonisti del pensiero economico* (Quadrio Curzio and Scazzieri, 1977–1982, 1983), 'The Exchange Production Duality and the Dynamics of Economic Knowledge' (Quadrio Curzio and Scazzieri, 1986) and 'On Economic Science, Its Tools and Economic Reality' (Quadrio Curzio, 1993).

of the production (and reproduction) of an economic system. And soon appeared the concepts of the 'circular flow' of production (that is to say, of the production of commodities by means of commodities), of 'interdependence' between sectors of the economy, of 'net product' or 'surplus' (the excess of social product over aggregate means of production). These concepts were elaborated in various ways and not only in the same direction by later authors. Classical English and Scottish economists like Smith, Malthus and Ricardo examined the relations between net product and accumulation, the problem of the distribution of the social product between different classes in society and between wages, profits and rents, and the question of effective demand. . . . After a period of relative inactivity (during which, however, important contributions to the theory of value and the theory of structural dynamics can be found), the fundamental idea of production became once again of primary significance, with Kalecki, Keynes, von Neumann, Leontief, Sraffa and others. In contrast with the fundamental idea of exchange, one can say that the core of the fundamental idea of production is that the 'wealth' of an economic system depends on its capacity to create a net product or surplus, on the distribution of the latter between the recipients of wages, profits and rents, and on the distribution of the surplus between consumption and investment (the growth of wealth through time is made to depend on this latter variable). (Quadrio Curzio and Scazzieri, 1986, pp. 378–9)

Quadrio Curzio and Scazzieri (1977–1982, 1983, 1986) were the first to systematically examine the implications of the production/exchange duality in the analysis of specific historical configurations of the economic system. Baranzini and Scazzieri (1986) further pursued the investigation of the duality by examining the parallel developments and mutual influences between the two corresponding lines of research.

3. Structural economic dynamics and the distribution of income: the macro-social approach and the structural approach

Structural economic dynamics investigates the way in which economic expansion is associated with changes in the sectoral composition of the economic system (Perroux, 1939; Furtado, 1967; Leontief, Chenery *et al.*, 1953; Pasinetti and Scazzieri, 1987b). Different types of income distribution have been examined in connection with research on structural dynamics. In particular, two main approaches can be distinguished: one is the macro-social theory of the classical or post-Keynesian type, the other is the structural and technological theory of the multi-sectoral type. These two approaches have a common conceptual background associated with the theory of income distribution originally formulated by David Ricardo (1817). Such a background may be summarized as follows:

1. Production (Y), initially measured in terms of corn, is distributed among wages (W), profits (P), and rents (R). Wages, profits and rents are

determined by the interaction of demographic, technical and economic factors. Total wages are equal to the unit wage (w) times the number of workers employed (L).

2. Ricardo relates the level of wages to the physiological necessity of workers to live and reproduce themselves, i.e. the so-called *natural wage rate*. More precisely, David Ricardo 'is convinced that in any particular type of society there exists a *real* wage-rate (so to speak, a certain *basket of goods*) which can be considered as the "natural price of labour". It needs not necessarily be at a strict *subsistence level* (the minimum physiological necessities of life); but at that level which in a given country and in a given state of society, besides allowing workers to live, induces them to perpetuate themselves "without either increase or diminution"' (Pasinetti, 1960a, p. 80).
3. The market wage unit depends on supply and demand of labour. According to Pasinetti, always '[w]hen capitalists accumulate capital, demand for labour increases and the market wage-rate rises above its natural level. However, Ricardo believes that such a situation cannot be other than a temporary one because, as the conditions of workers become "flourishing and happy", they "rear a healthy and numerous family" and the growth of population again brings back the real wage-rate to its *natural* level' (Pasinetti, 1960a, p. 80). The operating of this mechanism takes at least one generation, even if Ricardo's analysis is carried out as though this mechanism would operate almost immediately. Conversely, if the wage unit falls below the *natural wage rate*, the workers' families will have fewer children until the natural level is reached again.
4. What remains after having paid wages is a residual that will be distributed between rents and profits. Rents are determined by the difference between total production and the quantity of production obtained by multiplying all labour force by the product of the marginal land put into cultivation (this is the land that comes 'last' in the given order of fertility). The share of product exceeding the productivity of the least fertile land goes to the benefit of the landlords in terms of rent. What remains of total production, after payment of wages and rents, is retained, in the form of profits, by the capitalists, who are the real organizers of the production process.

Current research has developed this conceptual framework along two principal lines of investigation. On the one hand, income distribution has been investigated under the hypothesis that income shares (such as the wage share or the profit share in national income) are associated with the relative bargaining power of social classes or groups (social theories of income distribution of the classical, Ricardian or Marxian types), *or* with the condition for investment under the steady growth assumption (social theories of

income distribution of the post-Keynesian type). On the other hand, income distribution has been associated with the structural analysis of the technological conditions that may determine the formation of specific types of income (such as structural rents due to utilization of non-produced resources) independently of which individuals or social groups might be their final beneficiaries (see, in particular, Quadrio Curzio, 1967, 1975, 1980, 1990; Quadrio Curzio and Pellizzari, 1999).

The macro-social income distribution and wealth distribution and accumulation have been in the foreground of the classical, post-Keynesian and structural lines of research. The so-called Cambridge controversy on profit determination and growth rate determination has been a classical instance of the mutual influences between these analytical traditions (Harcourt, 2012). The following main points may be recalled. A number of these research students, research fellows and young lecturers were in England and particularly in Cambridge and Oxford in the early 1960s, when the 'Cambridge controversy' on profit determination and income distribution was taking off, following the publication of Nicholas Kaldor's (1956) seminal paper 'Alternative Theories of Distribution' and the long gestation and publication of Luigi L. Pasinetti's (1962a) generalization of the *Cambridge Theorem* ('The Rate of Profit and Income Distribution in Relation to the Rate of Economic Growth'). It is also important to mention in this connection the contribution of John Hicks in *Capital of Growth* (Hicks, 1965). In fact, in those years, three Cambridge scholars, Luigi L. Pasinetti, Nicholas Kaldor and Joan Robinson, were preparing their papers on the *Cambridge Theorem* that would be published in the 1966 special issue of the *Review of Economic Studies*, along with the long and provocative double paper of Paul A. Samuelson and Franco Modigliani with the title 'The Pasinetti Paradox in Neo-Classical and More General Models'. These issues were discussed in seminars as well as in lectures held in Cambridge and Oxford during those years (Mari, 2010). Luigi Pasinetti contributed to this line of research also with his Cambridge Ph. D. thesis on a new disaggregated model of economic dynamics in which technical progress and changes in the composition of consumers' expenditure bring about the need of changes in the relative proportions of sectors (Pasinetti, 1962b, 1965).

The structural and multi-sectoral theory of income distribution is to a large extent derived from the analytical framework presented in Piero Sraffa's *Production of Commodities by Means of Commodities* (Sraffa, 1960). This work outlined a theory of production, prices and income distribution in a stationary or single-period system. On this basis, Quadrio Curzio addressed the role of non-produced resources within the analytical framework of multi-sectoral analysis (see earlier). Sraffa had mainly investigated income distribution between wages and profits within a multi-sectoral framework

in which rent formation was also considered. However, neither rent formation nor natural resources belonged to the core of his theory (Sraffa, 1960, Ch. XI). Quadrio Curzio emphasized non-produced resources and examined their influence upon income distribution, accumulation, growth and structural change.

The structural analysis of non-produced resources identifies the possibility of intertwined trajectories of decreasing and increasing returns due to sectoral interdependencies and presents an overall picture of the dynamics of rents (of the structural type) that must be distinguished from the analysis of rents in the macroeconomic (Keynesian) theories of income and wealth. For in the former case there is a concentration of attention upon the technological determinants of rents (as 'differential rents'), whereas in the latter case attention shifts to 'absolute rents' and to the entitlements of certain individuals or social groups (see Section 2 of the final chapter of this volume).

4. The rationale and structure of the volume

The relationship between non-produced resources and production interdependencies is central to economic systems whose long-run dynamics is determined by the interplay of resource bottlenecks and technical opportunities arising within the production structure. As we have seen, those dynamics are characterized by the emergence of scarcities at various points of the production system, and by the adoption of individual techniques and/or production technologies that allow the overcoming of scarcities by an increase in the degree of producibility of means of production. The long-term relationship between scarcity and producibility, and the different paths followed by attempts to overcome scarcities, reflect the structural interdependence between sectors and between techniques, and the socio-institutional constraints determining the relative positions of individuals and groups within the social structure. The interplay between structural constraints and socio-institutional conditions also determines the effectiveness of any given society in pursuing long-term policies consistent with the transformation of scarcities into producibilities.

This conceptual scheme has suggested the organization of this volume into five parts: Part I focuses upon 'Resources and Distribution in a Structural Perspective'; Part II assesses 'Structural Dynamics: Resources and Multi-Sectoral Linkages'; Part III considers 'Resources, Institutions and Social Structures'; Part IV focuses on the themes of 'Resources, Industrial Change and the Structure of the World Economy'; Part V discusses ways to examine the 'Political Economy of Resources and Structural Change' and brings the volume to a close with a chapter by the editors on 'Resources, Scarcities and Rents: Technological Interdependence and the Dynamics of Socio-Economic Structures'.