THEORIES OF PROFIT FROM RICARDO TO DEBREU: AN ANALYSIS IN TERMS OF PIERO SRAFFA'S 'PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES'

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A C K N O W L E D G E M E N T S

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C O N T E N T S

CHAPTER I

INTRODUCTION

(i) The Topic of the Thesis

The topic of this thesis is theories of profit in economic analysis. More particularly, the aim is to analyse theories of the rate of profit.[1/] The procedure is historical, beginning with Ricardian theory and finishing with modern Walrasian theory as formulated by Debreu.[2/] The standard of evaluation throughout is in terms of the framework and results developed by Piero Sraffa in his 'Production of Commodities by means of Commodities'.[3/] This has been hailed as a path-breaking work in economic theory and most certainly provides a new perspective in terms of which critical evaluation can be structured.

The standard of evaluation determines in part those theories which are subjected to analysis. Sraffa's work is concerned with particular types of economic states which economists have traditionally referred to as 'equilibria'. Furthermore, the equilibria considered by Sraffa are of a particular kind: namely competitive equilibria where considerations of uncertainty do not play a major role. This implies that certain theories of profit cannot be considered in terms of Sraffa's work. The most notable exceptions are the profit

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1/ The term 'profit' is used in a deliberately loose sense in this section. The concept is more precisely defined in section (ii) below.

2/ Debreu (1959).

3/ Sraffa (1960).

theories of Schumpeter[1/] and Knight.[2/] Schumpeter considered the (temporary) market power associated with disequilibria engendered by innovating entrepreneurs to be the central explanatory force relevant to profits, while Knight emphasised that the origin of profit lay in non-insurable uncertainties. These are important and influential works in economics, but must be omitted from the subject matter of this thesis because the standard of evaluation does not encompass those matters which they stress.

The theories of profit which are, therefore, examined are those where disequilibrium, non-competitive forces and uncertainty do not form an integral part of the analysis. As such there are five theories of importance: those of Ricardian and Marxian economics, neoclassical productivity theory and Austrian capital theory, and Walrasian general equilibrium theory.[3/] In the following chapters the principal aspects of each of these theories are outlined and then subjected to evaluation in terms of Sraffa's analysis.[4/]

The importance of these principles of selection ought to be emphasised. Disequilibria, market power and uncertainty

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1/ Schumpeter (1912).

2/ Knight (1921).

3/ Each of these theories deals with profit in the context of competitive equilibria and, with the exception of Walras, all neglect uncertainty. Considerations of uncertainty do enter Walras' theory but, insofar as the formal aspects of this theory are concerned, they do so in an inessential way. Walras' theory relates to a temporary equilibrium of supply and demand in which economic agents act in terms of confidently held static expectations. See chapter XI, sections (iii) and (iv).

4/ There are other theories of profit which fall within the purview of Sraffa's analysis: for example, Mercantilist, Physiocratic and Smithian theories. However, these theories are no longer important in the sense that their influence on modern theory is either negligible or occurs through the theories considered in this thesis.

would seem intuitively to be crucial to developing an empirically relevant theory of profit. It is, however, true to say that the analysis of these phenomena has been neglected by economic theorists. The reason for this is easy to understand. They are all extremely difficult to model precisely and most economic theorists have considered the problems of profit quite complicated enough even when they are ignored.

Furthermore, utilising Sraffa's work as the standard of evaluation means that monetary factors cannot be considered. Sraffa deals with economic systems in which there is no specialised means of payment. However, this characteristic does not restrict the theories of profit with which this thesis is concerned. Theories of profit in economic analysis have overwhelmingly been 'real' rather than 'monetary' theories. Many of the theorists whose work is considered did develop an analysis of money but in no case does this significantly impinge upon the analysis of profits. These theorists considered that the main forces operating to determine profits in competitive equilibrium were largely independent of monetary magnitudes.[1/]

Sraffa's 'Production of Commodities by means of Commodities' is a very dense work. Propositions are developed from highly abstract models. These propositions show the form which economic relationships have to take in certain types of competitive equilibrium. The implications of these relationships are not made explicit by Sraffa and for the greater part there are not even hints as to their importance. Many theorists

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1/ Schumpeter (1954), pp. 277, 282, 588-589, 925 and 1118-1119.

who have studied Sraffa's work have attempted to spell these out. However, the task is far from completed. The major focus of attention has been the neoclassical theory of capital productivity and to a lesser extent that of Marxian economics and Walrasian general equilibrium theory.[1/] By comparison, Ricardian and Austrian economics have received virtually no consideration at all. Moreover, in carrying out a Sraffa-based critique of neoclassical productivity theory, Marxian economics and Walrasian analysis, important misconceptions have arisen while, in some areas in which the critique is valid, it has not been pushed far enough. This thesis seeks to make a contribution to rectifying these defects and in doing so to provide an overall assessment of Sraffa's work.

In the following sections of this chapter two key concepts, 'theory' and 'profit', are discussed, and definitions of them are formulated in the way in which they are used in the following chapters.

1/ The Sraffa-based critique of neoclassical productivity theory arose in the course of the famous 'Cambridge controversies' in the theory of capital. See Harcourt (1972). The critique of Marxian economics has been most developed by Steedman (1977) and the critique of Walrasian theory by Garegnani (1970a) and (1976).

(ii) Profit

The term 'profit' is used throughout this thesis as synonymous with the term 'interest'. Both relate to the income derived from a production activity which results from the difference between the revenues received from outputs and the cost of inputs needed to produce those outputs. The profitability of any production activity is computed on the basis of a set of prices by which inputs and outputs are valued. The relevant prices, in all the theories considered in this thesis, are those associated with competitive markets in equilibrium and in an environment where uncertainty is of no analytic significance.

Some economists, by contrast, have distinguished between interest and 'pure profit'. For example, it has been customary to use the term 'interest' to refer to the difference that would arise between competitively determined revenues and costs in an equilibrium of an economic system involving absolute certainty. Pure profit designates any surplus over and above interest and is associated with the absence of competition, disequilibrium and uncertainty. Since non-conpetitive economic structures, disequilibria and uncertainty play no essential role in the theories that are dealt with in the following chapters such pure profits would always be zero. The only difference between revenues and costs in any production activity would be interest, or, as we shall use the term, profits. The distinction between this and pure profits is, however, a useful one. While the two terms, interest and profit, are used to refer to the same concept, as defined above, the phrase 'maximisation of profits' will refer to the maximisation of the difference between revenues and costs per se,

irrespective of whether the context is one of equilibrium, competition and certainty.

There are other distributional concepts, used throughout the following chapters, which also need to be defined. The term 'rent' will be used to refer to the income which accrues to the owners of resources, or is imputed to them, over and above what is necessary to maintain the resources in their present use. In some cases this concept is important: for example, in Ricardian theory. In other theories, like neo-classical productivity theory, it is not. By the term 'return' is meant an income accruing over some period of time, which is received by the owners of an asset. This income may include 'pure-profit' as well as profit. If pure profit were zero it would refer to profit alone. The term 'net rental' is used synonymously with that of return. Corresponding to these two concepts are the terms 'rate of return' and 'net rental rate'. These express the ratio of income (over some time period) to the value of an asset (at some date). If pure profit was non-zero, both of these terms would refer to the ratio of 'profit plus pure profit' to the value of an asset. In the case where pure profit was zero, they would refer to the 'rate of profit' or, to give the same concept another name, the 'rate of interest'.

(iii) Theory

Theories attempt to link effects to causes or, to state the same thing in an alternative way, to determine the magnitudes which are the subject of the theory. It is as well to be clear about the meaning of the terms causation and determination from the start. They are used in this thesis to mean

the same thing: both refer to a relationship between exogenous and endogenous elements.

An economic theory can be decomposed into a number of components. There are assumptions specifying what is to be taken as given. These assumptions fix the values of certain magnitudes and specify the relationships which are taken to hold between certain variables. Such components are called exogenous. On the other hand, there are the endogenous components of the theory. These consist of those variables whose values the theory seeks to determine. The third component is a process of deduction. By this process of deduction, theorists seek to find what implications the assumptions about the exogenous elements have for the endogenous variables.

The terms 'causation' and 'determination' are used in regard to this relationship. More specifically, it is affirmed that the exogenous elements cause or determine the values attained by the endogenous variables. However, there are a number of points that should be noted in this regard. Firstly, if the theory is an equilibrium theory, causation will relate to the determination of the equilibrium values of the endogenous variables. The theory may not imply anything about the values of the endogenous variables outside of equilibrium and, therefore, of the processes which lead to the establishment of equilibrium values. Secondly, determination or causation may be incomplete. This would be the case if a theory was an equilibrium theory and equilibrium was non-unique. Thirdly, the theory may be empty. This would be the case if the theory was solely concerned to determine the values of the endogenous variables in equilibrium but the exogenous components

were not compatible with the existence of any equilibrium. In this case the theory has no causal connotations at all.

The classification of elements into exogenous and endogenous components relates to their role in a theory. A particular economic magnitude may be an exogenous component in one theory and an endogenous one in another. Indeed, one of the principal features of the differences between the theories discussed in the following chapters is what they take as exogenous and endogenous. Furthermore, it is difficult to lay down any criterion as to what should and what should not be regarded as exogenous or endogenous, other than claiming that the appropriate methodology is the one which is likely to prove most useful for the purposes of the theory.

This is often not accepted. Instead it is argued that the 'proper' procedure is to consider as exogenous only those matters which are 'non-economic'.[1/] This, however, raises a whole host of problems regarding what is to be classed as economic. Certainly, in the case of the theories considered in subsequent chapters, those matters which are treated as exogenous could not be considered as outside the legitimate enquiry of economists.

Given the above specification as to what constitutes a theory, a theory may be defective in two possible ways. It could be criticized on the grounds of logic or it could be empirically inadequate. The evaluation of theories of profit in terms of Sraffa's work is confined to the former criterion, that of assessing logical validity. In chapters III to XII

1/ See, for example, Bliss (1975), pp. 29-37.

the five theories of profit with which the thesis is concerned are evaluated on this basis. The mode of procedure is the same in each case. Firstly, there is a chapter specifying the content of the theory. This is then followed by another chapter which uses the Sraffa analysis to assess the theory's logical structure. Chapter II provides an outline of the main elements in Sraffa's analysis.

CHAPTER II

PIERO SRAFFA'S "PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES"

(i) Introduction

Sraffa's book is distinctly peculiar. It is sub-titled a "prelude to a critique of economic theory" although no economist later than Marshall is cited and few hints as to what this critique consists of are given. Furthermore, there is no explicit suggestion that the framework in which the analysis is presented might have a positive role in any reformulation. The assumptions on which the conclusions rest are not systematically presented but are scattered throughout the text and appendices. Moreover, these assumptions do not contain a statement of the institutional structures to which the analysis relates. There is, for example, no assumption pertaining to economic agents. In particular there is no specification that producers maximise profit, that consumers choose rationally and there is no reference to demand or supply relations. Conclusions are drawn from a reasoning which is not only terse, but in itself inadequate, when judged by the standards of proof generally demanded by economic theorists. The mathematical exposition is often expressed in terms now no longer used although the preface acknowledges the author's indebtedness to a number of distinguished mathematicians and Sraffa has expressed the view that economic theory can be, and should be, constructed with absolute precision.[1/]

It is, however, the case that Sraffa's work can be represented as a self contained piece of analysis, for which rigorous

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1/ Sraffa (1961), pp.305-306 and Bose (1975), p. 11.

proofs can be shown to exist,[1/] and one that may be shown to undermine conclusively the basis of much economic theory. The neoclassical tradition of distribution theory founded by J.B. Clark,[2/] developed by Hicks,[3/] Solow,[4/] and Samuelson,[5/] and which has been embraced by countless other less notable economists, is threatened. So is Marx's theory of exploitation,[6/] a fundamental aspect of all forms of Marxian social theory. It is also true of Austrian capital theory, originated by Menger[7/] and Bohm-Bawerk,[8/] and which has, in diverse ways, been extremely influential. Furthermore, Sraffa's work may be used to reinforce a theoretical approach attributed to Ricardo,[9/] although Ricardian economics too suffers severely when the implications of Sraffa's results are spelled out. In all cases the critique is not one of tangential relevance but strikes at the foundations of the conceptual coherence and logical structure of these theories. In Joan Robinson's perceptive phrase Sraffa's

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1/ Sraffa's results have been examined by a number of mathematical economists. See, in particular, Blackley and Gossling (1967), Bruno, Burmeister and Sheshinski (1966), Burmeister (1968) Garegnani (1966) (1970a), Miyao (1977), Morishima (1966), Newman (1962), Pasinetti (1966) (1977a), Schaik (1976), Schefold (1971) (1976a) (1976b) and Tucci (1976)

2/ Clark (1899).

3/ Hicks (1932).

4/ Solow (1956).

5/ Samuelson (1962).

6/ Marx (1867) (1894).

7/ Menger (1871).

8/ Bohm-Bawerk (1888).

9/ Sraffa (1951) and Works (IV) pp. 9-41.

analysis is a "doubly-distilled elixir" that can be savoured "drop by drop, for many a day".[1/] Nor may the damage stop at this point. It has been maintained by several theorists[2/] that Sraffa's analysis reveals critical defects in the general equilibrium approach emanating from Walras[3/] and formalised by Debreu.[4/]

It is clear, therefore, that the "Production of Commodities by Means of Commodities" represents a fundamental work on economic theory. This chapter represents an exposition of its central analytical structure. Subsequent chapters apply its results to an evaluation of Ricardian, Marxian and Austrian theories, as well as of the neoclassical theory of capital productivity and Walrasian general equilibrium theory.

(ii) The Problems Considered

Sraffa's concern is to examine the relationships which exist between technology, relative prices, the rate of profit and the wage within particular types of economic systems which are defined by the assumptions in section (iii). In every such system, the wage and relative prices are determined by technology, once the rate of profit is set at a specific viable level. Changing the magnitude of this variable is associated with changes in relative prices and the wage, so the general forms which these relationships take can be examined. A related problem which is also examined is the comparison of different economic systems with particular reference to how the system which maximises the wage alters as the rate of profit is set at different levels.

(iii) The Assumptions

The types of economic system considered are specified by Sraffa's assumptions. These relate to the form of technology, relative prices, the wage and the rate of profit.

1/ Robinson (1961), p. 197.
2/ Notably Garegnani (1976), Eatwell (1976) and Roncaglia (1978).
3/ Walras (1874).
4/ Debreu (1959).

1. Productive Processes

Each of the economic systems considered is represented technologically by a set of productive processes which transform input vectors into output vectors. Any particular production process within a system is distinguished from the others by the proportions in which it utilises and produces the various commodities.

2. Periods of Production

Each process of production in every system has the same period of production between the application of inputs and the realisation of outputs. In Sraffa's words, there is an "annual cycle of production".[1/] This is by no means as restrictive as it appears. For example, a production process that involves t years can be decomposed into t sub-processes by introducing t-1 intermediate input vectors and t-1 intermediate output vectors. Each sub process can then be taken to be a separate process with the same period of production. Every such multi-period production process can be treated analogously and moreover the periods chosen so that each overall process is an integer multiple of some "unit period" (Sraffa's year). All such multi-period production processes can, therefore, be decomposed into a set of unit period sub-processes and these taken to be the production processes of the system under consideration.[2/]

1/ Sraffa (1960), p. 10.

2/ There are certain limitations on this procedure however. It cannot deal with the case where inputs and outputs are continuous in time. Furthermore, to keep processes finite in number the overall processes from which they are derived have to terminate in some period.

3. Self-Replacement

Each system is capable of being brought into a "self-replacing state" with regard to produced commodities. Produced commodities are commodities which can be technologically produced as new goods without loss at the prevailing prices, wage and rate of profit.[1/] The system would be in a state of self-replacement if the aggregate of any produced commodity used as input was no greater than its aggregate output. Sraffa's assumption is not that the systems considered are actually in a state of self-replacement but only that every system considered is capable of being brought to such a state by changing the proportions in which the individual processes enter it.[2/] This condition represents an assumption of economic viability and is obviously a perfectly sensible one to make.

4. Uniformity of Wages, Prices and Profits

In every system each unit of labour receives the same wage reflecting the supposition that labour is "uniform in quality or, what amounts to the same thing, we assume any differences in quality to have been previously reduced to equivalent differences in quantity".[3/] In addition the price structure of every system is such that the price of a commodity is the same irrespective of whether it is an input or output and the price of each produced commodity is equal to its cost of production.[4/]

1/ There are two other types of commodity considered by Sraffa. These are scarce natural resources, whose supply is fixed by nature, and "obsolete" means of production that can be produced technologically but the production of which would not cover costs of production at the prevailing prices, wage and rate of profit. Labour is not considered a commodity.

2/ Sraffa (1960), pp. 4-5, 11.

3/ Sraffa (1960), p. 10.

4/ Sraffa (1960), p. 91.

In systems which involve profits it is assumed that the rate of profit is the same in each process and profits, determined by this uniform rate, are considered part of the costs of production.[1/]

The assumption concerning the uniformity of wages, prices and profit rates define what may be called a "Sraffa equilibrium" although Sraffa does not use the term equilibrium.[2/3/]

5. Payment of Wages

In most economic systems which involve a surplus of produced commodities over replacements it is assumed that the wage is paid "post factum" at the end of the production period and not advanced at the beginning.[4/] Certain results depend on this assumption and others do not.[5/] Sraffa's models, however, can be reformulated and results derived assuming advance payment of wages.

6. Determination

Each economic system is assumed to be comprised of data and relations which ensure that, given the rate of profit, the wage and relative commodity prices are determined uniquely and are economically meaningful. Sraffa explicitly expresses this

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1/ Sraffa (1960), p. 6.

2/ Such uniformity may not characterise an equilibrium of supply and demand. In this form of theory, equilibrium is defined in terms of the consistency of agents' plans and in general will not involve a uniformity of prices.

3/ With a positive rate of profit prevailing and with all prices and the wage positive the assumption of self-replacement obviously needs strengthening slightly so that a surplus of produced commodity outputs over inputs is possible.

4/ Sraffa (1960), p. 10.

5/ For example, in order to derive an inverse linear relation between the wage and rate of profit the assumption is essential but the inverse relation is unaffected if it is changed. It is also not clear, a priori, whether it is more reasonable to assume ex-post payment of wages or treatment as an advance. See Steedman (1977), pp. 103-105.

assumption by stating that, in each system, the number of distinct processes[1/] is equal to the number of commodities, both produced and non produced.[2/] However, he recognises that this is not in general an adequate representation of his assumption concerning determination.[3/] Therefore, the statement of this assumption by Sraffa lacks clarity. We proceed in terms of cases where the conditions are such that the equality of processes and commodities ensures the determination of relative prices and the wage when the rate of profit is known and viable.

7. Basic Commodities Exist

The commodities comprising any system are divided into two types, basic and non-basic. This distinction is important with regard to understanding the determination of relative prices and the wage given a rate of profit. Sraffa formulates the distinction between basic and non-basic commodities as follows:

"In a system of k productive processes and k commodities .. We say that a commodity or more generally a group of n linked commodities (where n must be smaller than k and may be equal to 1) are <u>non-basic</u> if of the k rows (formed by the 2n quantities in which they appear in each process) not more than n rows are independent, the others being linear combinations of these. All commodities which do not satisfy this condition are <u>basic</u>." [4/]

1/ Distinct in the sense that no process can be represented as a linear combination of the others.

2/ Sraffa (1960), pp. 5, 7, 44, 63, 77 and 78.

3/ See, for example, Sraffa (1960), pp. 59, 74-75 and 90-91. Sraffa's statements in terms of "counting equations and unknowns" have misled a number of economists. See, for example, Meek (1967), p. 164, Blaug (1974), p. 22 and (1978), p. 143.

4/ Sraffa (1960), pp. 51-2.

This means that if we had a system of k processes and k commodities we would delete from the matrix of non labour inputs those elements pertaining to the commodities other than the n commodities we are considering. Call this Matrix A*. We do the same for the output matrix. Call this matrix B*. We then combine A* and B* as a single matrix of dimension k x 2n and if its rank is n, or less, the n commodities are non-basic. Repeated application of this procedure will allow a splitting of the k commodities into the two mutually exclusive categories of basics and non-basics.

This formal definition provides no intuitive economic interpretation of the nature of basics in the general case.[1/] However, in the case of a system composed only of produced commodities, where each is produced by only one process, it does. In this special case basic commodities are those which enter, directly or indirectly, as means of production into all commodities.[2/]

Sraffa assumes that every economic system includes at least one basic.[3/] Each system, therefore, involves a "whirlpool" production structure where it is impossible, even in the case where each good is produced by only one process, to arrange the commodities in a hierarchy as in Austrian theory.[4/]

1/ It is, nevertheless, possible in all cases to specify the economic characteristics of non-basics. See Sraffa (1960), pp. 49-51, 74 and 78.

2/Sraffa (1960), pp. 7-8.

3/ Sraffa (1960), pp. 8 and 50.

4/ See below, Chapters IX and X

8. Labour Inputs

Sraffa does not explicitly state that labour is involved as an input in all production processes of every system. Nevertheless it seems implicit that this assumption is made, so there are no completely automated production processes involving no direct labour. However, Sraffa's results could be preserved without this assumption as long as direct labour was involved in the production of a basic commodity.

9. Returns to Scale

The analysis is "concerned exclusively with such properties of an economic system as do not depend on changes in the scale of production ..."[1/] Consequently there is no need for any assumptions concerning returns to scale or specification of demand and supply relations. Instead the analysis assumes predetermined levels of inputs and outputs. It follows that Sraffa does not appeal to any class of non-substitution theorem to substantiate his analysis regarding the determination of prices and the wage when the rate of profit is fixed. Thus his work is not properly classified as linear economics or, indeed, as economics within a supply and demand framework, This point has for the most part been misunderstood or ignored by commentators.[2/]

1/ Sraffa (1960), p. v.

2/ See, for example, Blaug (1974) (1978), Bose (1964a) (1964b), Burmeister (1975) (1977), Collard (1963) (1964), Eatwell (1977) Howard (1979), Levine (1974) (1975) (1977) and Quandt (1961).

(iv) The Systems Considered

The most general type of system defined by the above assumptions can include joint production as well as single-product processes, fixed as well as circulating capital and the utilisation of non-produced as well as produced commodities. Such a system can be written as:

$$Ap\,(1 + r) + Ds + fw = Bp \qquad (1)$$

where A is an m x n input matrix of produced means of production, D is an m x q matrix of non-produced means of production, B is an m x n output matrix, p is an n element column vector of relative prices relating to produced goods, s is a q element column vector of relative prices relating to non-produced goods, f is an m element column vector of labour inputs, r is the rate of profit and w the wage. By assumption 6, $m = n + q$. Once r is set at a viable level and a numeraire chosen p, s and w are determined uniquely and at economically meaningful levels.

Sraffa builds up to the conceptualisation and analysis of such a complex system by considering various simpler systems which are specialisations of it and also by concentrating analysis on particular segments of such systems. The simplest system considered is a subsistence and, therefore, zero-profit economy, where all commodities are produced and there is no joint production or any form of fixed capital. Such a system can be represented by the matrix equation:

$$Ap = p \qquad (2)$$

The second form of system considered is exactly the same as this except that a surplus exists which is distributed according to the equal profitability assumption. It can, therefore, be represented by the matrix equation:

$$Ap\,(1 + r) = p \qquad (3)$$

In both these cases wages are regarded as consisting only of what is necessary for subsistence and enter the systems as commodity

inputs "on the same footing as the fuel for the engines or feed for the cattle";[1/] consequently labour inputs do not appear explicitly. In the second case wages are, therefore, considered as advanced from capital.

The third form is the same as the second except for a reconceptualisation of wages as paid out of surplus, ex-post, so that the input matrix now incorporates only non-labour inputs and profit is a rate only on the value of such inputs. Such a system can be represented by the matrix equation:

$$Ap\ (1 + r) + fw = p \qquad (4)$$

The fourth form introduces fixed capital and this is accomplished by considering such durable goods in terms of a joint production framework. These goods at different stages of obsolescence are treated as different goods and older goods, remaining at the end of the production period, as bye-products. Consequently every such capital good lasts for only one period. This is the appropriate procedure in a general theory of capital.[2] The matrix equation representing such a system can be written as:

$$Ap\ (1 + r) + fw = Bp \qquad (5)$$

The fifth form introduces pure joint production, i.e. joint products other than those which arise from the use of fixed capital. Formally it can also be represented by equation (5).

1/ Sraffa (1960), p. 9.

2/ "Only by treating capital goods at different stages of wear and tear as qualitatively different goods, so that each capital good newly defined can serve only for one period, can we adequately deal with the age structure of capital" Morishima (1969), p. 89. See also Morishima (1969) chapter 6 and Morishima (1973) chapter 13. Sraffa attributes the origin of this conceptualisation to Torrens, but it is usually associated with the Von-Neuman growth model.

Sraffa also considers the production processes involving non- produced inputs which may form a sub-set of processes in any of the above types of system.

Although this chapter is purely expository, Sraffa's conceptualisation highlights a problem of which it is as well to be aware at the outset. Non-produced inputs cover both scarce natural resources and "obsolete" produced goods, i.e. produced goods employed as means of production in a system while not currently produced by that system.[1/] Now, we have seen that in addition to possibly using these types of inputs, all systems that Sraffa analyses have "whirlpool" production structures, because it is assumed that there is at least one basic commodity. An obvious question which therefore arises is how a system ever comes into being. The modern general equilibrium theory of Arrow-Debreu deals with this matter by postulating an endowment of resources which defines the transformations feasible within the production sets of producers and, therefore, the economic structures capable of emerging. Sraffa, however, does not. There is no assumption made concerning such historically given endowments relating to produced commodities in the systems considered. In other words, Sraffa simply assumes the possible operation of such systems or, alternatively, assumes implicitly that at the beginning of the period a produced input structure can be pulled forth precisely of that composition required by the system. This kind of assumption is not unusual in economic theory. It is typically made by Ricardo, Marx and neoclassical theorists of the stationary or steady state. It is also made in linear economics in the theoretical study of Leontief and Von-Neuman models. This implies that for a work in economic

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1/ Sraffa (1960), Chapter XI.

theory to be fundamental, it does not have to be "realistic". However, it does mean that using such a framework to depict the consequences of economic decisions is potentially treacherous. This point will be returned to at a later stage.[1/]

(v) Reconstructing a System

Sraffa explores the relationships which can be shown to exist between technology, relative prices, the wage and rate of profit in all these types of economic system. In addition, his analysis involves a comparison of different types of economic system with special reference to the problem of how the set of processes which maximise the wage for any viable predetermined rate of profit changes as the rate of profit changes. In generating his results Sraffa utilizes various devices which restructure the economic systems under examination so as to reveal their properties more clearly. These devices will be used extensively in the following chapters and it is, therefore, important to explain their main features.

1. Reduction to Dated Labour

In any system where direct labour inputs are explicitly stated and where there are no non-produced material inputs "reduction to dated labour" consists of resolving the price of a commodity into the series of labour inputs which may be said to be embodied in the commodity to which the price refers. Each such dated labour input is multiplied by the wage and the profit factor $(1 + r)$ to a power indicating the number of periods which have occurred between the utilisation of that labour and the emergence of the final product. Each term is thereby weighted by an appropriate magnitude indicating its date. Sraffa gives an

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1/ See below, Chapter XII.

example of such a procedure for a particular commodity produced in a system represented by the matrix equation (4).

$$Ap\ (1 + r) + fw = p$$

Let us write the equation representing the process as:

$$(a_{11}p_1 + a_{12}p_2 + \ldots + a_{1n}p_n)\ (1 + r) + f_1w = p_1$$

where a_{1j} $(j = 1\ldots n)$ represents the amount of commodity j used as input in the production of commodity 1, f_1 represents the labour input and p_j $(j = 1\ldots n)$ is the price of commodity j. "We begin by replacing the commodities forming the means of production of commodity 1 with their own means of production and quantities of labour: that is to say, we replace them with the commodities and labour which, as appears from their own respective equations, must be employed to produce those means of production; and they, having been expended a year earlier ... will be multiplied by a profit factor at a compound rate for the appropriate period, namely the means of production by $(1 + r)^2$ and the labour by $(1 + r)$ ... We next proceed to replace <u>these latter</u> means of production with their own means of production and labour, and to these will be applied a profit factor for one more year, or, to the means of production $(1 + r)^3$ and to the labour $(1 + r)^2$.

We can carry this operation on as far as we like and if next to the direct labour f_1 we place the successive aggregate quantities of labour which we collect at each step ... we shall obtain a reduction equation ... Besides the labour terms there will always be a "commodity residue" ... but it is always possible, by carrying the reduction sufficiently far, to render the residue so small as to have, at any prefixed rate of profits short of ... (the maximum)... a negligible effect on price".[1/]

Sraffa notes that, although the formal procedure of reduction is applicable to joint production processes, it will

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1/ Sraffa (1960), pp. 34-35. The notation has been altered to conform with this chapter.

not, in general, be appropriate. He refers to a case involving two processes each producing two commodities.

"...We... have to give a negative coefficient to one of the two joint production equations and a positive one to the other so as to eliminate one of the products while retaining the other in isolation. Consequently some of the terms in the reduction would represent negative quantities of labour, for which no reasonable interpretation could be suggested. What is worse, since the series would contain both positive and negative terms, the "commodity residue" instead of decreasing toward zero... might show steady or even widening fluctuations so the series would not converge, that is to say the sum would not tend to a finite limit."[1/]

This procedure is of importance for understanding the limitations inherent in the theories of value and distribution dealt with in the following chapters. It can be expressed more systematically for a whole economic system if we use matrix notation.

Take the most general form of a system to which the operation is relevant. This is represented by the matrix equation (5).

$$Ap\,(1 + r) + fw = Bp$$

The problem is to represent the price vector p in terms of a series of vectors each composed of appropriately dated labour quantities. Define $d^{(0)}$ as the column vector of direct labour inputs involved in the production of a unit of each commodity, such that $f = Bd^{(0)}$, so $d^{(0)} = B^{-1}f$. This represents the vector of unit direct labour requirements and is, therefore, the labour vector of date 0.

Define $f^{(1)}$ as the vector of direct labour requirements necessary, together with a matrix of non-labour inputs $A^{(1)}$,

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1/ Sraffa (1960), pp. 58-59.

to produce A (which, in turn, together with f, produces B). $f^{(1)}$ is, therefore, the first stage indirect labour requirements needed to produce B. Also define $d^{(1)}$ as the corresponding first stage indirect labour requirements to produce one unit of each commodity as final output, such that $f^{(1)} = Bd^{(1)}$, so $d^{(1)} = B^{-1}f^{(1)}$. Since $f^{(1)} = Ad^{(0)}$, $d^{(1)} = B^{-1}AB^{-1}f$. This represents the vector of first stage unit indirect labour requirements and is, therefore, the labour vector of date 1.

Defining $d^{(2)}$ as the second stage indirect unit labour requirements and carrying out a procedure analogous to the above we would find that $d^{(2)} = (B^{-1}A)^2 B^{-1}f$. This would represent the labour vector of date 2. This procedure may be repeated for $d^{(3)}$, $d^{(4)}$ ... Such terms are components of the matrix reduction series which represent the price vector p:

$$B^{-1}fw + (1 + r)B^{-1}AB^{-1}fw + (1 + r)^2(B^{-1}A)^2B^{-1}fw + \ldots \quad (6)$$

Hence we have a series of dated labour vectors each of which is multiplied by the relevantly powered profit factor and the wage. Given a "whirlpool" production structure such a series is necessarily infinite and with only a finite number of terms represented there should also appear a commodity residue matrix multiplied by the price vector and weighted by a profit factor.

Equation (6) gives a more complete formulation than that contained in Sraffa but the points made by Sraffa remain. It may not be possible to compute the series, for the inverse matrix B^{-1} will not exist if the output vectors of the production processes are not a linearly independent set. Some of the dated labour terms may be negative ($B^{-1}A$ need not be a non-negative matrix). The series does not necessarily converge. $(B^{-1}A)^t$ need not tend to 0 as t tends to infinity. However, in the case where each commodity is produced by only one process B becomes a diagonal matrix which, by a suitable choice of units, can be represented

by the identity matrix I and in this case (6) becomes:

$$fw + (1 + r) Afw + (1 + r)^2 A^2 fw \ldots \qquad (7)$$

Here, given Sraffa's assumptions, the terms can be computed, they are all positive and the series converges for $0 \leqslant r <$ Maximum r.[1/]

While the dated labour analysis has been applied to the price vector p, in the cases where it is a valid procedure, the sum of the dated labour vectors would represent the vector of total labour values. However, to compute this vector Sraffa typically uses another restructuring device called a sub-system as it is of wider applicability.

2. Sub-Systems

A sub-system is defined as a restructuring of an economic system such that the system is transformed into one which is in a self-replacing state and in which only one unit of a particular commodity appears in net output.[2/] Thus, for example, given a system whose produced input matrix is A and whose output matrix is B, we seek a row vector of multipliers, s, such that $sB - sA = 0$ so that $s = e(B - A)^{-1}$ where e is some unit row vector. The multipliers are then used on the actual system to convert it into the sub-system.

Although the aggregate of labour involved in the sub-system produces not only the commodity appearing in net output, nevertheless, since all the other commodities produced are replacements this labour can be regarded as being "embodied" in the commodity. "Thus in a sub-system we see at a glance, as an aggregate, the same quantity of labour that we obtain as a sum of a series of terms" in the reduction equation.[3/]

1/ Schefold (1976b), pp. 1-2, Steedman (1977), pp. 164-166.
2/ Sraffa (1960), p. 89.
3/ Sraffa (1960), p. 89.

In any economic system there are potentially as many sub-systems as there are produced commodities. However, such sub-systems may not be capable of being derived, for the matrix $(B - A)^{-1}$ may be singular. Also, in the case of joint production, some of the elements of s may be negative so that there is no way such a sub-system could represent an actual system.[1/] Nevertheless, for many purposes, this aspect does not prevent its usefulness. Indeed it is useful in great part precisely because of this property.[2/] However, given Sraffa's assumption, in a production system involving only produced goods and no joint production, the sub-system for each good is capable of calculation and the multipliers are non-negative.[3/]

3. The Basic System [4/]

In the previous section we have dealt with the distinction between basic and non-basic commodities. The importance of this distinction is that the former can be shown to play a far more fundamental role in determination than the latter. We can entirely eliminate non-basics from a system and preserve certain relationships unchanged.

Assuming we have a system comprising k processes and k commodities "we can find a set of multipliers ... which applied to the original k equations make it possible to combine these into a smaller number of equations (equal in number to the basic products) in each of which any quantity of a non-basic is cancelled by an equal quantity of opposite sign, so that only

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1/ Sraffa (1960), pp. 56-58, 60-61, and 68-69.

2/ See below, Chapter IV.

3/ Pasinetti (1977), pp. 62-63.

4/ The discussion here ignores certain complications which arise when non-produced means of production exist. See below, Chapter IV, section (viii).

basics are included in quantities different from zero".[1/]

In other words, Sraffa demonstrates that it is possible to find a set of elementary row operations applied to A and B which will yield matrices A* and B* such that the elements in the columns associated with non-basics will all be zero.

The resulting set of equations is called the basic system.[2/3/] This system is equivalent to the original in that the values which it determines for the prices of basics and the wage, given the rate of profit, will also be solutions for the original system.[4/] However, such a system may not be a feasible arrangement of actual production processes because a basic equation may not represent an actual process and it may contain negative quantities as well as positive.[5/] However, if the non-basics are all produced commodities and there is no joint production these difficulties do not occur.[6/] And, in any event, given the determining role of basics, it is possible for many purposes to concentrate attention on the simpler basic systems. This has important implications for Ricardian theory and theories of supply and demand.

4. Standard Proportions[7/]

The basic system can be used to reconstruct the economic system into proportions which highlight the relation between the

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1/ Sraffa (1960), p. 52.

2/ Sraffa (1960), pp. 52 and 92.

3/ Actually there are an infinite number of basic systems corresponding to any actual system because the units in which the multipliers are expressed have not been defined. We assume some convention has been adopted whereby this degree of indeterminacy has been closed.

4/ Sraffa (1960, pp. 55 and 62.

5/ Sraffa (1960), pp. 52-53.

6/ Sraffa (1960), p. 52.

7/ The discussion here again ignores certain complications which arise when non-produced means of production exist. See below, Chapter IV, section (viii).

wage and rate of profit. To derive this, we seek a vector, q, of multipliers which, when applied to the basic system, alter the proportions of these equations so that the aggregate output of each basic bears the same proportion to its use in aggregate as an input. Let the matrices $\bar{A}$ and $\bar{B}$ represent the input and output matrices of the basic system. What we seek is the vector q such that:

$$\bar{A}q\,(1 + R) = \bar{B}q \qquad (8)$$

The matrix equation (8) gives an equation for R of the same degree as the number of basics so there may be multiple values of R, to each of which corresponds a set of multipliers.[1/] However, only the lowest R and its set of multipliers turns out to be useful for Sraffa's purpose, which is to use the net product of such a reconstructed system as numeraire in the study of the actual system. The net product corresponding to the lowest R is in general the only one "in terms of which, at all levels of the wage ... (and ... at all the levels of the rate of profits from 0 to its maximum) it is possible for the prices of commodities to be finite".[2/]

The smallest R is termed, by Sraffa, the "standard ratio".[3/] The net product is called the "standard net product" or "standard national income" or "standard (composite) commodity".[4/] The set of equations taken in the proportions which produce the standard commodity is called the "standard system".[5/] Sraffa takes as

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1/ Actually there are an infinite number of multiplier sets corresponding to each R because the unit in which the multipliers are expressed has not been defined. Again we assume some convention has been adopted whereby this indeterminacy is abolished.

2/ Sraffa (1960), p. 54.

3/ Sraffa (1960), p. 21.

4/ Sraffa (1960), p. 20.

5/ Sraffa (1960), p. 20.

numeraire that amount of the standard commodity which would form the net product of the standard system, employing the whole annual labour of the actual system to which it relates.[1/] The annual labour of all actual systems is assumed to equal unity.[2/] Consequently with profits and the wage of the standard system measured in this numeraire we have:

$$\text{Profit} = 1 - \text{wage}$$

Division by the aggregate means of production of the standard system yields

$$r = R(1 - w) \qquad (9)$$

This shows that the rate of profit in the standard system is a decreasing linear function of the wage and is independent of prices.

The importance of this relation, and of the construction from which it is derived, is that Sraffa shows that it applies to the actual system from which the standard system is derived when the standard commodity is used as numeraire. "The same rate of profits which in the standard system is obtained as a ratio between quantities of commodities, will in the actual system result from the ratio of aggregate values".[3/] Furthermore, if equation (9) is added to the actual system, as a replacement for the equation defining the numeraire, then prices and wages are expressed in terms of the standard commodity.[4/] It follows that R may be termed the "maximum rate of profit" for the standard as well as the actual system.[5/] It is associated with a zero wage and as the wage, measured in the standard commodity, rises above zero, the rate of profit falls. Moreover, this relation is independent of the movement of prices.

1/Sraffa (1960), p.20

2/Sraffa (1960), p. 10.

3/Sraffa (1960), p. 23 and also 61-62. See also Blakely and Gossling (1967), Burmeister (1968), Pasinetti (1977) and Miyao (1977)

4/Sraffa (1960), p. 31.

5/Sraffa (1960), p. 17 and 22.

In the absence of joint production and scarce non-produced commodities all components of the standard commodity will be positive.[1/] In the more complex cases negative components can occur.[2/] This, however, does not restrict the use of the standard commodity as a numeraire, for the choice of a numeraire is arbitrary in an economic system which does not involve money. In such a case, the numeraire is only a unit of account. What is important is that the numeraire chosen has properties which aid analysis and the standard commodity numeraire is so endowed because of the simple relationship it establishes through equation (9).[3/]

In this section we have considered four operations of reconstruction. It is important to note that they do not conflict with assumption (9) concerning the absence of any specification relating to returns to scale.[4/] Sraffa points out, in relation to the standard system, that the actual system studied "consists of the same basic equations as the standard system only in different proportions ...": and that "particular proportions, such as the standard ones, may give transparency to a system and render visible what was hidden, but they cannot alter its mathematical properties".[5/] The substance of this point holds true for all the operations outlined above. They involve only hypothetical or notional rearrangements which are separate from any actual economic changes.

In the next four chapters we apply the results of this analysis to an evaluation of Ricardian and Marxian theories of

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1/ Sraffa (1960), p. 29.

2/ Sraffa (1960), p. 53, 72 and 77.

3/ See also, Sraffa (1960), p. 18.

4/ A number of writers have maintained that such a conflict exists, See, for example, Quandt (1961).

5/ Sraffa (1960), p. 23.

value and distribution. The following four chapters utilize it for an assessment of the neoclassical theory of capital productivity and Austrian theory. We then seek to examine the relation of Sraffa's model to that of Walrasian general equilibrium theory.

CHAPTER III

THE RICARDIAN THEORY OF PROFIT

(i) Introduction

This chapter is concerned with Ricardo's theory of profit. To seek to define Ricardianism more generally as a tradition or school involves major issues of controversy which are tangential at this stage.[1/] However, limiting analysis to the work of Ricardo alone still poses problems. Ricardo was a notoriously disorganised writer.[2/] The meanings he attached to such terms as 'value', 'profit', 'wages' and 'rent' are sometimes ambiguous.[3/] Despite his fame as an abstract and consistent model builder,[4/] the various parts of his system are poorly integrated.[5/] Moreover,

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1/ Even if we concentrate on profit theory the term 'Ricardian school' can be used in very different ways, reflecting diverse interpretations. For example, it is possible to argue, as in effect does Marshall (1890), that the labour theory of value, with its implications that profit represents 'deduction' or exploitation, was for the most part an irrelevance and Ricardo's main achievement was to abandon it. A polar opposite view is that of Marx (1862b) who maintained that Ricardo's analysis represents a significant stage in the development of a logically watertight theory of exploitation. Others, like Stigler (1958) imply that Ricardo's affinity to Marx's results stem from a pragmatic commitment to the labour theory, not a philosophic or even analytic orientation. On the other hand, Myrdal (1953) and Gordon (1959) reverse the basis of adherence.

Mill (1848) and Marshall (1890) considered themselves part of the Ricardian tradition as did Marx and the Ricardian socialists. Eminent historians of thought like Schumpeter (1954) argue that by 1831 Ricardianism was no longer a living force. In contrast the increased attention recently given to works of Bortkiewicz (1907), Dmitriev (1898) and Sraffa (1951), (1960), have led Dobb (1973) and Meek (1977) to reconstruct the history of thought in terms of a Ricardo-Marx-Sraffa tradition, distinguished from that of 'Supply and Demand' in which both Mill and Marshall are leading figures. Moving beyond the confines of profit theory, other uses of the term Ricardianism appear, of which that of Keynes (1936) is perhaps the most widely known.

2/ Sraffa (1951).

3/ Dobb (1973), pp. 84-7.

4/ See, for example, Schumpeter (1954), p. 474 and Dobb (1973), pp. 64-7.

5/ Modern economists have sought to reformulate these parts so as to form a consistent whole. See, for example, Barkai (1959), Brems (1970), Findlay (1974), Pasinetti (1960) and Samuelson (1978).

his theory was developed within a framework of controversy and he often, illegitimately, took as support for his own theory the defects in his critics' arguments. No attempt is made here to solve these problems. Instead Ricardo's terminology is interpreted as we would interpret that of a modern economist, except where this interpretation clearly misrepresents what Ricardo meant. Nor is any attempt made to integrate Ricardo's model in a logically satisfactory way, although arguments are made which do impinge on such attempts. However, attention is given to the historical development of Ricardo's ideas, as his earlier work is often important in its own right, and Ricardo's ideas on key matters cannot be understood without knowing this evolution.

(ii) The Problems Considered by Ricardo

Ricardo's central problem was to explain changes in class incomes within national income.[1/] It was central because Ricardo was concerned with the determinants of growth. In his view growth resulted predominantly from capital accumulation. Technical progress was not emphasised.[2/] Accumulation was considered a function of the economic surplus.[3/] It, therefore, became necessary to explain the size and composition of the surplus. The two elements of the surplus, rent and profit, were not of equal significance. Ricardo assumed that landlords' saving was negligible.[4/] The determinants of profit thus becomes crucial. Moreover, within this framework, the rate of profit is of special significance. The savings' propensity of the capitalists

1/ (Works I), p. 5 and (Works VIII), pp. 78-9.

2/ Schumpeter (1954), pp. 585-6.

3/ This consists, in Ricardo's work, of the net national product minus wages. No net saving is assumed to arise from wage income because wages are held down to subsistence levels by the Malthusian population mechanism.

4/ Ricardo assumes that the decision to save is also a decision to invest. See Garegnani (1978a).

was assumed to be a stable function of the rate of profit. Thus, given a rate of profit, the rate of accumulation is determined.[1/]

The main proposition of Ricardo's analysis is easily summarised. Assuming that wages are kept at subsistence by the Malthusian population mechanism, that agricultural production is subject to diminishing returns and is a component of the subsistence wage, that there is competition and that accumulation is a function of the rate of profit, then agricultural productivity must decline over time leading to a decline in the rate of profit. The decline in agricultural productivity causes agricultural goods to rise in price relative to manufactures, which are produced under conditions of constant returns to scale. The cost of the subsistence wage bundle of commodities also rises in terms of manufactures and this reduces profits per unit of capital throughout the economy. This causes the economy to approach a stationary state where the level of r is such that no further impetus to accumulation exists and the economy merely reproduces itself without changing scale.[2/] The greater part of Ricardo's theoretical work was an attempt to put these ideas into a consistent logical system.

His purpose was not solely analytic. The analysis was devised in order to attack those institutions which hampered the rising bourgeois class in its activity of accumulation. More particularly, the purpose was to demonstrate the inexpediency of the restrictions on the importation of agricultural commodities which then prevailed. In Ricardo's view, these restrictions

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1/ If capitalists are the only savers and their savings' propensity (s_c) is a constant, then the rate of accumulation (I/K) necessarily equals $s_c r$.

2/ (Works I), pp. 120-121.

could only hasten the onset of the stationary state. But, as the political issues dimmed, the theory increasingly became of significance in itself and the polemical motivations, which caused him to begin his investigations, withered.

(iii) Aspects of Ricardo's Method

Ricardo's problem is one of historical development. However, he often tackled the problem in other terms. The overall model is decomposed into sub-sets of relations which are then examined while holding other variables constant. This 'one at a time' method is particularly significant in the theory of profit and value. Thus, in studying the determinants of prices and the relation of wages, prices and profits, he holds outputs constant.[1/] Furthermore, he ignores rent. Rents are conceived as intra-marginal surpluses, determined once outputs are fixed, so they play no role in the determination of prices or in the relation between the wage and profits.[2/] Consequently Ricardo gets 'rid of rent' in order to concentrate on the relations of the wage, prices and profits.[3/] Moreover, the wage, prices and profits which Ricardo analyses are those associated with equilibrium. All are assumed uniform over time and between sectors.[4/]

There is, therefore, a dual concept of the 'stationary state' in Ricardo. It represents not only an actual state where the growth process terminates, but also 'a conceptual construct or tool of analysis ...' .[5/]

1/ This is particularly true of Chapter 1 in the Principles, (Works I). See also, Schumpeter (1954), pp. 483, 569 and 652-654.

2/ (Works I), p. 77.

3/ Sraffa (1951), p. xxiii and Schumpeter (1954),pp. 569,673 and 675.

4/ Ricardo was quite explicit on this. He wrote to Malthus 'You always have in mind the immediate and temporary effects ...(I) .. fix my whole attention on the permanent state of things that will result from them'. See Schumpeter (1954) pp. 494-5.

5/ Schumpeter (1954), p. 562.

These methods were used by Ricardo to assist in obtaining definite results. As such they have been both praised and condemned. For example, Blaug writes, 'His gift for heroic abstractions produced one of the most impressive models, judged by its scope and practical import, in the entire history of economic theory ....'.[1/] On the other hand Schumpeter has written, 'The comprehensive vision of the universal interdependence of all the elements of an economic system that haunted Thunen probably never cost Ricardo as much as an hour's sleep. His interest was in the clear-cut result of direct practical significance. In order to get this he cut the general system to pieces, bundled up as large parts of it as possible, and then put them into cold storage ... in the end, the desired results emerged almost as tautologies ... The habit of applying results of this character to the solution of practical problems we shall call the Ricardian vice.'[2/]

For our purposes, however, it only needs to be stressed that Ricardo's method makes the examination of his work in terms of Sraffa's analysis particularly easy.

(iv) The Argument of the Essay [3/]

In order to support his theory, Ricardo believed he needed to establish an inverse relation between the numeraire wage and the rate of profit. Accumulation, with diminishing returns operative in agriculture, would not alter the equilibrium level of the subsistence commodity bundle which workers could purchase, but it would, in his view, lead to a rise in the numeraire wage.

1/ Blaug (1978), pp. 140-141.

2/ Schumpeter (1954), pp. 472-473. See also pp. 569, 668 and 1171.

3/ 'An Essay on the Influence of a Low Price of Corn on the Profits of Stock, Showing the Inexpediency of Restrictions on Importation' (Works IV), pp. 9-41.

This would be the transmission mechanism by which diminishing returns reduced the rate of profit. However, Sraffa argues that initially Ricardo dealt with the relation of diminishing returns and the rate of profit in a simplified context, which precluded the need for valuation and allowed the relation to be formulated in product terms.

'At first, both in the Essay and in Ricardo's letters of 1814 and early 1815, a basic principle had been that "it is the profits of the farmer that regulate the profits of all other trades ..... " The rational foundation of ... (this) ... principle ... is that in agriculture the same commodity, namely corn, forms both the capital (conceived as composed of the subsistence necessary for workers) and the product; so that the determination of profit by the difference between total product and capital advanced, and also the determination of the ratio of this profit to the capital, is done directly between quantities of corn without any question of valuation. It is obvious that only one trade can be in the special position of not employing the products of the other trades while all the others must employ its product as capital. It follows that if there is to be a uniform rate of profit in all trades it is the exchangeable values of the products of other trades relative to their own capitals (i.e. relatively to corn) that must be adjusted so as to yield the same rate of profit as has been established in the growing of corn; since in the latter no value changes can alter the ratio of product to capital, both consisting of the same commodity ..... The advantage of Ricardo's method of approach is that, at the cost of considerable simplification, it makes possible an understanding of how the rate of profit is determined without the need of a method for reducing to a common standard a heterogeneous collection of commodities.'[1/]

1/ Sraffa (1951), pp. xxxi - xxxii.

Sraffa's attribution of a 'corn theory of profit' was anticipated by Dmitriev[1/] and has been widely accepted. However, it has been forcefully argued by Hollander[2/] that the textual evidence is not sufficient to justify it.[3/] The merit of the Sraffa interpretation, however, is that it makes sense of Ricardo in a way that Hollander does not. It may be that such a sense is an imposed one, but for the purpose of evaluation we shall follow Marshall's advice[4/] and generously interpret Ricardo by accepting Sraffa's argument.

Ricardo went on in the Principles to attempt to generalise this argument but it is opportune to note here that in doing so he remained within the confines of a model which distinguished between wage goods and non-wage goods, believing that the rate of profit is exclusively determined by the conditions of production in wage good industries. The conditions of production in industries producing 'luxuries' are irrelevant.[5/]

The need to generalise his theory was undoubtedly felt to be more acute because of the criticism made by Malthus. 'In no case of production, is the product exactly of the same nature as the capital advanced. Consequently we can never properly refer to a material rate of produce ... It is not the particular profits or rate of produce upon the land which determines the general rate of profits of stock ... '[6/] Moreover, Malthus

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1/ Dmitriev (1898).

2/ Hollander (1973) and (1975).

3/ 'It follows from the argument of this paper that substantially the same position as that ultimately appearing in the Principles was maintained from the very outset, namely that variations in the money-wage rate, in consequence of changing prices of wage goods, will be accompanied by inverse movements in the general rate of profit.' Hollander (1973), p. 260.

4/ Marshall (1890), Appendix 1.

5/ (Works I), pp. 118, 132 and 205.

6/ (Works VI), pp. 117 - 118.

argued, by implication, that Ricardo's position could not be validated in a general framework. In Malthus's own Principles he maintained that 'profits depend upon the prices of commodities, and upon the cause that determines these prices, namely the supply compared to the demand ... (Ricardo's) ... theory of profits depends entirely upon the circumstance of the mass of commodities remaining at the same price ... We can infer nothing respecting the rate of profits from a rise in money wages, if commodities, instead of remaining at the same price are variously affected ...'[1/] Malthus did accept that the rate of profit declined with capital accumulation but believed that the operative mechanism was very different from that described by Ricardo. The rate of profit fell, in Malthus's view, because of an excess of capital in relation to aggregate demand. ' ... All will in my opinion depend on the state of capital compared with the demand for it. This will be the prime mover, and it is this which will determine the profits which a capital employed in agriculture shall yield ...'[2/]

Ricardo yielded nothing substantial to Malthus. He adhered throughout to the view that profit arose from the conditions of production and that the forces of supply and demand

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1/ Malthus (1820), pp. 326-334 (quoted in Dobb (1973), p. 74). Malthus, of course, was not Ricardo's only critic. West believed that the wage and rate of profit were positively related. See Stigler (1952), p. 177. Other economists were, in general, not well disposed to accepting Ricardo's analysis. See Gordon (1959), Meek (1967), pp. 51-74. and Dobb (1973), pp. 96-136.

2/ (Works VI), p. 111. Malthus's position, like that of Ricardo, reflected an ideological commitment. In Malthus's case his opposition to Say's law reflected his attempt to reconcile the interests of the landlord and capitalists.

played only a subsidiary role of distributing this profit according to the requirements of a uniform rate on capital. What Malthus's arguments did, however, was to bring home to Ricardo the need for a generalization and to lead him to believe that his arguments were contrary to those of 'supply and demand' theory and that, as such, the latter was deficient.[1/]

(v) The Argument of the Principles

In the light of the above, it is not surprising that Ricardo believed that a generalization of his argument required a theory of value by which he could determine the effect which a rise in the numeraire wage would have on prices and through these on the rate of profit.[2/] He begins by adopting a labour theory of value where the ratio of equilibrium prices of any two commodities will equal the ratio of their embodied labour coefficients. The point which Ricardo stresses is that Smith, and his followers, had rejected the labour theory for erroneous reasons and that the theory is of more general applicability than they had believed.

Smith maintained that the labour theory of value held only in 'early and rude' society which 'precedes both the accumulation of stock and the appropriation of land.'[3/] However, as soon as private property in the means of production develops it ceases to be a valid principle governing relative values. In effect, Smith argues that the very existence of property incomes

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1/ (Works I), Chapters IV, XX and XXX. See also Schumpeter (1954), pp. 600-601.

2/ More specifically, Ricardo believed he required a theory of value applicable only to commodities 'which can be increased in quantity by the exertion of human industry, and on the production of which competition operates without restraint.' (Works I), p. 12. By value Ricardo generally means equilibrium price. See (Works I), p. 92. However, see below, section (vii).

3/ Smith (1776), p. 53.

invalidates the labour theory. In this context he develops an 'adding up' theory of value where the equilibrium price of a commodity equals the sum of the remuneration paid to the factors that produced it, i.e. wages, rent and profit.[1/]

Ricardo showed that, provided that the different forms of capital were used in the same proportions in all productive processes, the existence of profit, when allocated on the basis of a uniform rate, was not incompatible with the labour theory. Moreover, the existence of rent, whatever the circumstances, did not contradict the theory because rent was price-determined, not price-determining.[2/]

In defending the labour theory of value in this way Ricardo explicitly recognized its limitations. Where the 'constitutions of capital' were different between industries, the competitive requirement of a uniform rate of profit ensured that relative equilibrium prices no longer exactly equalled embodied labour ratios.[3/] However, he argued that the deviations were unimportant and that although the labour theory was not analytically correct, nevertheless, it gave a sufficiently good approximation for his purpose.[4/]

On this basis, Ricardo provided a generalization of his theory on profit. He did so by substituting embodied labour for corn as the unit in terms of which economic magnitudes were measured. Profit was now determined by the 'proportion of the annual labour ... directed to the support of the labourers.'[5/] Consequently the rate of profit would fall with diminishing returns because of the rising labour cost of corn, a necessary component of the subsistence wage bundle.

1/ Smith (1776), pp. 54-55.

2/ (Works I), Chapter II.

3/ (Works I), Chapter I.

4/ (Works I), p. 36. See also Sraffa (1951), pp. xxxvii and xl, and Stigler (1958).

5/ (Works I), p. 49.

(vi) The 'Ricardo Effect'

Ricardo never substantially improved upon this formulation of his theory. However, he did attempt to argue his position rather than simply assert it. These arguments are important in their own right and, moreover, form the basis of a problem, the solution of which evaded him during the rest of his life, i.e. the problem of determining an 'invariable standard of value'.

In his working out of the labour theory of value, Ricardo discovered what he termed the 'curious effect' of an increase in the numeraire wage and the corresponding decrease in the rate of profit.'[1/] Such a wage and rate of profit change, he argued, would, in industries which were sufficiently capital-intensive, cause prices to fall. In such a case, the reduction in profit costs would more than compensate for the increase in wage costs.

Although this implied that the labour theory did not strictly hold,[2/] Ricardo, rather than regarding it as weakening his attempt to generalize his profit theory, took it as a phenomenon in his favour. The reason for this is clear. Malthus had argued, in his opposition to Ricardo, that 'supply and demand' would operate to increase all prices, if the wage rate rose. This proposition was initially put forward by Smith and represented a deduction from his 'adding up' theory of value. Ricardo's examples indicated, by contrast, that prices would fall. In fact Ricardo was more explicit. In the first edition of the Principles he wrote 'it appears ..... that no commodities whatever are raised in absolute price,

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1/ (Works VII), p. 82.

2/ The defect of the labour theory of value due to different constitutions of capital can be looked at in two different ways. 'First, that of occasioning a difference in the relative values of two commodities which are produced by equal quantities of labour. Second, that of the effect which a rise of wages has in producing a change in their relative value.' Sraffa (1951), p. xivii.

merely because wages rise; that they never rise unless additional labour is bestowed on them; but that all commodities in the production of which fixed capital enters, not only do not rise in wages, but absolutely fall'. 1/2/

Ricardo's presentation was, however, contrived. The fact that no price rose, and those of commodities using fixed capital fell, resulted only because his numeraire commodity was produced under conditions of 'unassisted labour' which represented the lowest 'constitution of capital'. Malthus pointed this out,3/ and in the third edition of his Principles Ricardo responded by choosing as numeraire that commodity which had an 'average constitution of capital'.4 His examples were then formulated to show that, when numeraire wages rose and there was a decline in the rate of profit, those commodities with a 'constitution' above average fell in price and those

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1/ (Works I), p. 63.

2/ Understanding of Ricardo here will be aided if a criticism to be made later is anticipated. The reason why Ricardo took the 'curious effect' of a rise in wages to support his position is clear but not valid. It is not valid, as he formulated it, because it does not logically bear upon the problem of the relation of the numeraire wage and rate of profit. In his numerical examples dealing with this matter he postulates an increase in the numeraire wage and a fall in the profit rate rather than properly deducing the latter from the former. Obviously any result derived from such a procedure is irrelevant to his problem. It would appear that Ricardo was 'distracted' from his proper course by the criticisms of Malthus. In any event, to undermine one's critics does not in itself justify one's own argument. Malthus' method was no better, however. His main point represented no more than an indication that a true multi-sector analysis was more complex than that of the 'corn model', and an assertion that this complexity undermined Ricardo's position.

3/ (Works II), pp. 62-4.

4/ (Works I), p. 45.

with a below average 'constitution' rose in price. In the former case, the increase in wage costs was more than compensated by a decline in profit costs, and the reverse occurred in the latter. He still regarded this as supporting his theory, for the critics' arguments remained faulty.[1/]

The argument which he used directly to support or generalize his own theory remained that stated at the end of the last section. Ricardo maintained that the modifications required to be made to the labour theory of value on account of unequal 'constitutions of capital' were secondary. On this basis he considered that his theory was generalized.

(vii) An 'Invariable Standard of Value'

Ricardo's problem of finding an 'invariable standard' is really a set of problems and they are best kept distinct, although they do not appear as such in his work.[2/]

1/ Within the terms of Ricardo's argument, to get the Smith-Malthus result the numeraire would have to be that commodity with the highest constitution of capital. We have already seen, above p.44. that this analysis was logically irrelevant to a proper generalization of Ricardo's theory.

2/ Again, an understanding of Ricardo will be aided by anticipating criticism. Both Ricardo's own analysis concerning an invariable standard of value, and that of many commentators on Ricardo, are generally stated in terms which can only be described as gibberish. Indeed, the very phrase 'invariable standard of value' is problematic. Modern economists think of value as relative value, i.e. value relative tc some numeraire. Once a numeraire is chosen and its price set equal to unity it is necessarily invariable by definition. In any framework involving more than one commodity there are an infinite number of 'invariable' standards, because there are an infinite number of possible numeraires. However, Ricardo's analysis of the 'invariable standard of value' was partly based on rational grounds. There were meaningful problems he was struggling with, although interpenetrating with these were problems created by his own conceptual framework and prejudices, rather than problems which were inherent in the subject. In this section we state what these problems were and in the next chapter examine them in the light of Sraffa's analysis, particularly with regard to the properties of Sraffa's standard commodity. This has also been called an invariable standard of value, and has also been discussed in confused terms.

a) The concept arises in the problem of finding, whenever there is a change in the exchange rate of two commodities, in which commodity there has occurred a change in real or absolute value. Thus, Ricardo writes, 'When commodities varied in relative value, it would be desirable to have the means of ascertaining which of them fell and which rose in real value, and this could be effected only by comparing them one after another with some invariable measure of value, which should itself be subject to none of the fluctuations to which other commodities are exposed'.[1/] In general such a statement makes no sense because value is a relative concept. However, in a context where the labour theory of value holds, it is meaningful to talk in terms of real or absolute value. With each commodity can be associated a number, equal to its embodied labour, which can be defined as its absolute or real value. A change in the exchange ratio (relative value) of two commodities can then be regarded as the result of a change that has occurred in absolute or real values. Ricardo maintained that a commodity whose production conditions never changed would, in such a context, provide an appropriate numeraire which would show changes in absolute values. A variation in the exchange rate between it and another commodity would mean that the absolute value of the other commodity had changed.[2/]

b) Ricardo, however, continued to conceive of the above problem as a meaningful one outside the context of the labour theory of value. In other words, he believed that a concept of absolute or real value made sense even when embodied labour ratios no longer equalled relative prices so that the term 'value' could no longer refer to both embodied labour and

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1/ (Works I), p. 43.

2/ (Works I), p. 54.

equilibrium price. He failed to specify, or even to conceptualise, the conditions which an invariable standard would have to meet in these circumstances. He did, however, maintain that the commodity which was produced with an average constitution of capital provided the best approximation.[1/]

c) In his last paper on 'Absolute Value and Exchangeable Value'[2/] there is a reformulation of the problem. Essentially what Ricardo does is to merge the two concepts dealt with above. He writes, 'I may be asked what I mean by the word value, and by what criterion I would judge whether a commodity had or had not changed its value. I answer, I know of no other criterion of a thing being dear or cheap but by the sacrifices of labour made to obtain it'.[3/] On this basis, he sought a numeraire which would reflect only changes in embodied labour quantities, even when constitutions of capital were not the same. In other words, prices measured in such a numeraire would not change unless the embodied labour involved in their production changed. This concept of the invariable standard 'would act as a sort of sieve, allowing through the mesh the effects produced by a change in wages and retaining only those produced by a change in the quantity of embodied labour ....'.[4/]

d) The above problem does not explicitly appear in the Principles, although it may indeed help to understand what Ricardo meant on certain matters.[5/] However, according to Sraffa, an analogous problem is tackled. In the course of his investigations into distribution, Ricardo, 'was troubled by

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1/ (Works I), pp. 45-6.

2/ (Works IV), pp. 361-412.

3/ (Works IV), p. 397.

4/ Meek (1956), p. 112. Meek argues that Ricardo took this line because he came to identify 'labour embodied' as the sole 'real cost' of production. It is not clear, however, whether this represents a position of welfare economics or metaphysics.

5/ For example, in his critique of Smith's concept of an invariable standard, (Works I), Chapter I.

the fact that the size of ... (the national product) ... appears to change when the division changes. Even though nothing has occurred to change the magnitude of the aggregate, there may be apparent changes due solely to change in measurement, owing to the fact that measurement is in terms of value and relative values have been altered as a result of a change in the division between wage and profits. .... Thus the problem of value which interested Ricardo was how to find a measure of value which would be invariant to changes in the division of the product; for, if a rise or fall of wages by itself brought about a change in the magnitude of the social product, it would be hard to determine accurately the effect of profits'.[1/]

Each of these problems can be understood in terms of Ricardo's approach to the generalisation of the theory. He believed that a successful generalisation depended on the formulation of a theory of value. All his problems with an 'invariable standard' can be seen as attempts to show that the complexities of a genuine multi-sector economy could not be appealed to in order to support a case contrary to his own. In short, Ricardo believed that in all cases there were definite relationships between diminishing returns, changes in prices, changes in the wage and in the rate of profit and that as a consequence, it must be possible to choose a numeraire, or set of numeraires, which would clearly reveal these relationships.

1/ Sraffa (1951), p. xlviii.

(viii) Conclusion

Ricardo's theoretical work remained incomplete. He never succeeded in generalising his theory rigorously and had to content himself with 'patching up his argument as best he could'.[1/] With modern techniques, it is possible to do much better. In the following chapter Sraffa's analysis is utilized to evaluate the logic of the relationships Ricardo sought to derive and the methodology he employed in doing so.

1/ Robinson and Eatwell (1973), p. 22.

CHAPTER IV

THE RICARDIAN THEORY OF PROFIT AND THE "PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES"

(i) Introduction

This chapter examines Ricardo's theory of profit in terms of Sraffa's analysis. Some caution is warranted in that Ricardo's problem is essentially historical while this aspect does not figure at all in Sraffa. However, as we have seen,[1/] Ricardo employed a methodology which makes an examination of the relations he sought to establish particularly easy in terms of Sraffa.

(ii) The Argument of the Essay

We have indicated in the previous chapter[2/] how Ricardo initially based his analysis on the assumption of an independent corn sector. In short, he considered an economy embedded in which was an industry which allowed the rate of profit to be determined once its output and the wage had been specified. The correctness of Ricardo's formulation is very easily seen.

Assume that the following production process is involved at the margin, i.e. on the no-rent land.

$$a_{11}(1 + r)p_1 = b_{11}p_1 \qquad (1)$$

where a_{11} is the input of commodity 1 in the production of commodity 1 and b_{11} is the output of the same commodity. p_1 is the price of commodity 1 and r is the rate of profit. We can see immediately that

$$r = b_{11}/a_{11} - 1$$

In equilibrium the rate of profit is, therefore, determined

1/ Chapter III, section (iii) and (iv).

2/ Chapter III, section (iii).

by the production coefficients of this sector as a ratio of homogeneous quantities, independently of valuation.

In equation (1), labour inputs and the wage do not appear explicitly. This reflects Ricardo's assumption that in this sector wages are advanced and consist, as do any other capital inputs, of the same commodity as output. However, the result is not sensitive to this assumption. If instead the process was represented by

$$a_{11}(1 + r)p_1 + f_1 wp_1 = b_{11}p_1 \qquad (2)$$

where a_{11}, b_{11}, r, and p_1 stand as before while f_1 represents the labour input and w is the wage measured in commodity 1, we can see that

$$r = \frac{b_{11} - f_1 w}{a_{11}} - 1$$

Again r is determined by this sector independently of valuation.[1/]

Sraffa's analysis demonstrates that this analytical framework is more general than Ricardo realised. Associated with every economic system of the type considered by Sraffa is a unique standard commodity.[2/] Given the wage, measured in this standard commodity, the rate of profit is determined for the economic system as a ratio of homogeneous quantities of the standard commodity, independently of valuation.[3/] Sraffa's

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1/ In equation (2) we not only explicitly represent labour inputs but also treat the wage as paid ex post. However, the same result of r appearing as a ratio of homogeneous quantities, independently of valuation, would still hold if we treated the wage as advanced.

2/ However, see section (viii) below.

3/ Sraffa always discusses the standard commodity assuming labour inputs are stated explicitly and the wage is paid ex post. However, the construction is applicable to the Ricardian case. Here the maximum rate of profit (R) and r coincide.

standard commodity is, therefore, a generalisation of Ricardo's corn sector.[1/] Moreover, it is a powerful generalisation applicable as it is to systems involving fixed capital and joint production.

The standard commodity construction, therefore, indicates that Ricardo was under no logical necessity to abandon the essential idea involved in his corn model because of the criticisms of Malthus. The fact that there may be no single 'corn sector' in an economy is analytically irrelevant. Indeed, it is not even necessary for the standard to be a commodity capable of being produced. A necessary requirement for feasible production is that all elements of the standard be positive but such a condition is not required so far as the logic of determination is concerned. The 'determining sector' need only be capable of conceptualisation.

However, this point ceases to be true if we consider the wider aspects of Ricardo's model. It is not possible to use the standard commodity where outputs are changing in the way that the corn model can be used. Diminishing returns in the latter will raise a_{11} and/or f_1 but the rate of profit is determined as before. In the more general case, a change in technique can alter the composition of the standard commodity and, as a consequence, there will be no possibility of appropriate comparisons. Therefore, using the standard commodity does not allow us to infer the effect of diminishing returns on the rate of profit.

There is also a deeper difficulty. Ricardo's model is one involving a subsistence wage or, at least, it is a model where the commodity composition of the wage bundle is fixed.

1/ Or, stated alternatively, Ricardo's corn sector represents the standard system when there is only one basic commodity.

Only by a fluke would the composition of the wage bundle coincide with the composition of the standard commodity, even when the latter involved only positive elements. In the case where there were negative elements it is out of the question that this could be the case. Sraffa's generalisation is, therefore, of limited significance when we consider the overall structure of Ricardo's model.

(iii) Wage Goods and Luxuries

It was indicated in the previous chapter[1/] that all formulations of Ricardo's theories involved a distinction between 'wage goods' and 'luxuries'. Assuming that each commodity is produced by a single process the distinction is straightforward. Wage goods are those which enter, directly or indirectly, into the subsistence wage bundle. Luxuries are those that do not. Ricardo maintained that the production conditions of the latter were irrelevant to the determination of the rate of profit.

This proposition was subsequently proved by Dmitriev[2/] and von-Bortkiewicz,[3/] for Ricardo's single process model. The proposition is proved in a more general setting by Sraffa, through his distinction between basics and non-basics. The distinction between wage goods and luxuries appears not to be the same as the distinction between basics and non-basics. The former appears to be based on use; the latter, on technology. However, when proper attention is paid to the different structures of the two frameworks, the distinctions are equivalent. In the Ricardian system, unlike that of Sraffa,

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1/ section (iv).

2/ Dmitriev (1898).

3/ Bortkiewicz (1907). See Chapter V, section (iii).

labour is a produced commodity. The inputs required to produce labour are the components of the subsistence wage bundle. Since Ricardo implicitly assumes that labour enters directly or indirectly into the production of all commodities, wage goods are necessarily basic in terms of Sraffa's distinction. Moreover, no commodity in Ricardo's system can be basic in Sraffa's sense unless it is a wage good since labour is a produced commodity. Thus Ricardo's distinction is really a technological distinction and identical to Sraffa's when we recognise that labour is a produced commodity.[1/]

Sraffa's analysis, therefore, shows that Ricardo's insight into the determining role of wage goods was well founded and is capable of being generalised to the case of fixed capital and joint production. The device of the 'basic system' shows that basics alone are significant for the determination of the rate of profit. If, in any actual system, the output or input of any non-basic were altered, the effect on the rate of

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1/ In Sraffa's analysis wage goods may be non-basic. In most models involving a surplus Sraffa considers the wage as variable and paid out of surplus (pp.9-10). This implies that the 'necessaries' of consumption are not automatically classified as basics. For example, in the case where each commodity was produced by a single process, they would only be basic if they entered, directly or indirectly, as means of production into the production of all commodities other than through wage payments to labour.

profit would be zero.[1/]

This is important to the Ricardian system in a number of ways. It provides a rigorous foundation for Ricardo's statements on taxation. Given his objective function and assumptions, Ricardo was correct to recommend the taxation of luxuries rather than wage goods. Taxes on luxuries reduce consumption rather than accumulation while a tax on wage goods must reduce accumulation via a fall in the rate of profit. More importantly it shows that, in general, the rate of profit will not be functionally related to the size of the aggregate capital stock as Smith[2/] and Malthus[3/] had maintained. The capital stock includes non-basics and, therefore, elements irrelevant to the determination of the rate of profit. As such an aggregate, the capital stock can change in many ways without

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1/ In the case where each commodity was produced by a single proces 'an improvement ... in the method of production of a basic commodity ... would necessarily change ... the rate of profits and ... prices of all commodities, while a similar improvement in the case of a non-basic would ... (not).

This cannot be extended directly to a system of multiple products where both basics and non-basics may be produced by the same process. We can, however, find an equivalent in a tax (or subsidy) on the production of a particular commodity ... (paid in kind).

A tax on a basic product then will affect all prices and cause a fall in the rate of profits that corresponds to a given wage, while if imposed on a non-basic it will have no effect beyond the price of the taxed commodity and those of such other non-basics as may be linked with it. This is obvious if we consider that the transformed system of basic equations, which by itself determines the rate of profits and the prices of basic commodities, cannot be affected by changes in the quantity or price of non-basics which are not part of the system.' Sraffa (1960), pp. 54-55. See, however, section (viii) below.

2/ Smith (1776), pp. 98 and 375.

3/ See chapter III, section (iv).

affecting the rate of profit. It also shows that within Ricardo's system it is diminishing returns in wage goods alone which are of significance, not diminishing returns in general.

Again we see the Sraffa system providing support for Ricardo's insights. However, as in the previous section, Sraffa's support is much less strong when the full model is considered. The distinction between the two types of commodity is clear for any given set of production processes. If, however, there is a change in production processes, the composition of each class can change; commodities that were previously basic or wage goods can become non-basic or luxuries. Thus, if diminishing returns in agriculture involves the utilisation of new inputs, previously employed only in luxury uses, these inputs necessarily become wage goods. It follows that a system of taxes designed to aid accumulation may fail to do so after a technical change, and production processes previously irrelevant to the determination of the rate of profit now become relevant.

(iv) Ricardo's Generalisation: The Role of a Theory of Value

Ricardo sought to generalise his analysis through the development of a theory of value. No doubt this approach seemed to him to be a necessary one. The rate of profit in any sector will appear as a ratio of values. Moreover, it was to the movement of prices, following a change in the numeraire wage, that Malthus appealed in an attempt to counter Ricardo's analysis. It is, therefore, perfectly understandable for Ricardo to have sought a generalisation through a theory of value in the way that he did.

We have, however, already seen in section (ii) that the type of value theory he developed was unnecessary. Provided that the principles of price uniformity and equality with cost of production are accepted, the standard commodity construction can be employed to determine the rate of profit and reveal its inverse relation with the wage quite independently of the movement of prices. It is, of course, also true that the device of the standard commodity is of limited usefulness to Ricardo given his assumption of the subsistence wage and the historical nature of his model. However, it is easy to show that the key point remains: Ricardo's own endeavours in value theory were an unnecessary detour.

Assuming that each commodity is produced by a separate process, that prices are uniform and equal to costs of production, then the rate of profit is necessarily inversely related to the numeraire wage. This is true for any numeraire. '... If the wage is cut in terms of any commodity ... the rate of profits will rise; and vice versa for an increase in the wage.

It also follows that if the wage is cut in terms of one commodity it is thereby cut in terms of all; and similarly for an increase. The direction of the change is the same in relation to all commodities however different may be the extent'.[1/]

Indeed, there is an even more fundamental criticism implied by Sraffa's analysis. Ricardo need not have even considered the relationship between the numeraire wage and the rate of profit to establish his central thesis concerning the trend of the rate of profit. Diminishing returns, or more generally,

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1/ Sraffa (1960), p. 40. See also Pasinetti (1977), pp. 87-89. This result is unaffected by the method of wage payment, whether advanced or paid ex post.

a rise in any input coefficient, will necessarily reduce the rate of profit, given the subsistence real wage, providing each commodity is produced by a single process.

Since non-basics are not relevant to the determination of the rate of profit, they can be ignored and attention confined to the set of basics. The input matrix of such a set is square, non-negative and indecomposable. There have been important theorems established about such matrices and the utilisation of these gives the desired result.[1/]

The simplest of the Sraffa surplus systems is most relevant in this connection. The basic processes can be represented by the matrix equation[2/]

$$Ap\,(1 + r) = p \qquad (3)$$

Labour inputs and subsistence wage payments are not shown explicitly but are included in the elements of A. The reciprocal of the profit factor is the dominant eigenvalue of matrix A.[3/] The dominant eigenvalue is a continuous increasing function of every element of A. Consequently the rate of

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1/ Sraffa does not indicate the mathematical basis on which his work rests. However, it seems certain that the results of Part 1 were established on the basis of such theorems. See Newman (1962), Pasinetti (1977a) and Tucci (1976).

2/ See Chapter II, section (iv).

3/ Equation (3) implies $[A - \lambda I]\, p=0$ where $\lambda = 1/1 + r$. A necessary condition for this to have non-trivial solutions for p is that the determinant $|A-\lambda I| = 0$. If A is k x k in dimension then this characteristic equation is a polynomial of the kth degree in λ. To each solution for λ there corresponds an eigenvector p. Economic viability of the system requires that the dominant λ be less than 1 to which corresponds an $r > 0$. This eigenvalue alone can be associated with normalised all-positive p. See Newman (1962), Pasinetti (1977a), pp. 76-78 and 267-276, and Debreu and Herstein (1953).

profit is a continuous decreasing function of every element of A. Therefore, decreasing productivity in the production of any basic is necessarily associated with a declining rate of profit. It follows from this that not only did Ricardo not need a theory of value in the sense in which he developed such a theory,[1] but he also did not need to concern himself with the relation between the numeraire wage and rate of profit.

This result continues to hold if there is joint production.[2] However, in this case diminishing returns may not be associated with a decline in the rate of profit, assuming a fixed subsistence wage. Ricardo's conclusion, therefore, is not generally valid.

Consider the system

$$Ap\ (1 + r) + fw = Bp \qquad (3)^{3}$$

and assume that diminishing returns occur. We can, therefore, rewrite equation (3) as

$$A\ [I + k]\ p\ (1 + r) + fw = B\ [I + k]\ p \qquad (4)$$

where k is a diagonal matrix with elements k_j along the principal diagonal, all of which are non-positive and less than unity in absolute value. These elements k_j thus reflect a declining productivity of labour in transforming inputs into outputs.

1/ At one point Ricardo indeed seems to have perceived this intuitively. For example, he wrote to McCulloch in June 1820, 'After all, the great questions of rent, wages and profits must be explained by the proportions in which the whole of the produce is divided between landlords, capitalists and labourers, and which are not essentially connected with the doctrine of value'. (Works VIII), p. 194.

2/ But, unlike the case where each commodity is produced by a separate process, when there is joint production an increase in the numeraire wage can be associated with an increase in the rate of profit. However, if the standard commodity is used as numeraire the wage and rate of profit are always inversely related. See Sraffa (1960), pp. 60-61.

3/ See Chapter II, section (iv).

Equation (4) can be rewritten as

$$p = [I + k]^{-1} [B - A(1+r)]^{-1} fw \qquad (5)$$

Assume, without loss of generality, that prices are measured in labour-commanded units so that $w = 1$ and that labour is measured such that the total labour utilised is always 1. Also, define w^* as the row vector representing the fixed real wage bundle of commodities consumed by workers. Consequently $w^*p = 1$ and (5) becomes

$$1 = w^* [I + k]^{-1} [B - A(1 + r)]^{-1} f$$

Diminishing returns imply that the k_j become larger in absolute value. Therefore, the elements of $[I + k]$ become smaller and the elements of $[I + k]^{-1}$ become larger. This will always result in a decline in r only if $[B - A(1 + r)]^{-1} f$ is an increasing vector function of r. But this cannot be assured unless $B = I$, which implies the absence of joint production.[1/] It follows that in a system involving joint production it is possible for diminishing returns to be associated with an increase in the rate of profit.

(v) Ricardo's Generalisation: The Labour Theory of Value

Although Ricardo had no analytical need for a theory of value as he perceived it, nevertheless, it is important for an overall evaluation of his theory of profit to consider the value theory he did develop. After all, results may be established by more than one method. In this section we deal with Ricardo's statement of the labour theory of value, in the next with the 'curious effect' and in the following section with 'invariable standard'.

1/See Pasinetti (1977), pp. 267-276 and Steedman (1977), pp. 175-178.

Peculiarly enough, Ricardo never defined the procedure for computing embodied labour magnitudes and took it as self-evident that they could be calculated. Sraffa provides two alternative methods, that of reduction and that of sub-systems,[1/] the latter being the more general. Moreover, since the method of sub-systems is not precluded by the existence of fixed capital and joint production, his analysis shows that the labour theory is not rendered inapplicable by these complications per se.[2/] Although these methods are satisfactory there is a third procedure for computing values. Given a system represented by the equation

$$Ap\ (1 + r) + fw = Bp$$

embodied labour magnitudes can be derived from the equation

$$Av^* + f = Bv^*$$

where v^* represents the column vector of labour values. Obviously

$$v^* = (B-A)^{-1}\ f$$

Sraffa confirms the analysis of Smith and Ricardo concerning the applicability of the labour theory of value. Provided the rate of profit is zero, and all commodities are produced, equilibrium price ratios necessarily equal ratios of labour values.[3/] Also in the case where each commodity is produced

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1/ Or a variant of the sub-system approach. See Sraffa (1960), pp. 56-58, 68-69.

2/ The difficulties which the reduction procedure meets within joint production systems is seen by Blaug to be a major criticism of the labour theory of value. Blaug (1978), p.145. This is not the case. Labour values need to be defined but there is no requirement that they have to be computed by means of reduction to dated labour.

3/ Sraffa (1960), pp. 12, 56-58, 68-69. See also Pasinetti (1977), pp. 74-76 and below p.65.

by a single process and all production processes have the same structure regarding input proportions then the labour theory of value is valid even with a positive rate of profit.[1/] More importantly, however, Sraffa's analysis shows that Ricardo's faith in the labour theory being approximately valid when these conditions are not fulfilled was misplaced. There are cases where there can be no degree of approximation because embodied labour magnitudes are indeterminate, zero or negative while prices are positive.

Labour values will be indeterminate when the matrix [B-A] is singular. For example, consider a system composed of the following production processes:

	Inputs			Outputs	
	Commodity 1	Commodity 2	Labour	Commodity 1	Commodity 2
Process 1	4	0	1	5	1
Process 2	0	6	1	2	8

In attempting to compute labour values we end with two inconsistent equations

$$1 = v_1^* + v_2^*$$

$$1 = 2v_1^* + 2v_2^*$$

However, this system is capable of representing an equilibrium. Assuming that commodity 1 is the numeraire and that the real wage is one unit of commodity 2, paid in arrears, we find that $p_1 = 1$, $p_2 = 4$ and $r = 25\%$.

Even if [B-A] is non-singular, so that labour values are determinate, there is no assurance that they will be positive. For example, consider the following system:

1/ Sraffa (1960), p. 13 and Pasinetti (1977), p. 92. However, see section (vi) regarding Ricardo's notion of equal 'constitutions of capital'.

	Inputs			Outputs	
	Commodity 1	Commodity 1	Labour	Commodity 1	Commodity 2
Process 1	4	0	1	5	1
Process 2	0	16	1	2	20

Computation of labour values shows that $v_1^* = 1\frac{1}{2}$ and $v_2^* = -\frac{1}{2}$ However, this system is capable of representing an equilibrium. Assuming that commodity 1 is the numeraire and that the real wage is one unit of commodity 2, paid in arrears, we find that $p_1 = 1$, $p_2 = 2$ and $r = 25\%$.

In the system

	Inputs			Outputs	
	Commodity 1	Commodity 2	Labour	Commodity 1	Commodity 2
Process 1	4	0	1	5	1
Process 2	0	12	1	2	13

computation of labour values shows $v_1^* = 0$ and $v_2^* = 1$ where, with the same wage and numeraire as above, $p_1 = 1, p_2 = 2/3$ and $r = 25\%$.[1/]

Ricardo took the determinate and positive nature of labour values as self evident. These examples indicate that he should not have done so. They also indicate that the labour theory of value cannot, in general, be regarded as an approximately valid theory.

This point is also of some relevance in assessing Marx's theory of exploitation[2/] and it is pertinent to enquire into the economics that lies behind the algebra. Firstly, note that with the utilisation of positive direct labour inputs in all processes, the labour value of aggregate net output must be positive, for it is equal to the total of this direct labour.

1/ Sraffa does not explicitly call attention to the first and third possibility although he does to the second. Morishima (1973) and Steedman (1975) seem to have been the first to spell out the significance of negative labour values in the context of an evaluation of Marx.

2/ See Chapter (VI)

In the cases where labour values are determinate, this means that at least one commodity must have a positive labour value. However, it may not be possible in the face of joint production to allocate the labour value of national income between its component parts. This is the situation in the first example above, because both processes produce net outputs in the same proportions. A necessary condition for the calculation of individual labour values is that the processes produce net outputs in different proportions.

This condition holds in the second example. But in this case process 2 is more physically productive with regard to both net outputs. Consequently one can transfer labour from Process 1 to Process 2 and get more of both commodities in net outputs. However, these greater net outputs must absorb, or embody, no more labour than that saved by reducing the operation of the least productive process. This is only possible if one commodity has a negative labour value.

In the third example, we have a situation where Process 2 is more physically productive with regard to the net output of commodity 1 and has the same productivity in the production of commodity 2. By the same argument it follows that commodity 1 must have a zero labour value. Transferring labour from process 1 to process 2 results in the same labour value of national income and the same physical composition, except that more of commodity 1 is produced. This implies a zero labour value for commodity 1.

It follows that all labour values will be determinate and positive only when net outputs are produced in different proportions by the different processes and when no process dominates in productivity. Such conditions are not required to hold for an equilibrium to exist.

It was stated earlier that Sraffa's analysis supports Ricardo's proposition that the labour theory holds when the rate of profit is equal to zero. The above examples might seem to cast doubt on the validity of this proposition. But, in fact, the examples do not undermine the proposition. They indicate only that the proposition should properly be prefaced with an assumption: namely, that commodity labour values can be calculated. Negative or zero labour values would not be relevant in such a case for the least productive process would not be utilised. Operating only the more productive process would, of course, mean that labour values became indeterminate.[1/]

All these cases involve joint production - a phenomenon which Ricardo did not treat analytically. However, the criticism is valid; joint production cannot legitimately be considered a complicating detail of limited empirical or theoretical relevance. As has been noted above, a proper treatment of fixed capital requires the joint production framework.[2/] Nevertheless the main thrust of the argument against Ricardo is unaffected if attention is confined to systems involving no joint production. Take the Sraffa system represented by the equation

$$Ap\,(1 + r) + fw = p$$

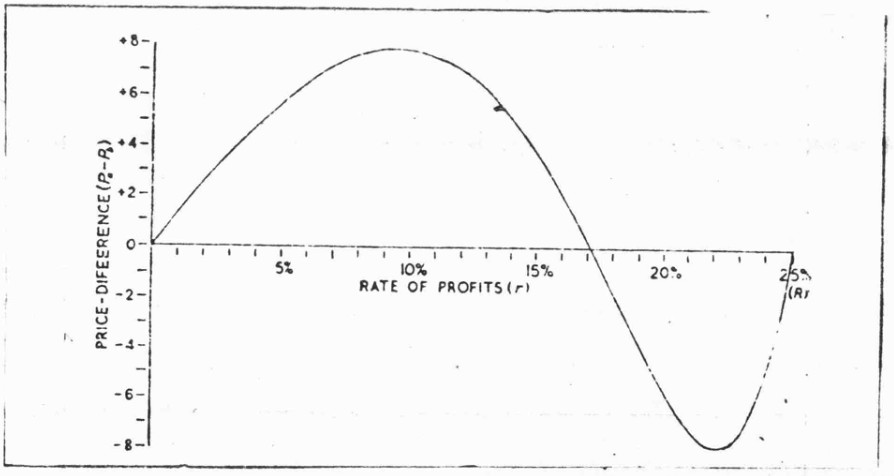
1/ This example indicates that when there is joint production there is necessarily a choice of technique problem for agents to solve. Systems involving joint production which maximize the wage at a given rate of profit may not, therefore, be operated at another rate of profit even if there are no other processes available. In other words, some processes may be jettisoned and replaced by no other. Sraffa implicitly recognizes this (p. 59) but does not examine it because it is not compatible with the assumption concerning determination.

2/ See above, Chapter II, section (iv).

Here labour values are determinate and positive [1/2/] but there is no assurance that labour values will provide an approximation to equilibrium prices. Sraffa's 'reduction to dated labour' is the clearest way of understanding this. Indeed Sraffa provides an example which, while not used by him for this purpose, does make the point convincingly. ' ... We may suppose two products which differ in three of their labour terms ... while being identical in all others. One of these, 'a', has an excess of 20 units of labour applied 8 years before, whereas the excess of the other, b, consists of 19 units employed in the current year and 1 unit bestowed 25 years earlier ... The differences between the standard prices at various rates of profits, namely

$$p_a - p_b = 20\ w\ (1 + r)^8 - 19w + w(1 + r)^{25}$$

is represented in ..... (the figure below)'.[3/]



where $w = 1 - r/.25$

1/ Formally the system represented in equation (4) can generate negative labour values. However, this would occur only when the system was not economically viable. Labour values are positive if the system is viable and at least one basic utilises direct labour in its production.

2/ The following discussion is unaffected by the treatment of wage payments.

3/ Sraffa (1960), pp. 37-38.

We see immediately that 'a' and 'b' have the same labour values but the price of 'a' relative to that of 'b' changes with different rates of profit. The example, therefore, indicates that the degree of approximation provided by embodied labour coefficients depends on the rate of profit and the implicit time structure of the labour inputs in each process of production.[1/]

In the above case, labour values have been regarded as independent of equilibrium prices and the rate of profit. However, this reflects a very special case which arises when there is no choice as to which processes to use.[2/] The existence of alternative technically efficient processes makes it impossible to determine the labour values of commodities prior to the determination of the rate of profit. The processes which are operated will change as the rate of profit changes. This means that the technological data from which labour values are calculated will change as the rate of profit changes. Consequently, any theory which seeks to determine the rate of profit on the basis of labour values is circular. 'The determination of the profit rate is ... logically prior to any determination of value magnitudes - it is hardly surprising, then, that the latter have nothing to contribute to the former'.[3/]

1/ The production processes and rates of profit operating in Ricardo's time could conceivably have been such as to provide, at worst, a 93% labour theory of value. See Stigler (1958). But whether this was, or was not, so Ricardo could not possibly have known. He simply did not have the information available from which to make a calculation. Moreover, the hypothetical calculations which he did make are significantly flawed. See below, section (vi).

2/ It has already been noted above that systems made up of joint production processes necessarily involve choices regarding which techniques will be operated.

3/ Steedman (1977), p. 65. See also Morishima (1973), pp.189-90 and Howard and King (1975), pp. 157-60.

(vi) Ricardo's Generalisation: The Curious Effect

Ricardo maintained that, given an increase in the numeraire wage and a corresponding decline in the rate of profit, relative price movements could be predicted on the basis of 'constitutions of capital'. Taking as numeraire a commodity with an average constitution, he believed an increase in the numeraire wage would lead to a decrease in the price of commodities with above-average constitutions and an increase in price for those with below-average constitutions. The rationale for this is clear. An increase in the numeraire wage and a corresponding decline in the rate of profit, would, in the absence of any price changes, lead to the capital-intensive commodities yielding a 'surplus' and labour-intensive commodities a deficit. The cost of production of capital-intensive commodities would decline more through a fall in the rate of profit than they would rise through an increase in the wage. In contrast, the labour-intensive commodities would experience a greater rise in costs due to a rise in wages than would be compensated for by a fall in profit costs. Consequently, to establish a uniform rate of profit there would have to be price changes.

Sraffa's analysis is directly relevant to assessing the adequacy of these propositions. It shows, in the case where each commodity is produced by a single process, that Ricardo was on the right track in locating the source of price changes in unequal constitutions of capital.

'The key to the movement of relative prices consequent upon a change in the wage lies in the inequality of the proportions in which labour and means of production are employed in the various industries.

It is clear that if the proportion were the same in all industries no price changes could ensue, however great was the diversity of the commodity composition of the means of production in different industries. For in each industry an equal deduction from the wage would yield just as much as was required for paying the profits on the means of production at a uniform rate without need to disturb existing prices.

For the same reason it is impossible for prices to remain unchanged when there is inequality of "proportions" ...

However complex the patterns of price-variations arising from a change in distribution, their net result, and their complete justification, remains the simple one of redressing the balance in each industry. They fully achieve that object, but it could not be achieved with anything less'.[1/]

However, the relationship between the numeraire wage and prices is much more complex than that considered by Ricardo. In general there is no simple rule of the Ricardian type by which these changes may be predicted. This is true even when each commodity is produced by a single process.[2/] Sraffa is quite explicit as to why this is the case. '... The relative price movements of two products come to depend, not only on the "proportions" of labour to means of production by which they are respectively produced, but also on the "proportions" by which those means have themselves been produced, and also on the "proportions" by which the means of production of those means of production have been produced, and so on. The result is that the relative price of two products may move, with the fall of wages, in the opposite direction to what we might have expected on the basis of their respective "proportions"; besides, the prices of their respective means of production may move in such a way as to reverse the order

1/ Sraffa (1960), pp. 12-15.
2/ Pasinetti (1977a), pp. 82-84,136 & 142, and Schefold (1976a).

of the two products as to higher or lower proportions ...'[1]

This passage indicates Ricardo's mistake. He does not properly allow for the revaluations of the means of production which will in general occur when there is a change in the numeraire wage. Typically he works out the effect on prices assuming that the value of the means of production in each line of activity remains unchanged.[2] It also indicates that Ricardo's calculation of the change in the rate of profit which results from a change in the numeraire wage is bound to be incorrect. Consequently, not only did Ricardo fail to realise that a value theory, as he thought of it, was irrelevant to his problem, but in developing his value theory he proposed relations which were inconsistent with the formulation of the correct solution.

This is the basic flaw of Ricardo's procedure, but there is also another. Even if Ricardo had allowed for revaluations, the categories in terms of which he worked were such that they would not have been correctly calculated. Ricardo worked in terms of capital aggregates; in particular, in terms of 'fixed' and 'circulating' capital. These are not arbitrary categories, as they are defined by different speeds of turnover or durability. However, to develop a logically sound theory of the rate of profit, no utilisation of such capital aggregates will suffice, except in special cases. Two commodities which are means of production in the production of some third commodity may have the same degree of durability in this function. But their own production conditions may be very different. In such a case, as Sraffa's reduction procedure makes clear, the revaluations which occur, given a change in distribution, will be very different. In short, knowing the

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1/ Sraffa (1960), p.15.

2/ See, for example, (Works I), pp. 35 and 57-58.

role which commodities play as means of production is not sufficient to understand their position within the economic system as a whole, and it is this which is required to formulate a sound theory of capital and profit.

(vii) Ricardo's Generalisation: The Invariable Standard

In section (vii) of the previous chapter it was shown how Ricardo sought to generalise his theory of profit in a more satisfactory way than that allowed by the labour theory of value by means of a concept of an 'invariable standard of value'. It was also pointed out that, although both the concept and the problems he sought to deal with using it were ill specified, nevertheless, they could be given a meaning within his conceptual framework.

Sraffa's own analysis appears to have a direct reference to the evaluation of Ricardo's endeavours in this area. He refers to the standard commodity numeraire as an 'invariable standard of value'.[1/] formulates its construction in Ricardian terms, [2/] and explicitly relates its origin to Ricardo's analysis.[3/4/] Furthermore, although Sraffa's own

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1/ Sraffa (1960), p. 32.

2/ Sraffa (1960), pp. 12-17.

3/ Sraffa (1960), p. 94.

4/ The properties of Sraffa's standard commodity numeraire do, however, rest on a treatment of wages different from that of Ricardo. Sraffa's use is based on wages being paid from surplus, ex post.

claims as to its properties are specific and limited, others have been less restrained.[1/]

There is but one property of 'invariance' that Sraffa's standard commodity processes in distinction from all other commodities. This is the invariance of its price, measured in any numeraire, in relation to the value of its means of production when distribution changes. It has this property because its means of production are made up solely of units of itself. Obviously no price can change in relation to itself although such a commodity's price can change in terms of any other. This property is unique to the standard commodity and in this sense it is meaningful to call it 'invariable'.

It plays a useful role within Sraffa's framework. Defining it as numeraire means that the rate of profit is an inverse linear function of the wage rate. Measuring in any

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1/ On this subject some modern economists have forgotten reason altogether. For example, Blaug maintains that Sraffa 'provides a final and definitive solution to Ricardo's old problem ..., that is, a standard for measuring relative output prices that will leave them invariant to changes in relative input prices, being sensitive only to changes in the underlying techniques of production ... Relative prices measured in ... (the) ... "standard commodity" do not change unless technology changes ... ' Blaug (1974), p. 22; see also, pp. 26, 30 and 38. This is obvious nonsense. Relative prices are independent of numeraire. Measuring in any standard will not change the relation of one price to another. Consequently, if a distributional change alters relative prices in one numeraire it alters them in all numeraires. If they do not change in terms of one numeraire they will not change in terms of any. However, Blaug's statements have the merit of specifying what is supposed to be invariant. Others have been much less forthcoming. See, for example, Hemmings (1962), p. 308, Bose (1975), p. 107, Bharadwaj (1963), pp. 187-90, Dobb (1973), pp. 65-95, Meek (1973), pp. 97-120, Reder (1961), pp. 688 and 691-2, Eatwell (1975b), p. 184 and Stigler (1952), pp. 189-90.

other numeraire does not lead to such a simple relation. In the case of joint production, the rate of profit may not even be a single-valued function of the wage and it can be that as the rate of profit rises, so too does the wage.[1/] Even where each commodity is produced by a single process, so that the rate of profit is an inverse monotonic function of the wage, this relation is likely to be extremely complex in a many-commodity model if the numeraire is picked arbitrarily. Use of the standard commodity as numeraire therefore ensures that the relationship between distributional magnitudes is of a certain regular type and moreover of a particularly simple type. Since much of Sraffa's analysis is concerned with precisely this relationship in diverse types of economic systems, such a numeraire greatly simplifies analysis. It gives unequivocal conclusions regarding the direction and magnitude of a change in one distributional variable consequent on a change in the other.[2/]

Sraffa's standard commodity can therefore stand as a construction quite independently of its Ricardian origins and the problems which concerned Ricardo. However, as noted above, Sraffa does relate this conception to Ricardo and many commentators have claimed that it solves Ricardo's problem. What precisely is the relation?

It is confined to Ricardo's second problem, as explained above,[3/] and provides no leverage on the others. Moreover, in solving Ricardo's second problem it does so in different terms from his own. In particular, no notion of absolute value is implied.

1/ Sraffa (1960), pp. 61-2. See Chapter X, section (v).

2/ One concrete manifestation of this function is the simplification or clarity that it lends to the conceptualisation of the maximum rate of profit.

3/ Chapter III, section (vii).

The 'solution' is as follows. Assuming that the numeraire is picked arbitrarily, prices will alter with a change in distribution if, and only if, they differ with respect to their labour/means-of-production ratios. If there were no differences, there would be no price changes.[1/] Prices change to eradicate 'deficits' and 'surpluses'. If they did not change, the production of some commodities would be in 'deficit' in the sense that their prices would be insufficient to cover costs of production, including wage and profit costs at the new rates. Other commodities would be in surplus. In the case where the numeraire is a commodity other than the standard commodity this function of price changes can be split into two. Not only does the price of a commodity have to change so that its production, and the production of other non-numeraire commodities, involves neither deficits or surpluses, but prices also have to change to eradicate any deficit or surplus in the production of the numeraire. By definition the numeraire has a price of unity which is invariant to a distributional change. Consequently, when a distributional change occurs which leads to a surplus or deficit in the production of the numeraire commodity, balance can be restored only if the prices of its means of production change appropriately. This means that its surplus or deficit eradication relies entirely on changes in other prices.

This indicates the uniqueness of the standard commodity. If the standard commodity is the numeraire, this second function of price changes has no role to play. Since the standard commodity's means of production are units of itself, their prices cannot change. It follows that the changes in

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1/ Sraffa (1960), pp. 12-17.

profit and wage costs exactly offset each other and all price changes occur to eradicate deficits and surpluses in the production of commodities other than that of the numeraire. Therefore, it is meaningful to say that the standard commodity numeraire is an 'invariable standard of value'. 'It is true that, as wages fell, such a commodity would be no less susceptible than any other to rise or fall in price relative to other individual commodities; but we should know for certain that any such fluctuation would originate exclusively in the peculiarities of production of the commodity which was being compared with it, and not in its own ... (We therefore possess) ... a standard capable of isolating the price movements of any other product so that they could be observed as in a vacuum'.[1/]

Sraffa's 'invariant standard' provides no solution at all to the other problems Ricardo tackled in terms of such a concept. The first and third problems[2/] are simply outside the scope of Sraffa's framework, for they involve changes in processes of production. When this occurs so will the composition of Sraffa's standard. Also, while Ricardo's own solution to the first problem is correct, no solution to the third is possible for it seeks to measure changes in labour values indirectly through changes in prices, in a context where labour values and prices are subject to different influences of change.

The fourth problem[3/] is, in fact, Sraffa's own interpretation of Ricardo's analysis. It is, therefore, not surprising that others have maintained that Sraffa's

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1/ Sraffa (1960), p. 18.

2/ See above, Chapter II, section (vii).

3/ See above, Chapter III, section (vii).

standard relates to this problem and that using Sraffa's standard as numeraire will preserve constancy of aggregate income in the face of a distributional change.[1/] However, it is easy to see that it does not possess this property. Non-basics do not enter into the standard commodity but, measured in its terms, will change in price with a change in distribution. National income can, therefore, change. Even in a system completely composed of basics the same result occurs. For example, the composition of the standard commodity is unaffected by output levels if there are constant returns to scale. If national income were to remain unchanged, in the face of distributional change, at one set of output levels, it would not remain constant at another, for counteracting price movements, operating at the former level, would no longer balance out. If the actual system were in standard proportions then of course no change in distribution could alter the value of national income. But outside of this case, if one wishes to keep national income constant in value terms, the simplest solution is to take national income as the numeraire.

Overall then, Sraffa's 'solution' to the Ricardian problems concerned with an invariable standard of value is a highly limited one. Furthermore, no notion of 'absolute' or 'real' value is implied by Sraffa's construction, whereas Ricardo's endeavours stem from a perceived need to establish such a notion. Moreover, what validity there is in the Ricardian theory of profit can, save in cases of joint production,[2/] be shown to be independent of the choice of numeraire.

1/ See, for example, Blaug (1974), pp. 27-8.

2/ See above, section (iv).

(viii) The Ricardian Theory of Rent

Ricardo sought to 'get rid' of the complications of land in dealing with his theory of value through his theory of differential rent. In equilibrium, relative prices equal marginal cost ratios and at the margin of any production, whether it be an extensive or intensive margin, no rent is yielded. The marginal process of production, therefore, involves only wage and profit costs, while rents result as differential surpluses from intramarginal processes.

The marginal processes are, of course, endogenous and only determined once output levels have been fixed. Ricardo has often been criticised for failing to recognise this or, more justly, for failing to specify precisely the demand relations which close the model.[1/] However, Ricardo employs a methodology which takes a set of output levels as given and then considers the relations of the wage, prices and rate of profit.[2/] Although the appropriateness of such an assumption is dubious, given that his problem is essentially historical, from a logical point of view it appears to place in cold storage the complications of land and rent. Sraffa's analysis, however, indicates that this is not the case. Even within Ricardo's highly restrictive framework of fixed outputs, the complications of land and rent will, in general, intrude.

The point can be shown most clearly in the simplest case involving only an extensive margin. Ricardo's implicit assumption throughout his work is that the different kinds of land can be ranked by their 'fertility' independently of

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1/ See, for example, Samuelson (1959a), (1959b), and (1978).
2/ See Chapter III, section (iii).

prices, wages and profit rates. In other words, he believed that the 'fertility' of any piece of land is a technological parameter, so that given fixed outputs the marginal land and the marginal production process are unambiguously determined. This belief is mistaken. Assume that corn alone is produced with land[1/] and that there are n different kinds of land in utilisation. Ignoring the rest of the economic systems, and assuming no joint production or fixed capital, the corn-producing processes can be represented by the matrix equation

$$Ap\ (1 + r) + Ds + fw = cp_c.$$

A is the matrix of produced inputs and is of dimension n X k reflecting that, at most, there are k produced inputs involved. D is an n X n diagonal matrix of land inputs and c is a n element column vector of corn outputs. p is a k element column vector of produced input prices, s is an n element column vector of land rents and f is an n element column vector of labour inputs. r is the rate of profit, w is the wage and p_c is the price of corn.

According to Ricardian differential rent theory one of the elements of s will equal zero. Assume that this is s_n. The other land rentals and p_c are then determined by the relative 'fertilities' or 'productivities' given r, w and p. Ricardo's method of procedure rested on the assumption that this ranking will be invariant to a change in distribution so that in the analysis of value and profit the nth process alone could be considered. This assumption cannot be made.' .... The order of fertility ... is not defined independently of the rents; that order, as well as the magnitudes of rent

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1/ This is the typical Ricardian assumption; see, for example, Stigler (1952), pp. 184 193 and Stigler (1958), p. 333.

themselves, may vary with the variation of r and w'.[1/] Thus, if at one r and w, n is the marginal process with $s_n = 0$, it may not remain the marginal process with a change in distribution. Such a distributional shift will alter the prices of all produced commodities as well as the profit and wage costs of all corn-producing processes. Consequently, assuming, in accordance with differential rent theory, that at least one element of s is zero, rents are determined by the matrix equation, but the relative order can change independently of a change in outputs. The marginal process is, therefore, endogenous and not susceptible to being treated as a constant in constructing a theory of profit.[2/]

This also reinforces the considerations dealt with in section (ii) concerning the generalisation of Ricardo's "corn model" through the device of the standard commodity. All types of land are necessarily non-basics.[3/] Consequently only that 'process which produces corn on no-rent land can enter into the composition of the standard system, since the no-rent land is eliminated from the equation, along with all other "free" natural resources which, although necessary for production, are not reckoned among the means of production'.[4/]

1/ Sraffa (1960), p. 75.

2/ Bharadwaj's defence of Ricardo against Samuelson's criticism on the endogenous nature of the margin is, therefore, invalid. It is true that Samuelson's point is to show that demands will affect the margin but the criticism implied by Sraffa has the same force concerning the endogenous nature of the margin. See Bharadwaj (1978), p. 166.

3/ Sraffa (1960), p. 74.

4/ Sraffa (1960), pp. 74-75.

Since such a process may change with a change in distribution, the standard commodity may itself change with distribution even though there has been no change in the processes operating in a system. It follows that, in such a circumstance, it is not a construction capable of being utilised in the analysis of distribution.

Land is but a particular example of non-produced commodities and what is true of it is also true of others.[1/] Consequently, even if land is excluded, by assumption, from the analysis this does not exclude the problems encountered in this section. To do this would require that the analysis consider only produced commodities.

(ix) Conclusion

Ricardian economics, taken as a whole, suffers severely when evaluated in terms of Sraffa's results. Ricardo did not establish his central propositions concerning profit outside very special cases and the methodology he employed in his attempt to do so was often wrong-headed or redundant. One is left with the distinct impression that Ricardo's logical powers have been exaggerated by most historians of thought.

Nevertheless, Ricardo's achievements must be ranked highly. His main propositions concerning the inverse relation of the rate of profit and numeraire wage, and the rate of profit and diminishing returns, were essentially correct. Qualifications concerning joint production are required but these matters were never raised by Ricardo's critics. His central policy recommendations concerning the freeing of trade and the taxation of 'luxuries' were also appropriate and could

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1/ Sraffa (1960), p. 78.

be established quite independently of his principle of comparative cost. His overall philosophy, liberalism, which underlies his theories and to which many of his conservative anti-capitalist, critics responded, is immune to the limitations inherent in his own analysis.

CHAPTER V

THE MARXIAN THEORY OF EXPLOITATION AND PROFIT

(i) Introduction

The Marxian theory of profit is a refinement of Ricardian ideas. Indeed, Schumpeter designates Marx to be 'Ricardo's only great follower' in this area.[1/] He was, however, a critical follower and used Ricardian analysis for his own distinctive purposes. He considered Ricardo's work to be flawed in both method and substantive propositions, believing the root of this to lie in Ricardo's failure to specify a conceptual structure allowing a precise linking of labour values, equilibrium prices and profit.[2/] Consequently Marx sought to fill this vacuum in Ricardian theory and thereby provide a secure foundation in labour values for the theory of equilibrium prices, capital and profits.[3/] He did so by providing a theory of exploitation whereby it could be shown that

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1/ Schumpeter (1954), p. 596 and 390. See also Meek (1967), pp. 51-74, Dobb (1973), pp. 96-120 and Meek (1977), pp. 149-164.

2/ Ricardo's analysis 'leads to erroneous results because it omits some essential links and directly seeks to prove the congruity of economic categories with one another'. Marx (1862b), pp. 164-5. See also pp. 167-8, 174, 190 and 427.

3/ On this basis he also attempted to derive what he considered adequate theories of circulation, rent and money. See Marx (1885), (1894) and Howard and King (1975).

equilibrium prices were the 'phenomenal form' of labour value and profit the 'phenomenal form' of exploited labour.[1/]

Marxian economics is, of course, much richer than the theory of exploitation and profit. However, these are pivotal to the logic of the whole structure. They provide the categories in terms of which the 'laws of motion' and 'contradictions' of the capitalist system are analysed. Moreover, they allow a classification of the capitalist economy as one based on domination and subject to the conflict of classes with 'irreconcilable' interests. Capitalism is thus subsumed into the theory of historical materialism and dialectical development. Consequently any faults discovered in the Marxian theory of exploitation and profit would have profound consequences for the overall economic and social theory.

The Marxian theory of profit is, however, more than Marx's theory. Although Marxism after Marx has been sterile in this area, significant contributions have been made by other analysts, particularly Bortkewicz[2/] and Seton.[3/] This chapter

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1/ Marx argued that 'reality as it appears' to social actors and theorists in capitalism is deceptive. He refers to 'reality' as hidden or concealed by 'appearance', or 'content' by 'form', or the 'hidden substratum' by the 'phenomenal form'. It is the role of science to penetrate through the former to the latter and explain 'appearances' in terms of the 'reality'. Marx (1894) part (VII). He further argued that all political economy had so far failed to do this adequately. Theories of supply and demand were considered to be solely concerned with 'appearances' and were dubbed as 'vulgar'. Classical political economy, especially Ricardo, was rated much better but it too, whilst laying the foundation, had failed to comprehensively perceive the 'real' structure of determination. This position forms the basis of Marx's theory of false consciousness, fetishism and ideology. See Howard and King (1975), Chapters 1 and 2.

2/ Bortkewicz (1907).

3/ Seton (1957).

will provide an exposition of the Marxian theory interpreted to include this work. Nevertheless, it will be predominantly expositional rather than critical. The evaluation in terms of Sraffa will be carried out in the next chapter.

(ii) The Theory of Exploitation

In contrast to Ricardo, Marx explicitly defines the value of a commodity as its embodied labour content. 1/ Equilibrium price is considered an analytically distinct category. Marx attempts to show how this latter concept can only be understood in terms of the former but there is no equivalence in definition.2/ Furthermore, and again unlike Ricardo, Marx decomposes the labour value of a commodity into three component parts.

1) The value of the physical means of production 'used up' in its production. This is called constant capital and symbolised by c.

2) The value which corresponds to the value of the workers' 'labour power'. This is called variable capital and symbolised by v.3/

3) The value created by workers over and above the replacement of the value of their labour power. This is called surplus value and symbolised by s.

1/ More precisely, Marx defines the value of a commodity as the amount of abstract, socially necessary, labour it embodies. See Marx (1867), pp. 39, 107 and 197. This is no more than a spelling out of the assumptions Ricardo took for granted in defining embodied labour. Since we assume homogeneous labour and consider only equilibrium positions they cause no difficulties. It should also be noted that we consider Marx's theory of value only as it applies to commodities which are reproducible.

2/ See below, section (iii).

3/ In Marx's terminology the worker does not sell his labour but his 'labour power'. He does not sell his 'productive activity' but his 'capacity for labour'. Marx considered this distinction to be crucial for clear thinking and criticised classical political economy for not realising this. See, for example, Marx (1859), pp. 61-62.

The value of any commodity, i, can therefore be written as $c_i + v_i + s_i$. Whenever surplus value is positive there is exploitation and Marx considered this to be a property inherent in the equilibrium of a competitive capitalist economy. He argued that such an equilibrium would be characterised by sufficient unemployment of labour to ensure that the equilibrium wage lay at the subsistence level.[1/] The value of labour power is, therefore, equal to the value of the subsistence wage bundle. It is also assumed that technology is such as to feasibly allow a higher wage rate. Marx deduces from this that surplus value and the rate of surplus value, s/v, will be positive, as labour inputs are required in all production and the subsistence wage is non-zero.[2/]

In the case where the labour theory of value holds, profit in each process would be equal to the surplus value created in that process, assuming prices to be measured in labour units. However, Marx was perfectly aware that equilibrium price ratios will equal ratios of corresponding labour values only under special conditions. Nevertheless, throughout Capital until part II of volume III Marx assumes that the labour theory of value does hold. He does so for three reasons.

1) He wanted to show that the existence of exploitation and profit is consistent with all commodities selling at their labour values. Marx believed that such a demonstration was

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1/ This involves Marx's theory of technical change and the 'reserve army of unemployed', 'the pivot on which the law of demand and supply of labour works'. Marx (1867), p. 639. This is logically deficient in a number of ways. See Samuelson (1957) and Howard and King (1975), chapter 6. However, we ignore this matter and simply proceed on the assumption that wages are fixed at some level below their maximum.

2/ Marx also refers to the ratio s/v as the 'rate of exploitation'.

important for it located the source of profit within productive activity and undermined theories based upon 'unequal exchanges'.[1/] In terms of Marx's categories, provided all commodities are produced under conditions of equal 'organic compositions of capital' (i.e. equal c_i/v_i's), the labour theory of value holds and is compatible with the existence of an equal rate of exploitation and uniform rate of profit.[2/] The rate of profit would equal $\sum_i s_i / \sum_i (c_i + v_i)$.

2) Marx considered that 'commodity production' and capitalist commodity production[3/] initially develop under conditions which ensure that relative prices equal corresponding ratios of labour values. Competitive relations and rational acquisitive behaviour, which together produce an equal rate of profit in all activities, develop historically, and initially labour values determine prices directly quite independently of sectoral organic compositions of capital.[4/]

3) In volume III of Capital[5/] Marx attempted to prove that even with a fully developed capitalist system, involving an equal rate of profit and different organic compositions of capital, the consequent departure of relative equilibrium prices from ratios of labour values was essentially a matter

1/ Dobb (1973), pp. 146-7, and Howard and King (1975), chapter 3.

2/ In analysing a fully developed capitalist system, operating und competitive conditions, Marx always assumes both uniformity in the rate of exploitation and rate of profit. As with Ricardo, the latter condition was considered a property of equilibrium. The former condition results from the assumption that labour is measured in homogeneous units, the wage is uniform and the length of the working day is the same in each activity.

3/ By commodity production Marx means an economic system where producers 'carry on their work independently of one another .... (and) .... do not come into social contact ... until they exchange their products' Marx (1867), pp. 72-73. Capitalist commodity production is distinguished by wage labour, i.e. by labour power itself becoming a commodity.

4/ See Meek (1967), pp. 93-112, Meek (1973), pp. i-xliv, Meek (1977), pp. 120-45, and Howard and King (1975), pp. 45-52.

5/ Part II.

of secondary relevance. In particular the propositions which hold under the labour theory of value regarding the determination of aggregate profit by aggregate surplus value and the equality of the rate of profit with $\sum_i s_i / \sum_i (c_i + v_i)$ remain valid. It is to the consideration of this third point that we now turn.

(iii) The Transformation of Value into Prices of Production and Surplus Value into Profit. [1]

Marx's transformation algorithm is simple and, as has been known since the turn of the century, too simple. Assuming the economy is composed of three departments or sectors, and that capital is a purely circulating capital, then the value system can be represented as follows:

Department I $\quad c_1 + v_1 + s_1 = v_1^*$

Department II $\quad c_2 + v_2 + s_2 = v_2^*$

Department III $\quad c_3 + v_3 + s_3 = v_3^*$

v_i^* $(i = 1,\ldots,3)$ represents outputs measured in value.[2] The relation between v_i^* and the output of department i evaluated in prices of production, $v_i^* p_i^*$, where p_i^* is the price/value ratio applicable to department i, and the relation between surplus value and profit, are represented by the following equations.[3]

Department I $\quad (c_1 + v_1)(1 + r) = v_1^* p_1^*$

Department II $\quad (c_2 + v_2)(1 + r) = v_2^* p_2^*$

Department III $\quad (c_3 + v_3)(1 + r) = v_3^* p_3^*$

$$r = \sum_i s_i / \sum_i (c_i + v_i)$$

1/ What we have called 'equilibrium price' Marx calls 'price of production' in Capital.

2/ v_i^* does not necessarily represent unit labour values. Marx, like Ricardo, assumes that outputs are fixed.

3/ Marx (1894), pp. 155 - 157.

It follows that aggregate surplus value necessarily equals aggregate profits, and aggregate output measured in values equals aggregate output measured in prices of production. Value magnitudes, therefore, determine price and profit magnitudes in the aggregate. Furthermore, prices of production deviate from values in a systematic fashion. The department with an average organic composition of capital would have a price/value ratio equal to unity. A department with above average composition would have a price of production higher than its unit labour value and conversely for a below average department. Consequently all that is involved in the transformation is a redistribution of surplus value. But it is this, according to Marx, which explains the deceptive 'appearances' created by capitalist relations of production and the development of erroneous, 'vulgar' theories attributing profit to the productivity of capital. 'It is then only an accident if the surplus value, and thus the profit, actually produced in any particular sphere of production, coincides with the profit contained in the selling price of a commodity ... At a given degree of exploitation, the mass of surplus value produced in a particular sphere of production is then more important for the aggregate average profit of social capital, and thus for the capitalist class in general, than for the individual capitalist in any specific branch of production. It is of importance to the latter only insofar as the quantity of surplus value produced in his branch helps to regulate the average profit. But this is a process which occurs behind his back, one he does not see, nor understand, and which indeed does not interest him. The actual difference of magnitude between profit and surplus-value -- not merely between the rate of profit and the rate of surplus-value --.

in the various spheres of production now completely conceals the true nature and origin of profit not only from the capitalist, who has a special interest in deceiving himself on this score, but also from the labourer'.[1/]

The labour theory of value is, therefore, on Marx's argument, essential to the scientific understanding of profit and prices. 'If one did not take the definition of value as the basis, the average profit, and therefore also the (prices of production), would be purely imaginary and untenable. Without ... (the determination of value by labour) ... the average profit is an average of nothing, pure fancy'.[2/] In Meek's words, surplus value provides a 'prior concrete magnitude' determining profit, 'a magnitude independent of market prices which could plausibly be regarded as constituting the ultimate source of profit'.[3/]

Despite these strong claims, however, Marx realised that his transformation algorithm was faulty. It did not represent correctly the price and profit structure of an equilibrium. If the economy is technologically inter-connected, as Marx assumes,[4/] capital inputs have also to be transformed into price magnitudes. The relevant capital magnitudes on which profit is calculated are not labour value magnitudes, but magnitudes evaluated in equilibrium prices. Marx realised this[5/] but never formulated a transformation algorithm that incorporated it. As a consequence a problem was posed.

1/ Marx (1894), pp. 167-168

2/ Marx (1862b), p. 190.

3/ Meek (1977), p. 126. See also p. 151.

4/ Marx is forever pointing to the 'socialisation' of production that occurs under capitalism and an essential aspect of this is an increasing technological interdependence between different sectors. See Howard and King (1975), Chapter 1.

5/ Marx (1894), p. 161.

The first acceptable solutions of the problem were proposed by Dmitriev[1/] and Bortkiewicz[2/]. Bortkiewicz was, historically speaking, the most influential.[3/] He assumed that Department I produced constant capital, Department II produced wage goods and Department III produced luxuries. In addition he assumed stationary conditions.[4/] On this basis he represented the procedure for transformation in the following equations:

$$(c_1 p_1^* + v_1 p_2^*)\ (1 + r) = v_1^*\ p_1^*$$
$$(c_2 p_1^* + v_2 p_2^*)\ (1 + r) = v_2^* p_2^*$$
$$(c_3 p_1^* + v_3 p_2^*)\ (1 + r) = v_3^* p_3^*$$
$$p_3^* = 1$$

The last equation represents a condition specifying the numeraire. It defines the unit of measurement for prices in terms of labour values. Such an assumption is what Seton later called an 'invariance postulate'[5/] linking the units of measurement for prices to the value system.[6/] Bortkiewicz

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1/ Dmitriev (1898).

2/ Bortkiewicz (1907)

3/ Both of these writers were not widely known for many years. Only with the publication of Sweezy (1942) did Bortkiewicz's contribution receive its proper attention. The 'rediscovery' of Dmitriev's work had to wait until the 1960s. See Nuti (1974).

4/ In Marx's terminology he assumed the conditions of 'simple reproduction'.

5/ Seton (1957).

6/ Marx in formulating his transformation algorithm did not explicitly measure prices in terms of labour to compare them with labour values. Instead he normalised prices so that the costs of production, other than profit costs, remained unaffected by the transformation. Such a procedure is valid only under very special conditions. See Morishima (1973), Chapter 7 and Shaikh (1977).

solved these equations to show that p_1^*, p_2^* and r could be represented as functions of the labour value data.[1/]

However, certain problems are implicit in the Bortkiewicz algorithm. In general it will not be true that $r = \sum_i s_i / \sum_i (c_i + v_i)$ or that $\sum_i v_i^* = \sum_i v_i^* p_i^*$ although, given stationary conditions, $\sum_i s_i = r \sum_i (c_i p_1^* + v_i p_2^*)$.[2/] Marx, however, had stated that all these conditions would hold and, more importantly, in developing his theory of the laws of motion had assumed them to hold.[3/] So far as the internal coherence of the Marxian theory of profit was concerned, therefore, Bortkiewicz's 'solution' proved something of a mixed blessing and much debate has been generated as a consequence.

A typical reaction was that of Winternitz,[4/] who asserted that what was of importance was the equality $\sum_i v_i^* = \sum_i v_i^* p_i^*$.

1/ Bortkiewicz (1907), pp. 202-3. The solutions are as follows:

Defining, $f_i = v_i/c_i$ and $g_i = \frac{(c_i + v_i + s_i)}{c_i}$, $i = (1,\ldots,3)$

$$p_1^* = \frac{f_1 p_2^* (1 + r)}{g_1 - (1 + r)} \qquad r = \frac{f_2 g_1 + g_2 - \sqrt{(f_2 g_1 - g_2)^2 + 4 f_1 g_1 g_2}}{2(f_2 - f_1)} - 1$$

$$p_2^* = \frac{g_3}{g_2 + (f_3 - f_2)(1 + r)}$$

It is interesting to observe that neither g_3 nor f_3 appears in the solution for r. The rate of profit is, therefore, independent of the conditions of production in the luxury department.

2/ It is inherent in the Bortkiewicz procedure that all these conditions cannot be met unless both 1) the organic composition of capital in Department III is equal to the social average; and 2) the numeraire or invariance postulate is chosen in terms of p_3^*. Formal proof of this is provided by Seton (1957).

3/ See below, section (iv).

4/ Winternitz (1948). See also, for example, Meek (1967), pp. 143 - 157 and Laibman (1973).

This, it was maintained, was 'the obvious proposition in the spirit of the Marxian system'.[1/] Consequently the fourth equation of the Bortkiewicz algorithm was deleted and replaced by this condition. This also made the assumption of stationary conditions redundant and it was dispensed with, thus apparently allowing of greater generality. Outside special cases, neither $r = \sum_i s_i / \sum_i (c_i + v_i)$ nor $\sum_i s_i = r\sum_i (c_i p_i^* + v_i p_2^*)$ will hold in the reformulated transformation procedure but this was not commented upon by Winternitz. Therefore, all that had really been accomplished was a redefinition of the numeraire without specification of why the change was of significance.

The Bortkiewicz-Winternitz method of transformation was generalised by Seton[2/] for 'the most general n fold subdivision of the economy, in which each product may be distributed among several or all possible uses ....'[3/] It was concluded that 'the internal consistency' of the procedure is 'fully vindicated'[4/] subject to one reservation.

'No doubt the .... (invariance postulates so far considered) ... do not exhaust all the possibilities. There may be other aggregates or relationships with perfectly reasonable claims to invariance whose candidacy has not so far been pressed. But ... the principle of equal profitability in conjunction with any one invariance postulate will completely determine all prices ... and thereby solve the transformation problem. However, there does not seem to be an objective basis for choosing any particular invariance postulate in preference to all the others, and to that extent the transformation problem may be said to fall short of complete determinacy.'[5/]

1/ Winternitz (1948), p. 279.
2/ Seton (1957).
3/ Seton (1957), p. 163.
4/ Seton (1957), p. 176.
5/ Seton (1957), p. 167.

Debate has continued as to what is of importance.[1] The debate has no analytic significance for it is no more than a debate concerning the choice of numeraire.[2] What is important for Marx's theory of profit is that the source of profit is surplus value. This can be shown to be valid quite independently of price normalisation for it has been proved by Morishima and others[3] that, for the cases discussed in this section, positive surplus value (or a positive rate of surplus value) is a necessary and sufficient condition for the existence of positive profits (or a positive rate of profit). This result is appropriately called the Fundamental Marxian Theorem.[4] It is an exceedingly powerful result for it involves both sufficiency and necessity. Consequently, within its frame of reference, any representation of a capitalist economy involving positive profits, whether stated in labour value terms or not, can be shown to involve exploitation.

(iv) The Theory of the Falling Rate of Profit

Marx discusses the tendency of the rate of profit to fall immediately after his analysis of transformation.[5] Consequently, he felt justified in using the formula $r = \sum_i s_i / \sum_i (c_i + v_i)$. We have seen, however, that Marx's transformation procedure is inadequate and moreover that the rate of profit cannot in general be so represented in the Bortkiewicz-Winternitz-Seton method of transformation.

1/ See, for example, Meek (1967), pp. 143-157, Laibman (1973), Howard and King (1975) and Meek (1977), pp. 95-119.

2/ Labour values and equilibrium prices are different categories and the units of measurement of both are necessarily arbitrary in a model without 'money'.

3/ Morishima and Catephores (1978), p. 30.

4/ Morishima (1973), p. 6.

5/ Marx (1894), pt. III

There is, therefore, a major problem associated with Marx's theory which is quite independent of the analysis he provided. The following chapter returns to this issue. Here we assume that conditions are such as to ensure that Marx's formula is valid.[1/2/]

Dividing through by $\sum_i v_i$, $r = e/k + 1$, where e is the rate of exploitation and k the aggregate organic composition of capital. Marx argues that the labour-saving bias inherent in technical change will increase the k. With a given subsistence wage this will necessarily raise e but Marx argues that e will, after some point, increase less rapidly than k so that r will fall.[3/] 'Counteracting influences' are recognised[4/] but are considered insignificant.[5/]

(v) Marx's Method

Marx devoted considerable attention to methodological matters and in several significant ways the procedures he adopted were novel.[6/] However, the essential method involved in the issues discussed above is Ricardian. It is the method of equilibrium analysis, assuming outputs are fixed, and the comparison of equilibria. Values are transformed not into prices but into equilibrium prices, defined in terms of cost

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1/ A sufficient condition for this would be the validity of the labour theory of value.

2/ The use of this formula implies that the wage and rate of profit are always inversely related assuming an unchanging technology.

3/ Marx (1894), p. 305 and (1857), p. 304.

4/ Marx (1894), p. 232.

5/ Marx (1894), p. 236, 239.

6/ Howard and King (1975), Chapter 2.

of production based on uniform wages and a uniform rate of profit.[1/] The theory of the declining rate of profit in no way appeals to matters involving disequilibrium states. Marx uses a formula for the rate of profit which he believes is valid for an equilibrium and recognises that it would not be valid outside such an equilibrium.[2/] Consequently, his dynamic theory has the status of equilibrium comparisons. Sraffa's analysis is, therefore, directly applicable to an evaluation of Marx's work.

1/ Meek (1967), p. 145.

2/ Shoul (1957).

CHAPTER VI

THE MARXIAN THEORY OF EXPLOITATION AND PROFIT: AN ANALYSIS IN TERMS OF THE 'PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES'

(i) Introduction

The role of the labour theory of value within the Ricardian scheme was that of a device used to generalize a theory of profit which had initially been formulated in a special context precluding the need for valuation. It was, however, an analytically unnecessary device. In the case where each commodity was produced by a single process, the substance of Ricardo's theory could be generalized without the need for explicit valuation intervening. In cases involving joint production, the theory met with a possible exception, but again, the matter can be dealt with without a theory of value as Ricardo perceived it.[1/]

Within the framework of the Marxian theory of profit the labour theory of value holds a more fundamental position. It is, of course, true that Marx emphasizes more explicitly and strongly than does Ricardo the defects of the labour theory as a predictive theory of price.[2/] Moreover, Marx never suggests, nor does he require, that ratios of labour values 'approximate' ratios of equilibrium prices. But this is only an indication of the more profound role that labour values play in the Marxian system. It is because Marx considers he can express equilibrium prices and profits in terms of labour values and that the labour theory is strictly valid for aggregative relations that he has no need to retain the Ricardian features.

1/ See chapter IV, section (iv).

2/ Marx (1862b), chapter X.

In this sense Marx is more theoretical than Ricardo; and it is why the Sraffa-based critique of Marx is so much more fundamental. The defects that the Sraffa analysis exposes in the labour theory of value extend right to the heart of the Marxian scheme, in a way that they do not in the Ricardian case.

(ii) Indeterminate, Negative and Zero Labour Values

We have seen above [1/] that in Sraffa systems involving joint production labour values may be indeterminate, negative or zero. In itself, this has no direct significance for the Marxian theory of profit for Marx is not concerned with labour values, per se, but with the derived magnitudes, c, v, s, c/v, s/v and s/c + v. However, if the primary concept is inadequate so, too, will be the derived concepts. And the possibility of indeterminacy, negativity and vanishing labour values do make labour values inadequate primary concepts, given Marx's purpose of demonstrating a precise relationship between exploitation and profit. Following Ricardo, Marx implicitly assumes that labour values are well defined, non-negative magnitudes which are positive for all produced commodities. Furthermore, he is required to make such assumptions. Without them the derived labour value magnitudes may also become undefined, vanish or be of the 'wrong sign'. In such cases Marx's proposition cannot be expressed or cannot be expressed in a sensible way. The three numerical examples provided in Chapter III are quite sufficient to demonstrate this.[2/]

1/ Chapter IV, section (v).

2/ See chapter IV, section (v).

In the first example the labour value of both commodities is undefined. It follows that all of Marx's derived value magnitudes are undefined. Consequently, all propositions made in their terms are vacuous. In the second example both labour values and all the derived magnitudes are defined.[1/] However, the variable capital magnitudes are of perverse sign as is the rate of exploitation. In the third example, the surplus value generated by both processes is zero so the rate of exploitation is also zero.[2/] These last two examples, therefore, show that the fundamental Marxian theorem[3/] will not cover cases involving joint production. Positive surplus value is not a necessary condition for positive profit and a positive rate of surplus value is not necessary for a positive rate of profit.[4/] Furthermore, Marx's formula for the rate of profit is clearly flawed. In the second example, it predicts a profit rate of -100% and in the third a profit rate of zero. But we know that in both cases the rate of profit is 25%. This indicates that Marx's formula can be incorrect with respect to both sign and magnitude. It follows that Marx's formula does not necessarily even approximate the correct rate of profit.

1/ $c_1 = 6$, $c_2 = -8$, $v_1 = -\frac{1}{2}$, $v_2 = -\frac{1}{2}$, $s_1 = 1\frac{1}{2}$, $s_2 = 1\frac{1}{2}$.

2/ $c_1 = 0$, $c_2 = 12$, $v_1 = 1$, $s_1 = 0$, $s_2 = 0$.

3/ See chapter V, section (iii).

4/ Surplus value is, therefore, not a 'prior concrete magnitude ... which could plausibly be regarded as constituting the ultimate source of profits.' Meek (1977), p. 126.
In the second example above, the negativity of the rate of exploitation results from the negativity of variable capitals. It is easy to construct examples where a negative rate of surplus value results from negative surplus values.
Following Sraffa (1960), pp. 60-61, Steedman (1975) was the first to explicitly point out the possibility of negative surplus value co-existing with positive profits. He did so, however, in the context of Sraffa systems which were assumed to be in steady state growth. It is unclear why this complication was introduced for it is quite redundant to establishing the point.

(iii) The Rate of Profit

Marx's formula for the rate of profit is seriously flawed even in the absence of joint production. It involves the summation of surplus values, constant capitals and variable capitals over all processes. We know, however, that non basics are irrelevant to the determination of the rate of profit. Marx's formula, therefore, includes redundant data.

Dividing through by variable capital, Marx's formula can be written as $e/k + 1$, where e is the rate of exploitation and k is the economy-wide organic composition of capital. e depends on the productive conditions in wage good industries alone. The 'value of labour power' is determined by the labour value of the real wage. The surplus value generated by each worker is given by the difference between this and the length of the working day, which is uniform in all processes. The rate of surplus value is, therefore, completely independent of the non-basic sectors of the economy. However, k is not, for it is the economy-wide organic composition.[1/]

Even in the case where non-basic or luxury sectors are non-existent, Marx's formula is still incorrect. The rate of profit can obviously be represented as $p_s{}^*s^*/p_k{}^*k^*$ where s^* is the column vector of commodities forming profit measured in units of embodied labour (so that the elements represent surplus values); k^* is the column vector of commodities as inputs,

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1/ It follows that when Marx criticised Ricardo for maintaining that the production conditions of luxury industries were irrelevant to the determination of the profit rate, (1862b), pp. 349, 423, 431, he was criticising the logically correct position. Marx himself was deceived by the false 'appearances' generated through his conceptualisation in terms of labour values!

including wage payments to workers, again measured in units of embodied labour; p_s^* and p_k^* are row vectors of equilibrium price/value ratios. In general, the p_s^* and p_k^* will not be such that $p_s^* s^*/p_k^* k^* = i_s s^*/i_k k^*$ where i_s and i_k are row sum vectors. If they were equal for one particular case of production time structures, they would not be equal for another. Labour values are aggregates of dated labour components and the composition of the latter necessarily affects the price/value ratios.

In fact, Marx's procedure is deficient in a more basic way. Like Ricardo, Marx uses aggregate capital magnitudes. The non-wage elements of capital are aggregated in each process, and over different processes, into constant capital magnitudes. Similarly, elements of wage capital are aggregated into variable capitals. Such aggregation by labour values would only be permissable if the price value coefficients of each element of constant capital were the same and if price/value ratios of each element of variable capital were the same. 'Since some commodities enter both constant and variable capital, this in effect requires that all commodities have the same price/value coefficient, i.e., the prices are proportional to values and the whole ... problem of transformation is absent.' 1/2/

1/ Steedman (1977), p. 68.

2/ We saw above, chapter IV, section (vi), that it was not possible to relate the movement of equilibrium prices, consequent on a change in the numeraire wage, to 'constitutions of capital'. The same point holds regarding Marx's attempt, above, chapter V section (iii), to relate the deviations of prices of production from labour values to sectoral organic compositions of capital. On this, see Pasinetti (1977), pp. 136 and 142.

(iv) Transformation

It has frequently been asserted that Sraffa's analysis 'solves the transformation problem'.[1/] This is important because the problem had previously been examined only in models where each commodity was produced by a single process, so there could be no proper treatment of fixed capital and joint production. However, such assertions have not been supported with a demonstration that this is true, or what restrictions, if any, are required for it to be true.[2/]

The considerations of section (ii) might be thought to have quite disastrous consequences for the deriving of equilibrium prices and profits from data on labour values. Indeed they do. But the implications are not as severe as might appear. Provided labour values are determinate and non-zero it is always possible to undertake such a transformation in terms of a Sraffa system involving only produced commodities. Neither fixed capital or joint production have to be ruled out. Nor is it required that labour values be positive.

The units in which commodities are measured are arbitrary. It is, therefore, possible to take the units to be embodied labour values. The prices of a Sraffa system then become prices 'per unit of labour value' or price-value ratios. Given the wage, similarly specified in terms of labour value, and a normalisation condition for prices, the assumptions on which

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1/ See, for example, Dobb (1961), p. 48, Dobb (1973), p. 161, Robinson (1965), p. 30, Roncaglia (1978), pp. 137-138, and Steedman (1977), p. 33.

2/ Sraffa, of course, demonstrates that for each of his systems it is possible to derive equilibrium prices and a distributional variable from knowledge of technology and the remaining distributional variable. However, that is not a solution to the transformation problem. The transformation problem involves a determination on the basis of labour values, not technological data.

a Sraffa system is built indicates that a solution exists for the prices and the rate of profit. Consequently, transformation is possible.

In the case where there are negative labour values, a negative entry for inputs and outputs would occur. However, this would only indicate that an economically meaningful solution would involve the corresponding price-value ratio being non-positive. In this case the physical quantities of the commodity would be traded for non-negative amounts of the numeraire. Negative labour values, therefore, cause no problems for transformation. But if labour values were undefined, or zero, a transformation would not be possible. It would not be possible to measure commodities in units of embodied labour and price-value ratios would become undefined.

Apart from this, there are other matters which are of significance in understanding the status of the transformation carried out via Sraffa's analysis. So far as the computation of prices and profits is concerned, it clearly shows the transformation problem to be a pseudo-problem. Labour values are magnitudes derived from technology. In order to compute them, technological information is required which, together with the specification of the wage, is sufficient to compute prices and profits. Consequently Samuelson was perfectly correct to characterize the transformation procedure as an 'unnecessary detour'[1/] from a computational or predictive viewpoint. It also follows that Marx was quite wrong to assert that without working from labour values it would be impossible to calculate prices of production and the rate of profit.[2/]

1/ Samuelson (1957), (1970), (1971).

2/ See chapter V, section (iii).

Moreover, when choice of technique considerations is explicitly allowed for, as it is in the third part of Sraffa's work,[1/] it is the case that not only is technology required to determine labour values, but the relevant technology cannot be specified independently of some procedure which determines which techniques are utilised.[2/] Furthermore, such procedures may result in labour values being either underdetermined or over-determined. Determination of labour values requires that there be sufficient processes utilised to solve the equations defining labour values, and we have already given an example where technical choice may preclude this.[3/] Overdetermination can occur if the number of processes used exceeds the number of commodities produced. No such possibility can occur in a Sraffa system, by assumption.[4/] However, at a given wage and price vector more than one system may be equally profitable so that the substance of the problem remains in the Sraffa framework. Each system can define a different set of labour values and if both systems are operated simultaneously labour values will be overdetermined.

This last situation is one in which there corresponds to a rate of profit and price vector more than one set of labour values. The converse situation can also arise. Corresponding to one set of labour values there can correspond more than one

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1/ Sraffa (1960), pp. 81-87. We have already noted, above p.65 that with joint production a choice of technique problem is necessarily implicit. Sraffa recognizes this in part II, but does not explicitly consider its implications.

2/ See chapter IV, section (v).

3/ above, p. 65.

4/ See chapter II, section (iii).

rate of profit and price vector. This is possible if there is joint production.[1/]

It follows from the above that Sraffa's 'solution' to the transformation problem is a highly limited solution. Moreover, even if these limitations are ignored, the economics that lies behind it is not well founded. The rationale of transformation within the Marxian scheme lies in stripping away the deceptive 'appearances' created by the competitive forces of supply and demand. Its main purpose was to show that the source of profits lay in surplus value, and indeed, in surplus value alone, despite the fact that a uniform rate of profit appeared to indicate that it was not exploited labour, but capital productivity, which created profit.

Marx's own attempt to do this went beyond transformation. In addition, he argued that $\sum_i s_i = r\sum_i (c_i p_1^* + v_i p_2^*)$ and that $\sum_i v_i^* = \sum_i v_i^* p_i^*$ which together ensured that $r = \sum_i s_i / \sum_i (c_i + v_i)$. In general both the first two conditions cannot be met simultaneously. Nor indeed can the third. More importantly, surplus value may be negative and, therefore, of the wrong sign. Thus even when transformation can be accomplished it lacks a rational foundation.

Can anything be saved from this wreckage? A consideration of Sraffa's standard commodity indicates that some salvage may be possible.

1/ Sraffa (1960), pp. 61-62.

(v) Exploitation, Profit and the Standard Commodity

In the course of dealing with transformation, Marx indicated that a commodity which was produced with an average organic composition of capital would not only have a price of production equal to its value, but also its conditions of production were sufficient in themselves to determine the rate of profit. In the context of Marx's transformation algorithm this proposition is correct. He computes the profit rate from the formula $\sum_i s_i / \sum_i (c_i + v_i)$ but the same result would occur if instead these aggregate value quantities were replaced by those from the industry of average organic composition. Dividing through by Σv_i, Marx's profit formula becomes $e/k + 1$, where e is the economy-wide rate of surplus value and k the economy-wide organic composition of capital. The average industry is, by definition, the industry with the same organic composition as the economy as a whole, i.e., k. while e is uniform in all sectors. Consequently, the determinants of the rate of profit can be represented either in terms of the aggregate relations of production and exploitation or in terms of those relations as they apply to the industry of average composition alone.

We have seen in the previous sections that Marx was in fact wrong concerning his formulation of determination in terms of economy-wide aggregates. The second representation is also incorrect. The industry he defined as 'average' would not be capable of determining the rate of profit when the transformation of inputs was incorporated into a transformation algorithm. The prices of its means of production cannot be determined independently of the other sectors and without this it cannot determine the profit rate in isolation. Nevertheless, the 'spirit' of Marx's second formulation can be shown to be correct through the use of Sraffa's standard commodity.

In Sraffa's analysis, as in that of Marx, the determinants of the profit rate can be represented in two ways: by considering the conditions of production in the whole system or by considering those of the standard commodity. Moreover, in any Sraffa system involving only produced commodities, a unique standard commodity can be constructed, while the existence of Marx's 'average commodity' would be accidental.[1/] Furthermore, this is true of systems which involve fixed capital and joint production just as much as for the simpler case where each commodity is produced by a single process, which is the case to which Marx's analysis is confined. Also, it is true independently of whether the wage is advanced or paid in arrears. For simplicity in this section we make the latter assumption. However, the use of Sraffa's standard commodity to represent Marx's argument does require in all cases that the wage be measured in units of the standard commodity.[2/]

The physical units in which Sraffa measures the standard commodity are the net product of the standard system when this system employs one unit of direct labour in total. Consequently, the labour value of a unit of the standard commodity is equal to unity.[3/] When it is used as numeraire its price-value ratio is also unity so that it sells at its 'value'. Since its means of production consist only of units of itself their price-value ratios are also unity. The maximum rate of profit (R) is the ratio of net product to means of production.

1/ Marx's 'average industry' is an actual industry. Technology and outputs, which determine the average organic composition of capital, may be such that no actual industry is 'average'.

2/ Without this assumption it could not be assured that surplus value was positive. Without this assurance there is no rationale to the exercise.

3/ The units in which the standard commodity is measured can, of course, always be defined in such a way as to ensure a labour value of unity.

This is necessarily equal to the ratio of the labour value contained in the net product to the labour value of the means of production. Moreover, the rate of profit associated with any wage, paid in the standard commodity, can be meaningfully represented as a ratio of surplus value to the labour value of capital.

The labour value of the net product of the standard system can be decomposed into v_s and s_s, where v_s is the labour value of the wage and s_s the residual surplus value. The labour value of the means of production in the standard system can be symbolized by c_s. Thus, the maximum rate of profit (R) equals $(v_s + s_s)/c_s$. We know that $r = R(1-w)$ and that $(1-w)$ is simply the proportion of the net product of the standard system which goes to profit. Consequently, $r = R(1-w) = (v_s + s_s)/c_s \cdot (1 - v_s/(v_s + s_s) = s_s/c_s$. This is a ratio of exploited labour, or surplus value, to the labour value of capital. Clearly a positive s_s is a necessary and sufficient condition for a positive r, given that c_s is positive.

Meek's conclusion, formulated for systems involving no fixed capital or joint production and where the wage is paid in arrears in terms of the standard commodity, is in fact true for all systems considered by Sraffa which involve only produced commodities.

'Sraffa is postulating precisely the same relation between the ... rate of profits and the conditions of production in his "standard" industry as Marx was postulating between the ... rate of profits and the conditions of production in his industry of "average organic composition of capital" ....

Sraffa's "standard industry", seen from this point of view, is essentially an attempt to define "average conditions of production" in such a way as to achieve the identical result Marx was seeking'. 1/2/

1/ Meek (1967), pp. 177-178.

2/ An alternative 'salvage' operation to that discussed in this section is the one proposed by Morishima (1973), (1974), (1976) and Morishima and Catephores (1978). This involves a redefinition of labour value and exploitation such that a reformulated 'fundamental Marxian theorem' may be retained in the face of joint production. What Morishima calls the 'true' value of a commodity is defined as the minimum amount of labour required for its production, given all the available methods of production and not just the processes actually employed. The value of labour power, therefore, is the minimum quantity of labour required to produce the commodity bundle which forms the wage. Surplus value is the difference between the total labour employed and the value of the total labour power employed. The rate of exploitation is the ratio of the former to the latter. It is proved that 'true' values cannot be negative and that a (reformulated) fundamental Marxian theorem holds even in cases involving joint production.

This approach has serious defects. 'True' values are different concepts from Marxian values. They are determined via a linear programming computation quite alien to the solution of simultaneous equations implicit in Marx's approach; and the computation is carried out in terms of techniques which may never be utilised. Furthermore, they are 'non-additive' and do not allow a commodity value to be expressed as the sum of constant capital, variable capital and surplus value. Since Marx implicitly assumes additivity, and formulates other aspects of his analysis on this basis, an acceptance of Morishima's new concepts would require a reformulation of virtually all of Marx's economics. Of at least equal significance is the fact that the sociological properties Marx attributes to his value concepts (see Howard and King (1975), Chapter 2) cannot be transferred to 'true' values, so that, not only the economics, but the more general social theory, would require extensive revision. In short, Morishima's analysis, despite its ingenuity, is a purely formal one having no more than a nominal connection with Marxian economics. None of this criticism, of course, represents an argument in favour of the reformulation in terms of Sraffa's standard commodity. This, too, has defects. See below, section (vii).

(vi) The Theory of the Falling Rate of Profit

Marx's theory of the falling profit rate was presented in terms of his formula for the profit rate, e/k + 1. It can, therefore, relate only to special cases. The Sraffa-based reformulation of the previous section does not provide a more general foundation. The composition of the standard commodity will, in general, change with technical progress so there is no basis in terms of which comparisons can be made. In addition, Marx's statement of this proposition on the movement of the profit rate is essentially assertive. It rests upon the statement that the rise in the organic composition of capital will, after some point, exceed the rise in the rate of exploitation.[1/] No analysis is provided indicating the conditions which are required for this to occur.[2/] There is, however, no difficulty in showing, through Sraffa's analysis, that Marx's theory is seriously defective.

Marx's position is exactly contrary to that of Ricardo. For Ricardo it is the declining productivity of inputs which result in a falling rate of profit, given a fixed subsistence wage. For Marx, it is the rising productivity of inputs, resulting from technical progress, which leads to the falling profit rate, given the fixed subsistence wage. It follows that the same formal analysis as was used to substantiate the essentials of Ricardo's analysis undermines that of Marx and and the possible exception to the Ricardian case, resulting

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1/ The rise in the organic composition of capital is taken for granted by Marx. It should not have been. See Howard and King (1975), Chapter 6 and Steedman (1977), pp. 124-125, 132-136.

2/ See Howard and King (1975), pp. 205-207.

from joint production, provides the only salvation for Marx.[1/] Since neither Ricardo nor Marx formally incorporated joint production into their analysis, what may be taken as an insight of the part of Ricardo is a blindness on the part of Marx.

It follows that, outside possible exceptions stemming from joint production, if there are no Ricardian diminishing returns,[2/] if the commodity composition of the wage is fixed,[3/] and the economy closed,[4/] then, technological regression rather than technological progress is required to ensure a falling rate of profit. There is, of course, no reason for expecting such regression, especially in a capitalist economy.

1/ See chapter IV, section (iv). For an alternative formulation of the analysis in terms of the wage-profit curves, developed in part 3 of Sraffa (1960), see Samuelson (1972) and (1973).

2/ Rosdolsky (1956), Erlich (1967) and Gusten (1965) have suggested that Marx did supplement his argument with Ricardian elements. There seems to be some evidence for this. However, Marx's main argument certainly does not involve diminishing returns. His exposition of the falling rate of profit occurs before his discussion of land.

3/ As is explicitly assumed by Marx, see chapter IV, section (ii).

4/ Marx refers to foreign trade only as a counteracting influence to the tendency of the rate of profit to fall, Marx (1894), p. 237.

(vii) Conclusion

The Sraffa-based analysis of the Marxian theory of exploitation and profit creates a long trail of destruction and little else.

Marx's criticism of Ricardo for failing to provide an intermediate conceptual structure linking labour values, equilibrium prices and profits may be considered well founded. But his own attempt to fill the vacuum will not suffice. Indeed Marx's own proposed structure of explanation is contrary to some of the analytical advances made by Ricardo. This is particularly true regarding the irrelevance of luxury production to the determination of the rate of profit and the relation of productivity to the rate of profit.

Marx's definition of surplus value and exploitation is precise. However, these definitions will not support the conclusions Marx sought to derive. In particular it cannot be reasonably argued, without important qualifications, that surplus value is the source of profits. Outside special cases, surplus value may become a vacuous concept or endowed with 'peculiar' properties, such as negativity, even though profits are positive. By adopting an alternative treatment, suggested by Marx's concept of the 'average industry', it is true that a relationship between a concept of surplus value and the profit rate can be shown to exist in the 'spirit' which Marx intended. If there is any real support given to Marx by Sraffa it lies here. However, there are several important points to note in assessing the significance of this.

Firstly, neither Marx's own arguments, nor the arguments of Marxists since, have been generally framed in such terms. Instead they have predominantly referred to a concept of

surplus value derived from an analysis of the whole economy.

Secondly, and more importantly, the analysis in terms of Sraffa's standard commodity requires that the subsistence wage bundle consists of units of the standard. The value of labour power, as defined by Marx, is the labour value of the commodity bundle which forms the wage. If this commodity bundle is different in composition from standard proportions, it can embody a labour value sufficiently large to result in the surplus value of the standard system becoming negative. Furthermore, since the analysis of section (v) requires, in any case, that the numeraire wage be measured in the standard commodity, the price relations between the wage bundle, if different in composition from that of the standard, and the standard commodity need determining. This would not be possible without moving outside the confines of the standard system, so that this system alone would not be capable of determining the rate of profit.[1/] To avoid these problems, Marx's treatment of the wage must be abandoned and it must be assumed that the commodity composition of the wage is undetermined so that the wage is simply a numeraire wage. This, however, is not Marx's argument and indeed leads to a third problem.

Any argument which seeks to show that surplus value is the source of profits is exceedingly limited in terms of its causal implications. Steedman puts the point clearly as follows. 'The very fact that the proposition in question "runs both ways" (r is positive <u>if and only if</u> surplus value is positive) means at once that it does not constitute a theory of why r is positive. Any theory of <u>why profits are positive</u>

1/ Those who have argued in favour of reinterpreting Marx's argument in terms of Sraffa's standard commodity seem to have missed these defects. See Meek (1967), pp. 161-178, Medio (1972), Eatwell (1973), (1975b), and Howard and King (1975 pp. 149-156,

will at the same time, be a theory of why surplus value is positive ... the only possible role, in a theory of profits, for the statement that "r is positive if and only if s is positive" is as a final link in an argument the earlier stages of which show why s is positive'.[1/] Marx, of course, has such an argument in the theory of the industrial reserve army of unemployed. But this is so defective on logical grounds, quite independently of its weak empirical basis, that it could no longer be seriously entertained.[2/] Marxists, however, have provided no substitute and are, of course, ill disposed toward Ricardian or neoclassical alternatives.

Fourthly, the significance of the proposition 'exploitation is the source of profits' is in itself far from clear. It has obvious emotive connotations but, although Marx used these for propaganda purposes, they formed no part of the social theory he sought to construct. The analytic significance Marx gave to such propositions was twofold. It established, he believed, an objective foundation for the conflict of classes. Exploitation implied that class interests were irreconcilable within capitalism. Furthermore, the capitalist system was thereby integrated into the general theory of economic change - historical materialism. It is these wider sociological aspects which give the analysis of surplus value its significance for Marx. To establish, or reestablish, the propositions in isolation of these aspects, or independently of an alternative framework which fulfils the same role, leaves the propositions

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1/ Steedman (1977), pp. 58-59.

2/ See Howard and King (1975), pp. 195-203.

on exploitation in search of a rational foundation. This, however, is precisely what much modern work on Marxian economics does.[1/]

Without such a rationale, Marx's theory is, in Samuelson's words, 'an unnecessary detour'. The commodity production equations that define the Sraffa systems, together with the wage, are quite sufficient to determine prices of production, profits and the rate of profits. Marx's value magnitudes are derived from these and for predictive or computational purposes clearly represent a redundant complication.

1/ Morishima (1973), (1974), and Harcourt and Kerr (1978) are particularly good examples of this.

CHAPTER VII

THE NEOCLASSICAL THEORY OF CAPITAL PRODUCTIVITY AND PROFIT

(i) General Characteristics of Neoclassical Economics

In the last third of the nineteenth century the basic conceptual structure of neoclassical economics developed. Since that time it has also been the predominant approach adopted by economic theorists. Its chief characteristics are the following.

Firstly, emphasis is placed on economic agents being decision-makers or choice-makers, rather than social actors whose behaviour is structurally determined. Of course, some neoclassical economists may recognise that sociological matters are important in determining agents' 'choices' but they do not explicitly take account of these in the construction of theory. Agents are classified as consumers or producers and simply assumed to have 'tastes' or 'goals' which, subject to certain constraints, they seek to satisfy in some way. How the content of these tastes and goals arose is not considered. Furthermore, neoclassical economists invariably consider choice-making behaviour from a particular perspective. Decisions are assumed to be the outcomes of optimisation procedures.[1/]

1/ In the early development of neoclassical economics this was synonymous with marginal analysis. Indeed, Blaug (1978), p. 312, goes so far as to state that the 'whole of neoclassical economics is nothing more than the spelling out of ... (the equi-marginal principle) ... in ever wider contexts.' It is, therefore, not difficult to understand why the development of neoclassical economics is frequently referred to as the 'marginalist revolution'. Nevertheless, modern neoclassical general equilibrium analysis cannot be considered marginalist in any fundamental sense. No marginal concept is required in its construction. It may under certain circumstances be stated in such terms but there is no need to do so. Consequently it is inappropriate to consider marginalism to be an essential characteristic of neoclassical economics. See chapter XI, section (viii).

Although it is possible to interpret Ricardian and Marxian economics in such terms, and indeed for critical purposes it may be useful to do so, this would be to impose assumptions not strictly necessary to the structure of this theory. It is more appropriately considered in a different light; agents are classified not as consumers and producers but according to the social relationships in which they participate, and their actions are determined by these relationships. There is, therefore, an explicit sociological basis absent from neoclassical economics.[1/]

Secondly, neoclassical theory considers agents' choices in terms of the concepts of demand and supply.[2/] Consumers' decisions regarding consumption goods and producers' decisions regarding inputs are 'demands'. Consumers' decisions with respect to inputs and producers' decisions over outputs are 'supplies'. The results emanating from producer and consumer interactions depend on these demands and supplies

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1/ See, for example, Howard and King (1975), chapter 2, Schumpeter (1954), pp. 543 and 568, and Meek (1977) pp. 149-175.
Some neoclassical economists, like Walras, did not categorise agents simply as 'consumers' and 'producers' but instead adopted a class typology similar to that of Ricardo and Marx. However, unlike Ricardo and Marx, no specific class behaviour was assumed. Class terminology represented only names to highlight different economic activities and carried no implications of different socially-determined behaviour patterns.

2/ This is true of all neoclassical theory considered in this thesis. However, there is an approach stemming from Edgeworth (1881) which is not formulated in terms of supply, demand and a price system. Instead this approach conceptualises agents' activities as a bargaining process, and has been formalised by modern neoclassical economists in terms of game theory.

and in particular equilibrium prices are determined by their balance. Again, this is not a characteristic of Ricardian and Marxian economics. Instead, equilibrium magnitudes are determined by elements conceived as being independent of demands and supplies; namely, by technology and distributional magnitudes.[1/]

Thirdly, in neoclassical theory the determination by supply and demand is a universal principle. It includes the determination of factor prices. Consequently distribution theory is but a particular application of a more general theory of value. Ricardian and Marxian economics, by contrast, have no such overall determining principle. Equilibrium land rentals are determined by differential surpluses over marginal cost of cultivation,[2/] the wage rate by the costs of producing subsistence and commodity prices by technology, so that profit emerges as a residual surplus.

Fourthly, the structure of causation in Ricardian and Marxian theory is different from neoclassical economics. Exogenous and endogenous variables are different. So far as the theory of value is concerned, both Ricardo and Marx assumed that outputs and a distributional magnitude are exogenous. By contrast neoclassical theorists treated both as endogenous.[3/] In neoclassical theory it is demand and

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1/See, for example, Marx (1867), p. 538 and Ricardo (Works I), pp. 382-385.

2/Marx also develops a theory of absolute rent based upon the divergence of the agricultural organic composition of capital from the social average. See Howard and King (1975), pp. 111-116, 139-141.

3/It is true that early neoclassical economists often took the supplies of all commodities as fixed. This had the effect of emphasising the importance of demand in determining equilibrium prices. However, such an assumption necessarily excludes production activities in the neoclassical framework and is, therefore, of limited interest in regard to this thesis.

supply relations, together with initial endowments, which are considered exogenous, while in the Ricardo-Marx structure these are not explicitly specified at all.

Fifthly, the theory developed by neoclassical economists has been predominantly equilibrium theory. Theories of disequilibrium have received much less attention. Neoclassical theorists have defined equilibrium in various ways, but essentially what is involved in all cases is the notion that equilibrium involves a consistency of intended actions. This consistency allows all actions to be realised simultaneously. An important special case of this condition is one where supply and demand on each market are equal.

Although Ricardian and Marxian economics are similarly equilibrium economics, this concept of equilibrium is not the one which is involved. Instead of a consistency of plans, or the balance of supplies and demands, it is the uniformity principle which is the defining quality. In other words, an equilibrium state is one where wages, prices and the rate of profit are uniform.

These characteristics typify all neoclassical theory. However, within this approach there have always been a number of sub-groups and their differences, particularly in the areas of capital and profit, are important. In this regard we may distinguish the Walrasian, the Austrian and capital productivity theories.[1/] Walrasian theory is examined in chapters XI and XII, Austrian theory is dealt with in chapters IX and X, and the theory of capital productivity is the topic of this and the following chapter.

1/ There is also the Marshallian approach. However, this is of no interest because the partial equilibrium method is inherently incapable of dealing with the main issues involved in the theory of profit.

(ii) The Neoclassical Theory of Capital Productivity

The defining quality of this group of neoclassical theorists is the treatment of 'capital' as a factor of production formally equivalent to other factors like land and labour. It was believed that factor prices vary inversely with relative scarcities and are determined by supply and demand. Consequently the rate of profit, conceived as the price of capital within this approach, declines as capital becomes less scarce and is determined by the supply and demand for capital.

The major theorists involved in the development of this analytical framework are Clark,[1/] Hicks,[2/] Solow,[3/] and Samuelson.[4/] Its roots lie in a particular interpretation of Ricardo's theory of diminishing returns and rent.[5/] Clark considered Ricardo's theory as one in which the composite factor (labour and capital) received a remuneration equal to its marginal product and land received the residual difference between the sum of these payments and total output. He generalised this into the principle that any variable factor received a remuneration equal to its marginal product and any fixed factor received the remainder. Thus, since each factor

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1/ Clark (1899). The propositions of this approach are much older than the work of Clark. See, for example, Schumpeter (1954), pp. 464-469, 656-657, 1032, Dobb (1973), pp. 96-120 and Meek (1967), pp. 51-74. Clark, however, was the first to provide a systematic exposition of these ideas in the 1880s and 90s. Since then it has been the convention to regard him as the principal founder of the theory.

2/ Hicks (1932).

3/ Solow (1956).

4/ Samuelson (1962).

5/ Schumpeter (1954), pp. 674, 868, 936. See also Hicks (1932), p. 112.

may be considered variable or fixed, the principle of marginal productivity is of universal application.[1/] In equilibrium all factors will receive a return based upon their marginal productivities. Given diminishing returns to the employment of any variable factor[2/] and the equality, in equilibrium, of the marginal product of capital with the rate of profit,[3/] it follows that as capital becomes relatively less scarce the rate of profit declines.[4/] This provides a basis for a theory which sees the rate of profit as determined by the supply and demand for capital.[5/]

A requirement for this set of propositions to form an internally coherent whole is that the distributional relations based upon marginal productivity be consistent with the technological relations between inputs and outputs. This implies that the total product be equal to the sum of factor payments when each factor is paid according to its marginal productivity. Wicksteed[6/] and Flux[7/] provided a solution to this problem

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1/ Clark (1899), pp. 188-205. Clark was not alone in formulating this generalisation. It was also accomplished by Wicksteed (1910) and Wicksell (1901). However, Clark's presentation was directly integrated with the theory of capital productivity in contrast to the work of these other theorists.

2/ Clark (1899), pp. 38, 165, 197-198, 208.

3/ Clark (1899), pp. ix-x, 21, 160, 187, 249, 255.

4/ Clark (1899), pp. 184-186.

5/ See below, pp. 133 - 134.

6/ Wicksteed (1894).

7/ Flux (1894).

through the application of Euler's theorem on homogeneous functions.[1/] The Wicksteed-Flux analysis also aided the explicit formulation of the concept of a production function in terms of which the marginal productivity results could be integrated.[2/]

Prior to Hicks,[3/] marginal productivity theory was a theory of input prices. Hicks sought to deal with factor shares and formalised those properties of the production function relevant to this problem in the concept of the elasticity of substitution.[4/] This was used in relation to an aggregate production function, the arguments of which consisted of aggregate capital and labour. Hicks also sought to analyse the distributional effects resulting from a shift in such a production function. In doing so he introduced his famous classification of technical change.[5/] With these analytic developments, Hicks added to Clark's earlier formulation a theory of relative shares in income which involved three determinants, relative input quantities, the elasticity of substitution and the direction of bias in technical change.

Clark and Hicks were both explicit in confining their analysis to stationary states and their comparison.[6/] Thus, although the purpose of both was to analyse a process of capital accumulation the method was one of comparisons. The

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1/ In doing so they opened the debate on what has since become known as the 'adding-up problem'. See Stigler (1941), chapter 12.

2/ Schumpeter (1954), pp. 1030, 1035-1036, 1051.

3/ Hicks (1932).

4/ Hicks (1932), pp. 117-120.

5/ Hicks (1932), p. 121.

6/ Clark (1899), pp. vi, 12, 60, 399-430, Hicks (1932), pp. 6, 113, Hicks (1963), pp. 335-336, 338, 342, 345, 366. See also Schumpeter (1954), p. 565.

rationale for this lay in the belief that 'a comparison of a sequence of stationary states ... (would) ... give a first approximation to a slow process of steady accumulation.'[1/]

Growth was introduced into the capital productivity framework by Solow.[2/] However, this did not involve a significant break with the stationary framework utilised by previous theorists. Solow assumed that there was only one produced commodity which was perfectly malleable and could be either invested or consumed. The decisions as to how much of the commodity to use as capital in the following period and how much was to be consumed could be made at the end of every production period and did not affect the economic processes operative during that period. Consequently the growth path could be conceived as one whose form did not differ from a movement through successive stationary states. Furthermore, Solow made other assumptions which ensured a convergence to a steady state equilibrium. The growth path thereby took the form of a movement between stationary states which differed only by a scale factor.

On the basis of Solow's analysis there developed many further results. Various paths of growth and distributional change could be analysed, each dependent on the assumptions which governed the form of the production function, the type of technical progress, the supply of capital and initial endowments of resources.[3/] Also, associated with this

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1/ Champernowne (1953), p. 77. See also, Schumpeter (1954), pp. 564-565, 868, 929-930, 1022.

2/ Solow (1956).

3/ See, for example, Hahn and Mathews (1964) and Johnson (1966).

theoretical work there were attempts at empirical testing and application. Starting in 1928, Cobb and Douglas used an aggregate production function to explain time series and cross-section data drawn from the U.S. economy.[1/] The results were interpreted as supporting the theory of capital productivity with distribution determined by marginal productivity. Solow[2/] extended this to locate and measure the sources of growth in the U.S. economy. These studies, however, are only the most notable of a large set. In a certain sense they are a tribute to neoclassical economists, for they represent attempts to consider how closely the abstract theory fits the statistics drawn from actual economies.

(iii) Capital

Essential to the theoretical structure of the productivity theorists is a precise conceptualisation of capital. Clark dealt with this at length[3/] but without success. He made a distinction between capital and capital goods. Capital goods are heterogeneous, non-permanent and relatively fixed in areas of utilisation. Capital, on the other hand, is homogeneous, permanent and mobile. It is the entity made up of capital goods, it is reduced as they become obsolete and is increased by investment.[4/] In a stationary economy it is permanently maintained. In a progressive economy it increases in magnitude.

1/ Cobb and Douglas (1928), Douglas (1948)
2/ Solow (1957).
3/ Clark (1899), chapter IX.
4/ Land is included within these categories.

' ... Capital was to denote a fund of abstract productive power ... he thought of it as a physical thing, the meaning of which he tried to convey by analogies. A waterfall consists, in any given fraction of a second, of individual drops of water, but these individual drops pass on and are replaced by others and yet the waterfall as such remains the same waterfall. Similarly ... capital consists at any moment of individual capital goods; those individual goods ... are indeed destroyed and replaced by others, yet ... capital as such remains .... the same .... capital.'[1/]

There is, therefore, a metaphysical aura that surrounds Clark's discussion of capital. Since the marginal product which determines the rate of profit is the marginal product of 'capital',[2/] there is considerable ambiguity as to the exact definition of this marginal product.[3/]

The same lack of clarity in the definition of capital concepts exists in Hicks.[4/] Shove emphasized this in his perceptive review. 'Unfortunately "capital" is not defined and we are not told how quantities of it ... are to be measured, and similarly with "saving". Presumably these are "matters which properly belong to the theory of capital".[5/]

1/ Schumpeter (1954), p. 902.

2/ Clark (1899), pp. ix - x, 21, 160, 187, 249, 255.

3/ Clark, however, frequently measures capital in terms of values; Clark (1899), pp. 119-121, 157. This is the correct procedure, given the results he was attempting to establish. See chapter VIII, section (ii).

4/ Hicks (1932).

5/ Shove (1933), p. 264. In his 'commentary' on the 'Theory of Wages' in 1963, Hicks aggregates capital goods through values. See Hicks (1963), p. 344.

Clark and Hicks are by no means exceptional. It has been a general attribute of those economists of the capital productivity school to be vague as to the exact specification of their concepts of capital.[1/] This was pointed out most forcibly by Robinson in 1953. ' ... The production function has been a powerful instrument of miseducation. The student of economic theory is taught to write $O = F(L,C)$ where L is the quantity of labour, C a quantity of capital and O a rate of output of commodities. He is instructed to assume all workers are alike and to measure L in man-hours of labour; he is told something about the index number problem involved in choosing a unit of output; and then he is hurried on to the next question, in the hope that he will forget to ask in what units C is measured.'[2/]

There is, of course, no difficulty in defining capital as distinct from capital goods. Capital goods can be aggregated into 'capital' in many different ways. The difficulty is not in aggregation per se but in doing so in such a way as to yield the results of productivity theory. The procedure must allow the rate of profit to be an inverse function of the scarcity of capital and to bear a relation of equality to its marginal product.[3/]

Robinson's complaint had the desired effect. In subsequent work, productivity theorists were more precise in the construction of their models. There was a convergence as to the appropriate theoretical formulation: namely, a

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1/ See, for example, Stigler (1941).
2/ Robinson (1953), p. 47.
3/ See chapter VIII, section (ii).

one-commodity model.[1/]

The rationale of this formulation was spelt out most clearly by Samuelson as follows: 'Repeatedly ... I have insisted that capital theory can be rigorously developed without using any Clark-like concept of aggregate "capital", instead relying upon a complete analysis of a great variety of heterogeneous physical capital goods and processes through time ... What I propose to do here is to show that a new concept, the "surrogate production function", can provide some rationalization for the validity of the simple J. B. Clark parables ... We can sometimes predict exactly how certain quite complicated heterogeneous capital models will behave by treating them as if they had come from a simple generating production function .....'[2/]

In other words, Samuelson argued that, despite appearances to the contrary, the one-commodity formulation did not necessarily lead to drastically incorrect results. The distributional relationships of such a model could remain unscathed when its defining quality was relaxed and heterogeneous produced commodities were introduced. As a consequence the one-commodity model could be used as a 'parable' to illustrate relationships that would hold more generally and to interpret actual growth processes and distributional patterns.

In the following section, this 'corn model' formulation of the modern productivity theorists is stated precisely.

1/ See, for example, Solow (1956), Swan (1956) and Meade (1961) and above, p. 122.

2/ Samuelson (1962), pp. 213-215.

The next chapter then applies the Sraffa framework of analysis to evaluate the logic of the whole approach.

(iv) The Model of Modern Productivity Theory

Assume that the following conditions hold:

(1) There exists a commodity which is used as an input, together with homogeneous labour to produce itself. Also, this commodity is the only commodity that can be consumed. We call this commodity 'corn'.

(2) There exists a set of constant returns to scale processes of production ($\alpha, \beta, \gamma, \ldots$). Each process is characterised by the amount of the capital input (corn) and labour input required per unit of output (corn). Thus, for example, we can represent the α process as

$$l_\alpha + k_\alpha \Rightarrow c_\alpha$$

Below we assume $l_\alpha = 1$ for convenience of exposition.

(3) All processes have the same period of production and are 'productive' in the sense that the input of corn per worker is strictly less than the output per worker. In the case of process α this means $k_\alpha < c_\alpha$.

(4) There is no 'free' production. In other words, positive labour and capital inputs are needed to produce positive output.

(5) Corn, as input, is used up in each period of production. In other words, capital is solely of the circulating variety. Net output of corn per worker, resulting from the operation of any technique is represented by the symbol q. In the case of process α, $q_\alpha = c_\alpha - k_\alpha$. In a capitalist economy this is split into property income and wages.

(6) Process β requires a greater input of corn capital per worker than does α but results in a larger net output. Likewise, γ requires a greater input of corn capital per worker and is associated with a greater net output compared to β. However, there are diminishing returns to capital-deepening. If the economy moves from α to β, q increases but the increment is proportionately smaller than the increase in capital.

(7) There are two classes, capitalists and workers. Capitalists own capital, workers supply labour. These categories need not be mutually exclusive.

(8) Competition exists and capitalists are profit-maximisers.

(9) The employed labour force is constant and supplies labour independently of the real wage. It is assumed that wages are paid in arrears.[1/]

(10) The relation between output and inputs is twice differentiable throughout. This implies, among other things, that there is an infinity of processes such that any increase in capital per worker, no matter how small, is associated with an increase in net output per worker.

(11) Given the above assumptions we can represent the model by a smooth continuous production function.

$$Q = F(K,L)$$

Q represents total <u>net</u> output, K total capital and L the

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1/ If wages were paid in 'advance', the wage bill would form part of capital and this would make for complications regarding the representation of the rate of profit. The assumption of payment in arrears simplifies the analysis without greatly affecting the substance of the results with which we are concerned.

total labour force. Constant returns to scale means that if K and L are changed in magnitude to λK and λL, then Q changes to λQ. In symbols:

$$\lambda Q = F(\lambda K, \lambda L), \qquad \lambda > 0$$

If we let $\lambda = 1/L$ we can write the production function in per capita form as:

$$q = F\left[\frac{K}{L}, 1\right]$$

Defining the function f(K/L) as equal to F(K/L, 1) and denoting K/L by k we then have q = f(k).

Our assumptions mean that this function is 'well-behaved'. This means it has the following properties:

(1) $f(0) = 0$
(2) $f'(k) > 0$
(3) $f''(k) < 0$

We now add two further assumptions:

(4) $f'(k) \longrightarrow \infty$ as $k \longrightarrow 0$
(5) $f'(k) \longrightarrow 0$ as $k \longrightarrow \infty$

These conditions (1) to (5) are usually referred to as the Inada conditions.[1/]

We now investigate the distributional relationships that will hold in an equilibrium. Let 1 denote the price of corn in period 1 with the delivery date of 1. In other words corn delivered in period 1 is the numeraire, so that p_1 equals 1. Let p_2 refer to the price of corn in period 1 with the delivery date of 2. In other words p_2 is the present-value price of corn which will be delivered in period 2. We can define the one period rate of profit on corn as $r_{1,2} = 1/p_2 - 1$. This shows the extra amount of corn which can be received in period 2 per unit surrendered in period 1. It is therefore the rate

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1/ Inada (1963)

of profit at which the commodity, corn, is lent and borrowed over this time.

Corn in period 1 can be transformed through production into corn at date 2. The marginal rate of transformation is represented by the partial derivative $\partial c_2/\partial c_1$, where c_1 represents corn at date 1 and c_2 corn at date 2. The marginal rate of transformation can be used to define the marginal rate of return on investment. The marginal rate of return on a one-period investment from date 1 to date 2 is designated by $i_{1,2}$ and is equal to $\partial c_2/\partial c_1 - 1$. It shows the extra amount of corn that can be had at date 2 if one extra unit of corn in period 1 is used as an input in the production of corn. Since corn is the capital good this rate of return is also the marginal product of capital. This can be represented by the partial derivative $(\partial Q/\partial K)^{1,2}$. Given that Q represents net output we have $i_{1,2} = (\partial Q/\partial K)^{1,2}$. An equilibrium of competitive profit-maximising producers, given our assumptions, implies the equality of marginal transformation rates and relative prices. Therefore, in equilibrium we will have $\partial c_2/\partial c_1 = 1/p_2$. This in turn implies that $i_{1,2} = r_{1,2}$. The analysis may be repeated for any two dates and consequently we can say that $\partial Q/\partial K = r$: the marginal product of capital is equal, in equilibrium, to the rate of profit.

This distribution relation can be represented in terms of the per capita production function since $\partial Q/\partial K = dq/dk$[1/].

1/ $Q = F(K,L) = LF(K/L, 1) = Lf(k)$. Therefore:

$$\frac{\partial Q}{\partial K} = \frac{\partial L(F)}{\partial K} = L\left\{\frac{df}{d(k)}\right\} \cdot \left\{\frac{\partial(k)}{\partial K}\right\} = f'(k)$$

Given any arbitrary k (denoted by k*) the equilibrium rate of interest will be given by the slope of the line tangent to f(k*). Thus in Figure 1

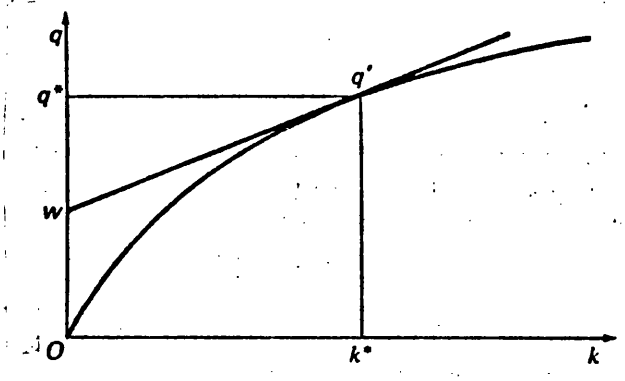

Figure 1

the rate of profit at k* is equal to the slope of the line wq'. In competitive equilibrium the owner of any unit of a factor will receive a return equal to its marginal value product. Thus measuring in corn of the output date, owners of capital will receive total returns equal to $\partial Q/\partial K \times K^*$, where K* is the K appropriate to k*. In terms of the per capita production function this means that profit per worker is represented by q*w and q*w/q* is the share of profit in net income.

Similarly, in competitive equilibrium workers will receive their marginal value products, so that the wage rate (measured in corn of the output date) is equal to the marginal produce of labour. Diagrammatically the wage rate is equal to Ow and w/q* represents the share of labour in income when the capital-labour ratio is k*. This follows from constant returns to scale, which by Euler's theorem, implies that

$$Q = \left(\frac{\partial Q}{\partial L}\right)L + \left(\frac{\partial Q}{\partial K}\right)K$$

So that dividing through by L and rearranging we have:

$$\frac{\partial Q}{\partial L} = q - rk$$

where rk is profit per worker. This ensures that the distributional relations are consistent. Payment of factors according to marginal products exactly exhausts output.

It is clear that as k increases so does q. It is also clear that the proportional increase in q will be less than that of k. Consequently the capital-output ratio rises with k. Furthermore, as k and k/q rise, r falls and w increases, so that r declines as capital becomes less scarce.[1/]

It is useful for subsequent analysis to consider the relationship between the rate of profit and the capital stock from a slightly different perspective. Our production function $Q = F(K,L)$ implies a relationship between r and K because in equilibrium r equals the marginal product of capital and the

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1/ Relative shares depend on the properties of technology summarised in the Hicksian concept of the elasticity of substitution. This is defined as follows:

$$\sigma = \frac{\text{relative change in k}}{\text{relative change in w/r}}$$

$$= \frac{d(k)}{k} \Big/ \frac{d(w/r)}{w/r}$$

If $\sigma<1$, labour's share increases with capital-deepening. If $\sigma>1$, labour's share decreases, and when $\sigma = 1$, labour's share is a constant. The reason is straightforward. For example, when $\sigma = 1$ this indicates that a 1% increase in the wage rate relative to r will lead to a substitution of K for L to the extent that k increases by 1%. Consequently the increase in K exactly compensates for the relative fall in r. Thus if the production function exhibits a constant σ equal to 1, capital-deepening will preserve relative shares in growing output.

amount of labour is always fixed in supply.

Given our assumptions the rate of profit can be represented as a decreasing monotonic function of K (see Figure 2). This enables us to characterise the model in a number of ways:

(i) The curve dd can be taken to represent a demand curve for capital. It shows, given any rate of profit, the amount of capital which capitalists in aggregate would plan to utilise in production when the whole economy is in equilibrium.

(ii) The d.d. curve is not only negatively inclined but also asymptotic to both axes and continuous throughout. This ensures that given any supply of capital an equilibrium exists and is unique.

(iii) The rate of profit can be taken to represent the price of a unit of capital service over a period defined by the production cycle, i.e. its net rental. The rate of profit is the price that would be paid for the loan of a unit of corn capital when the unit of corn is fully restored to the lender in the following period. As capital accumulates (which is equivalent here to capital-deepening) this price decreases. It could therefore be said that this reflects the declining relative scarcity of capital.

(iv) In this model the marginal product of capital is a determinant of the rate of profit. Alternatively, given a supply of capital, the marginal product of capital determines the rate of profit. The rationale of such statements lies in the fact that the marginal product of capital in this model is a technical relationship between physical quantities of

corn. Since technology is an exogenous component of the model so, too, is the marginal product of capital.

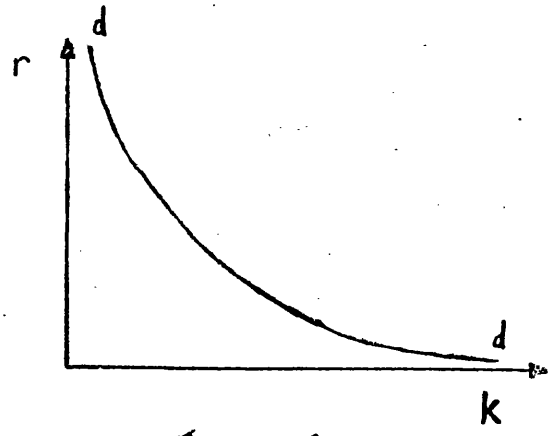

Figure 1

CHAPTER VIII

CAPITAL PRODUCTIVITY AND SRAFFA'S 'PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES'

(i) Sraffa, Neoclassical Economics and the Productivity Theorists

The discussion of the general characteristics of neoclassical economics in section (i) of the previous chapter indicated that Sraffa's analytical framework corresponds much more closely to Ricardian and Marxian theory than it does to the neoclassical. It was argued there that the defining qualities of neoclassical economics involved viewing economic agents as optimising choice-makers, whose decisions were considered as 'demands' and 'supplies' which could be used as general principles for all economic explanation. None of these are important analytical elements of Ricardian and Marxian theory. This is even more true of Sraffa's work. While it is possible to see the neoclassical characteristics as embryonic in Ricardian and Marxian theory, as indeed many neoclassical historians of thought have done, it is clear that in Sraffa's framework they have no role at all. There is no reference whatsoever to economic agents or to their choices. 'Supplies' and 'demands' are never mentioned, so there is not even any indirect reference to their existence. Furthermore, following Ricardo's and Marx's theory of value, Sraffa analyses the relationships of economic systems assuming given outputs and a uniform wage, rate of profit and commodity prices. Neither Ricardo or Marx explicitly consider such a state as one involving a consistency of intended actions, and this is also

characteristic of Sraffa's work to an even more marked extent. Ricardian and Marxian theory can be interpreted as implying such a consistency so that neoclassical ideas exist, as it were, in an underdeveloped form. But this is not so in the case of Sraffa, who was writing after neoclassical theory was well developed and must, therefore, have deliberately chosen to exclude these considerations.

There would, therefore, appear to be a much more pronounced problem in developing a Sraffian evaluation of neoclassical theory than arose in the case of Ricardo and Marx. Nevertheless, as far as neoclassical productivity theory is concerned, these difficulties are easily surmounted. The key to this lies in the form of equilibrium utilised in this approach. All productivity theorists have conceived of equilibria as embodying the uniformity principle; in each time period wages, prices and the profit rate are taken as the same as in other time periods. Even if neoclassical productivity theorists had not done this, there would still be no major problem, owing to the importance which stationary and steady state analysis played in their work. A steady state, irrespective of whether it is stationary or not, can always be sustained as a competitive equilibrium by a price system incorporating the uniformity principle.[1/] Their propositions ought, therefore, to cover such a possibility.

Furthermore, there is a consistency between other aspects of the systems analysed by neoclassical productivity theorists and the assumptions on which Sraffa builds his analysis. This form of neoclassical theory concentrates on the production sub-system of an economy. Consumption

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1/ Bliss (1975), pp. 88-91, Dixit (1977).

activities play no significant role. In addition, and in contrast to Austrian theory[1/], the intertemporal aspects of production are not emphasised, so that each process of production is conceptualised as having the same period of production; and, again unlike Austrian theory,[2/] no assumption of the productivity theorists excludes the existence of basic commodities. Indeed, the one-commodity model, which emerged as the theoretical framework for the modern theorists of this tradition, necessarily has a basic commodity. As this model was outlined above,[3/] it also incorporates ex-post payment of the wage which is the same assumption as that employed by Sraffa.

Consequently, the type of economic system and the form of equilibrium analysed by the neoclassical prodictivity theorists are the same as those analysed by Sraffa. It follows that the formal relationships which exist between the elements of such systems in equilibrium will be the same, irrespective of the framework in which they are incorporated.

This is also true of comparisons of such systems. Instead of analysing a process of accumulation dynamically, neoclassical productivity theory adopted the method of comparisons formally akin to that of Ricardo and Marx. Thus, for example, the relation between the rate of profit and the scarcity of capital is, in this approach, a relation derived from comparing equilibria which differ in capital intensity. Sraffa's analysis incorporates a comparison of equilibria[4/]

1/ See below, Chapter IX.
2/ See below, chapter IX.
3/ Chapter VII, section (iv).
4/ Sraffa (1960), especially part III.

and, again, the relationships deduced will be the same as those which apply to neoclassical theory.

Thus, while the underlying analytical framework of neoclassical theory and Sraffian theory are different, the relationships which must hold in one must also hold in the other. Given a validly deduced relationship between the economic variables of a Sraffa system, or between economic variables as we compare one system with another, if that relationship does not hold in neoclassical theory the theory is flawed. It follows that the conceptual and analytical framework which generated the erroneous result involves an error. This indicates the appropriate method of procedure. We will use the relationships uncovered by Sraffa to evaluate neoclassical productivity theory. Before doing so, however, the neoclassical theory is in need of some conceptual clarification.

(ii) Capital and the Marginal Product of Capital

In section (iii) of the previous chapter it was pointed out that the early neoclassical productivity theorists did not specify exactly the nature of their concept of capital. It follows that their concept of the marginal product of capital was also ill defined. Analytically, however, this poses no difficulty in evaluating their arguments. Unless capital is defined to be value capital it would not be possible for these arguments to be valid.

The price of a unit of some physical capital's services in equilibrium - its net rental rate - is the rate of profit multiplied by the price of a unit of that capital good. Thus we require the price of a unit of the capital good to be equal to 1 for its net rental rate to equal the rate of profit.

This is, in general, impossible unless the units in which capital is measured are value units. To aid clarity, this point may be stated somewhat differently. The rate of profit is a pure number. It expresses a percentage per unit of time. If a marginal product is to be equal to it, it must be expressable as a pure number. The marginal value product of a unit of physical capital is the (infinitesimal) small addition to the value of net outputs over the (infinitesimal) small addition to the physical capital that this is associated with. It is, therefore, not a pure number except in special cases. To make it such we have to make a unit of capital a unit of value, i.e. to measure capital goods in terms of their values. We can then talk of a marginal product of <u>capital</u> as a pure number and it has a chance of being equal to the rate of profit.

This point raises another. In what prices do we value units of physical capital and output? There will be different marginal products depending on which set of prices are chosen. The solution to this problem lies in the 'comparative' nature of the marginal product concept. The marginal product of capital is formed by comparing two equilibria which are marginally different and it is, therefore, the (limiting) ratio of the increment in the value of output to the increment in the value of capital as we hypothetically move between equilibria. Consequently these increments must be calculated as differences between the values of outputs and capitals of different equilibria where the commodities in each equilibrium are valued at the price system appropriate to that equilibrium.

(iii) The Rate of Profit and the Scarcity of Capital

In section (iv) of the previous chapter it was shown how the rate of profit was inversely related to the scarcity of capital as measured by the size of capital per worker or the capital-output ratio. The question considered in this section is whether this relationship carries over to models allowing heterogeneous commodities. We, therefore, proceed by constructing a model made up of a set of Sraffa systems which mirrors the one-commodity model except for the fact that it allows for more than one produced commodity.[1/]

(1) There is a set of Sraffa systems of production. Each system is comprised of two processes of production. One process denotes a method for producing a capital good and the other produces a consumption good. Each process uses fixed but normally different proportions of labour and the capital good. Both are characterised by constant returns to scale. Thus one system of production can be represented as follows:

$$\begin{aligned} l_1 + k_1 &\rightarrow x_1 \\ l_2 + k_2 &\rightarrow x_2 \end{aligned} \qquad (1)$$

where l_1 and l_2 are unit labour requirements for each process, k_1 and k_2 the unit capital requirements, x_1 a unit of the capital good and x_2 a unit of the consumption good.

(2) Each system of production produces the same consumption good but the capital good is different. All

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1/ The model used in this section is similar to that developed by Sameulson (1962) which set the framework for the subsequent 'Cambridge controversies' in the theory of capital. The results of this section were proved by the Cambridge critics during the course of these controversies. See, for example, Pasinetti (1966) and Garegnani (1966) (1970). However, the significance given to these criticisms, here and later, is different from that attributed to them by these critics.

capital is circulating capital.

(3) In the operation of these processes capitalists are assumed to be profit-maximisers and competitive relations hold between all economic agents.

(4) Each system of production defines a possible competitive equilibrium in the sense that at some wage rate each maximises profits and at that wage rate is thus operated by capitalists.

(5) These equilibria are assumed to be stationary states so that the only net outputs are outputs of the consumption good.[1/] All capital employed is used up and replaced in each time period.

(6) The labour force in each stationary state is the same and is paid at the end of the production period.

In price terms, assuming that the wage is measured in the consumption good and the consumption good is the numeraire, the system portrayed in (1) can be written as follows:

$$\begin{aligned} l_1 w + k_1 p_1 (1 + r) &= p_1 \\ l_2 w + k_2 p_1 (1 + r) &= 1 \end{aligned} \qquad (2)$$

From these two equations we can obtain an equation relating w and r:

$$w = \frac{1 - k_1(1 + r)}{l_2 + (l_1 k_2 - l_2 k_1)(1 + r)} \qquad (3)$$

This indicates the wage rate which will correspond to any profit rate (r) received by capitalists when they are utilising this technique in stationary equilibrium conditions.

1/ This means that the Sraffa systems we are dealing with are of the form which he terms 'sub-systems'. See chapter II, section (v).

w and r are inversely related, i.e. $dw/dr < 0$. This equation can be represented diagrammatically as a 'wage-profit curve'. The three shapes that are possible, given our assumptions, are concave (Figure 1), convex (Figure 2) and linear (Figure 3). Figure 1 represents the case where the proportion between physical capital and labour is higher in the capital-goods sector, i.e.

$$\frac{k_1}{l_1} > \frac{k_2}{l_2}$$

Figure 2 represents the case where the proportion between physical capital and labour is lower in the capital-goods sector, i.e.

$$\frac{k_1}{l_1} < \frac{k_2}{l_2}$$

Figure 3 represents the case of equal physical capital-labour ratios, i.e.

$$\frac{k_1}{l_1} = \frac{k_2}{l_2}$$

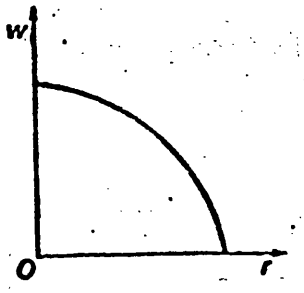

Figure 1

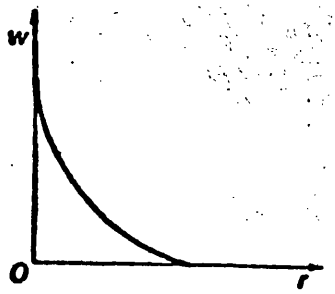

Figure 2

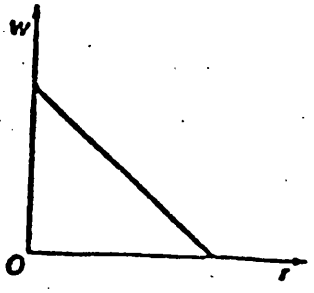

Figure 3

Given a wage-profit curve we can deduce certain properties of the Sraffa system from which it is derived. Take, for example, the case of Figure 1, which is redrawn as Figure 4. Ow_{max} measures the wage rate when the rate of profit is zero. As the maximum w possible when only this system is used it also measures the net physical product per worker when the system is operated in a stationary state, with the consumption good the only net output. Given a wage

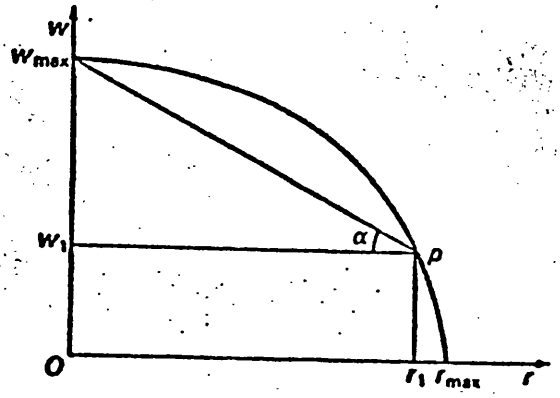

Figure 4

Ow_1, $w_1 - w_{max}$ measures the amount of the consumption good received as profit by capitalists per worker employed. Consequently the tangent of the angle α measures the value of capital per worker at the wage rate of w_1. The value of capital per worker is equal to

$$\frac{\text{profit per worker}}{r} = \frac{w_{max} - w_1}{w_1 p} = \tan \alpha \qquad (4)$$

The value of capital per worker will change with the wage rate in the case above. Since the physical capital per worker is a constant the change in value indicates the changes in p_1 as r changes. Just as we may derive the equation relating w to r above, so we can derive the following equation relating p_1 to r:

$$p_1 = \frac{l_1}{l_2 + (l_1 k_2 - l_2 k_1)(1 + r)} \qquad (5)$$

This shows how the price of the capital good changes as r changes when the system is operated under stationary equilibrium conditions:

$$\frac{dp_1}{dr} \gtreqless 0 \text{ if and only if } l_1k_2 \gtreqless l_2k_1$$

In words, as r increases, p_1 rises if and only if $l_1k_2 < l_2k_1$; p_1 decreases if and only if $l_1k_2 > l_2k_1$: p_1 is invariant if and only if $l_1k_2 = l_2k_1$. The reason for these relations can easily be understood. Consider the case illustrated in Figure 4 in which the physical capital-labour ratio is higher in the capital-goods sector, implying $l_1k_2 < l_2k_1$. An increase in r (and, therefore, a decline in w) involves a shift in income distribution away from wages towards profits. If p_1 remained unchanged, the capital-goods sector would be in 'deficit' in the sense that its price would be insufficient to pay its wage bill and at the same time remunerate capital at the new higher rate of profit. In contrast the consumption-good sector would be in 'surplus'. Consequently, to restore equal profitability to the two sectors, which is a condition of equilibrium, p_1 must rise[1/]. The other two cases can be explained in a similar fashion.

We have assumed that there is more than one Sraffa system of production, and following the above procedure we may determine a wage-profit curve for each. Since the net output of each system is assumed to be made up of the same consumption good and the wage rate is measured in this, all the wage curves can be drawn on the same diagram.

1/ This is called a 'price Wicksell effect' and is a special case of the relations considered by Sraffa (1960), Chapter III.

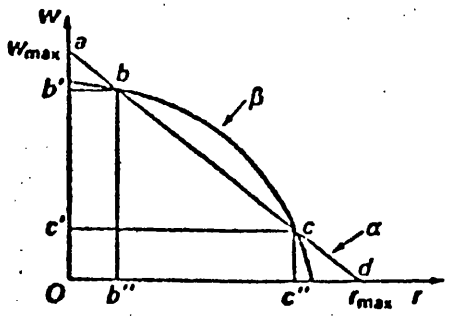

Figure 5

Two such systems are presented in Figure 5. The outer envelope of these curves forms the 'factor price frontier'. In the case represented here it is made up of the section ab from curve α, bc of curve β and cd of curve α. If these are the only systems of production available, the frontier shows the maximum r associated with any wage or the maximum wage associated with any r. Since the systems of production represent stationary competitive equilibria the operation of a given system by capitalists must imply that that system maximises profits. Consequently, with w in the range b'c', system β would be chosen and outside this range system α. At points b and c both systems are equally profitable. Such a point is called a 'switch point'. If the wage rate were at c' or b' capitalists would not strictly prefer to use either of the two systems represented.

This example indicates immediately that the neoclassical productivity theorists' conception of capital-deepening is not going to hold without exception. Figure 5 exhibits what is called 'reswitching' or 'double switching'.[1/] At very high rates of profit (between c" and r_{max}) process α is used. At profit rates below this (between b" and c") process β is used.

1/ This is analysed in Pt 3 of Sraffa (1960)

But at even lower profit rates α is used. We thus have a situation where the same system of production is the most profitable at more than one rate of profit while another system of production is more profitable at rates of profit in between. Associated with this is 'capital reversal', a situation where, as there is a change from one system to another as the rate of profit falls, a lower value of capital per worker occurs. Such a phenomenon is clearly contrary to the neoclassical ideas where higher capital-labour ratios were thought to result as the rate of profit fell. The case represented in Figure 5 is reproduced with the values of capital per worker also indicated. Capital reversal occurs at point c.[1/]

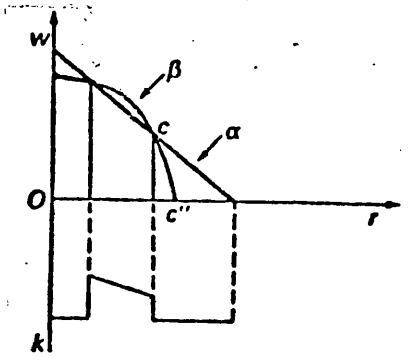

Figure 6

It is true, of course, that the example which has been used is a constructed one. However, it is not an example which is particularly special or fixed. The wage curve of each system depicted in figures 5 and 6 depends on the parameters

1/ It is also easy to demonstrate that lower rates of profit can be associated with lower capital-output ratios, which is again contrary to the neoclassical theory. See below p. 149.

of the system to which it relates.[1/] These parameters can be changed, so shifting the curves, but capital reversal can still occur. In other words, the demonstration of cases contrary to the neoclassical position do not require choosing just the right set of parameters.[2/] Moreover, while in the simple model considered in this section reswitching and capital reversal are always associated with each other, it is possible for capital reversal to occur without reswitching in models involving more complex systems.[3/4/]

It will prove useful for analysis later to consider a numerical example constructed by Garegnani[5/] from Sraffa systems of production of the form which we have considered in this section. Garegnani considers an infinitely large number or 'family of systems' such that: (i) the wage curve of each system cannot contribute segments but only points to the factor price frontier and (ii) the frontier no longer shows any switch points. All switch points are now inside the frontier.[6/] Figure 7 reproduces the frontier so derived together with some

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1/ They are the graphs of equation (3) for each system.

2/ In chapter X an algebraic analysis is given.

3/ This is shown by Pasinetti (1966), Spaventa (1968) and Bliss (1975), pp. 193-194. Blaug (1974), pp. 39-40 discusses the question of how likely it is empirically that reswitching will occur, in the belief that the significance of the Sraffa-based criticism of neoclassical productivity theory is affected by the answer to this. The fact that capital reversal can occur independently of reswitching shows that this belief is erroneous. Even if it were possible to show that reswitching could not occur this would not weaken the criticism for it is capital reversal that is the relevant matter. Blaug's mistaken methodology can be traced to his incorrect view that 'if reswitching does not occur, neither does capital reversing'. p. 41.

4/ The relationship between the rate of profit and relative scarcity of capital is also undermined by the considerations dealt with above, p. 55.

5/ Garegnani (1970).

6/ Pasinetti (1969) and (1970).

members of the family of systems having the frontier as their envelope.

Some values of this construction are presented in Table 1. As can be seen from this there are multiple cases or reswitching. The relationships between r and q, r and k, r and K/Y, and q and k are shown in Figures 8 to 11.

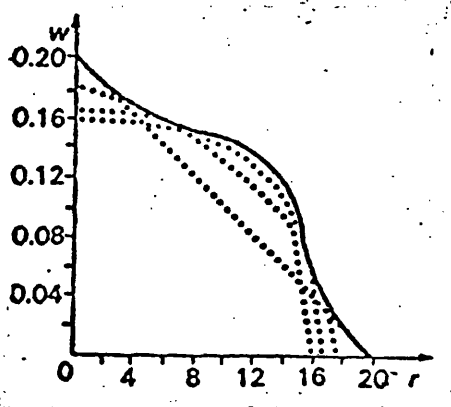

Figure 7

Rate of profit	System in use (i.e. system giving maximum wage)	Wage	Net physical product per worker	Value of capital per worker	Ratio of capital per worker to net physical product per worker
0.0	α	0.200	0.200	1.080	5.400
2.6	β	0.175	0.192	0.635	3.307
4.1	γ	0.169	0.183	0.393	2.147
6.1	δ	0.159	0.175	0.257	1.468
8.3	ϵ	0.151	0.167	0.184	1.101
10.5	ξ	0.144	0.159	0.148	0.930
12.9	η	0.129	0.152	0.179	1.177
14.4	ξ	0.105	0.159	0.379	2.383
15.1	ϵ	0.083	0.167	0.552	3.305
15.9	δ	0.061	0.175	0.715	4.085
16.9	γ	0.041	0.183	0.850	4.644
17.5	β	0.026	0.192	0.947	4.932
20.0	α	0.000	0.200	1.000	5.000

Table 1

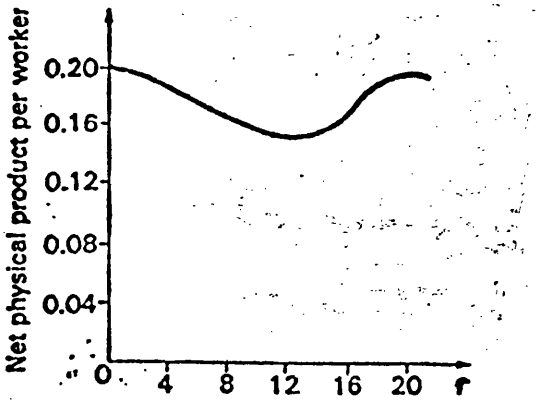

Figure 8

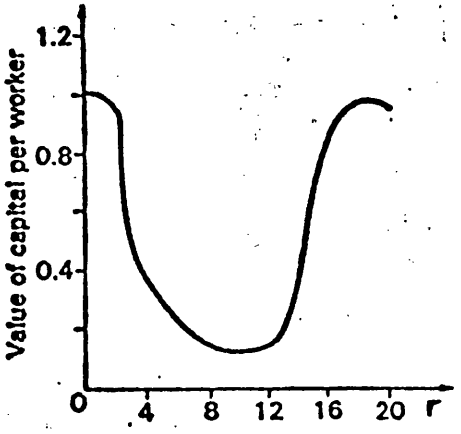

Figure 9

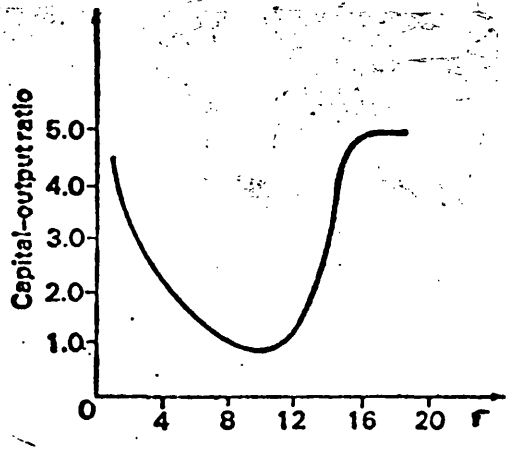

Figure 10

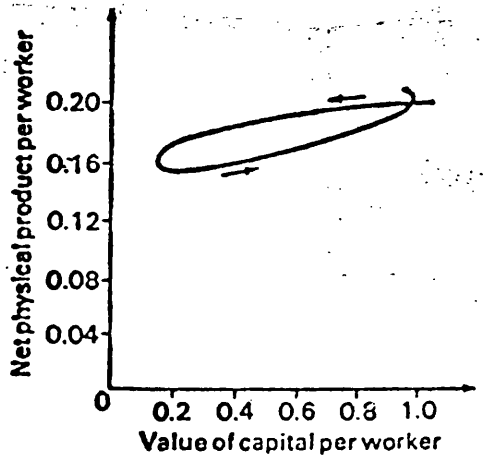

Figure 11

Figure 10 shows a relationship between the rate of profit and the capital-output ratio contrary to the neoclassical position referred to above.[1/] Figure 11 shows what figure 6 indicates, that it may be impossible to construct an aggregate production function where output per worker is a function of value of capital per worker. In Figure 11 we do not have a functional relationship: q is not uniquely associated with k.

1/ p. 146.

(iv) The Marginal Product of Capital and the Rate of Profit

In the one-commodity model of section (iv) in the previous chapter, the marginal product of capital was not only equal to, but also a determinant of, the rate of profit. Indeed, this was a position adhered to by neoclassical productivity theorists in general. Thus, for example, Clark writes, 'One law governs wages and interest - the law of final productivity. By one mode of statement of the law ... We get wages as an amount directly determined by this principle.... By another mode of stating the law ... we get interest as the amount that is positively fixed by the final productivity law .... Wages and interest are both determined by the law of final productivity'.[1/]

This is, in general, incorrect. The dependence of the magnitude of the marginal product of capital on equilibrium prices means that, outside special cases, it cannot be regarded as a determinant of the rate of profit. Equilibrium prices are, in general, endogenous variables and so, therefore, is the marginal product of capital. Marginal products can only be regarded as determinants when they are given exogenously. Consequently the only relation which could possibly hold in the Sraffa-based model of the previous section is the equality between the marginal product of capital and the rate of profit; any causal interpretation is inappropriate.

We can immediately find a case where a marginal product of capital is equal to the rate of profit. Consider a 'switch point' between two systems, as portrayed, for example, in Figure 6. At such switch points the two systems are equally profitable at a common wage. Consequently the increased

1/ Clark (1899), pp. 200-203.

productivity per worker of α over β, expressed as a proportion of the difference in the capital values per worker of the two systems, must be equal to the rate of profit. If we call the (limiting) magnitude of this ratio the marginal product of capital, the relevant neoclassical equality holds. This definition, however, only applies to a switch point. Furthermore, away from a switch point the magnitude of dq/dk will be zero or undefined. Where there are a finite number of systems any system may contribute a segment of points to the factor price frontier. At points on such a segment, but not at an end, if the wage-profit curve was non-linear, capital per worker would change with movement along the frontier but output per worker cannot. Consequently dq/dk would be zero. If the wage-profit curve were linear, neither capital per worker nor output per worker could change and dq/dk would be undefined. The only way to get round this would be to take a case where along any segment of the frontier the number of systems is infinite. In this case, however, switch points cease to be on the frontier and consequently marginal products defined in terms of them have no interest.

Let us now examine the case where systems of production become infinitely large so that the magnitude of change in r required to move producers from one system to adjacent systems is infinitesimally small. The marginal product of capital will now be defined as the limiting ratio of differences in two net products and two 'quantities of capital' corresponding to two different systems, each of which would be most profitable at a different rate of profit. We assume that such a marginal product is always defined. In other words, we assume that,

as in the one-commodity model, the values of capital per head and output per head which are associated with changes in systems of production are continuous and differentiable functions.[1/] This assumption makes the case as favourable as possible for the theory being examined. In other words the procedure will be to compare two systems of production that differ 'marginally' in terms of their outputs per worker, values of capital per worker and the wage-rate of profit sets at which they are most profitable. From this we can define a marginal product and consider its relation to the rate of profit.[2/]

The following condition must always hold, because it is an identity:

$$q \equiv kr + w \qquad (6)$$

q is the net output per worker, k is the value of capital per worker, r is the rate of profit and w the wage rate. If we take the total differential we obtain

$$dq = rdk + kdr + dw \qquad (7)$$

and hence we find that the marginal product of capital dq/dk is not equal to r unless drk + dw = 0, or expressed alternatively, unless k =-dw/dr. Only in special circumstances will this be so, as can be seen from Figure 12. f is a point on the factor price frontier f' f" and the wage-profit curve which contributes that point to the frontier is drawn in as b'b". We know from the identity above that the value of k must be equal to $\tan\alpha$. For the equality dq/dk = r to hold we require that $\tan\alpha$ = -dw/dr at point f. The value of

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1/ This is a genuine assumption. It is not implied simply by allowing the number of systems of production to become infinite

2/ The procedure in the subsequent paragraph follows Bhaduri (1969).

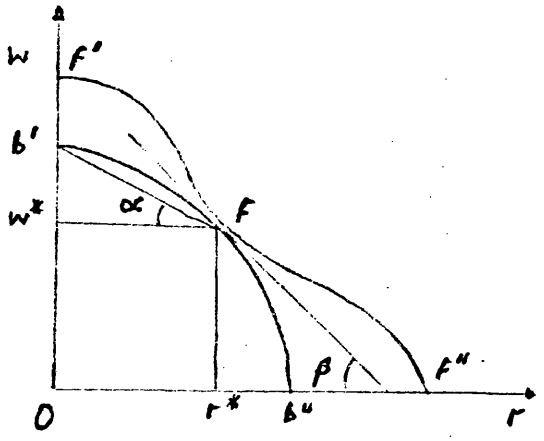

Figure 12

-dw/dr at f is represented by tan β . The figure indicates that in the case of a concave wage-profit curve tan $\alpha \neq$ tan β and the same would be true if the wage-profit curve were convex. In both cases, therefore, the marginal productivity result does not hold.

(v) The Inverse Relation of the Wage and Rate of Profit

The capital productivity theorists shared the belief, held by Ricardo and Marx, that comparing equilibria of economies using the same technology would always show an inverse relation of the wage and rate of profit. Sraffa's result showing that for systems involving joint production this may not hold[1/] is relevant as a criticism of neoclassical theory just as much as it is for the others.[2/]

1/ Sraffa (1960), pp. 61-62

2/ Further discussion of this is undertaken in chapter X, section (v).

(vi) The One-Commodity Model again

The results of sections (iii) to (v) show that the relationships inherent in neoclassical productivity theory are not general. They apply only in special cases like the one-commodity model. The reason why they hold in this particular context is now easy to explain given the previous analysis. The key lies in the form which the wage-rate of profit relation takes; it is linear for each process.[1/] The processes can, therefore, be represented by figure 13.

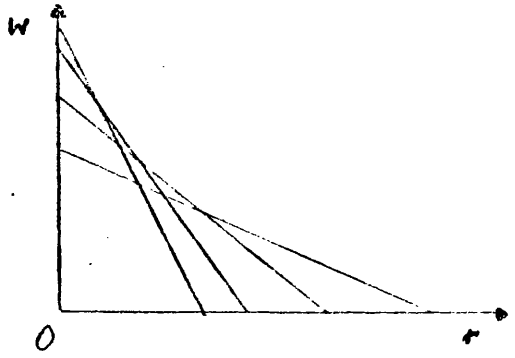

Figure 13

The linearity of each wage-rate of profit relation implies that at any switchpoint the process which is most profitable at a lower rate of profit has the higher capital intensity so that capital reversal never occurs.[2/] This follows simply by applying an equation (4) to calculate capital per worker. Linearity also implies that the marginal product of capital is equal to the rate of profit. Figures 12 and 13 show that $\tan \alpha$ is always equal to $\tan \beta$ in that case. Furthermore, it is valid to regard the marginal product of capital as a determinant of the rate of profit. The rationale for this

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1/ Process i ($i = \alpha, \beta \ldots$), written in price terms, is represented by the equation $l_i w + k_i (1 + r) = 1$; consequently $w = 1/l_i - k_i/l_i (1 + r)$.

2/ Linearity also implies that reswitching cannot occur because a wage-profit curve can never return to the frontier once it has moved away.

lies in the fact that the marginal product of capital in this model is both a marginal physical and a marginal value product and is, therefore, a technical relationship, independent of equilibrium prices, which can be taken to be exogenous. Finally, since the one-commodity model necessarily excludes joint production there is no possibility of any direct variation of the wage and rate of profit. All wage-profit curves have a negative slope.

The one-commodity model is not the only one exhibiting linear wage-rate of profit relations. For example, in the case of the model dealt with in section (iii) the relation for each process will be linear if $k_1/l_1 = k_2/l_2$. However, this is not really a distinct case. A unit of a capital good may be defined as anything we like. Therefore, we can take as units those amounts which use the same amount of capital and labour as that used in the production of the consumption good. Consequently, from a technological perspective, consumption and capital goods are identical[1/] Furthermore, since in this case $dp_1/dr = 0$, p_1 is a constant, thus allowing the marginal product of capital to be treated as if it were exogenous and a determinant of the rate of profit.

(vii) Wicksell

The critical results of this chapter have been derived from a model based upon the analysis of Sraffa. The central fallacy in the neoclassical theory which these results expose

1/ This, in fact, is the case whenever wage-rate of profit relations are linear. This follows because price Wicksell effects are neutral so that relative commodity prices do not change with changes in distribution. Consequently, these prices may be used as weights for non-distorting aggregation into a single-sector macro model.

is the treatment of capital as a factor of production formally the same as land and labour. This is both the defining quality of neoclassical productivity theory and the source of its defects. It is somewhat surprising that it was a point clearly perceived by Wicksell at the turn of the century. 'Whereas labour and land are measured each in terms of its own technical unit ... capital, on the other hand ... is reckoned ..... as a sum of exchange value .... a unit extraneous to itself. However good the practical reasons for this may be, it is a theoretical anomaly which disturbs the correspondence which would otherwise exist between all the factors of production'.[1/]

Furthermore, Wicksell recognised that as a result the marginal product of capital would not, in general, equal the rate of profit. ' ... (the) .. analogy between interest, on the one hand, and wages and rent on the other, is incomplete. With labour and land .... the law of marginal productivity applies ... But this theory only applies to capital, as usually conceived, when we look at it from the point of view of the individual entrepreneur, to whom wages and rent are data, determined by the market. If we consider an increase (or perhaps a decrease) in the total capital of society, then it is by no means true that the consequent increase (or decrease) in the total social product would regulate the rate of interest ... new capital competes with the old and thereby results .... in a rise of wages and rent ..... (which absorbs capital)'.[2/]

1/ Wicksell (1901), p. 149. See also Wicksell (1900), pp. 107-108.

2/ Wicksell (1901), p. 148. See also Wicksell (1900), p. 107.

Here Wicksell is referring to capital stock revaluations which have subsequently become known as 'Wicksell effects'.

What Wicksell failed to perceive, however, is that these effects may operate in such a way as to result in capital reversal. He erroneously believed that when the equilibrium rate of profit fell the associated changes in prices would always operate in the direction of increasing the magnitude of the pre-existing capital stock. As a consequence the marginal product of capital is always less than the rate of profit. This belief stemmed from the model which Wicksell used to derive his conclusions; an Austrian point input-point output model,[1/] in which it is always true that as the rate of profit falls capital intensity rises.[2/] Wicksell's pupil, Ackerman, did perceive that a capital stock devaluation could occur as the rate of profit fell and that the marginal product of capital could be greater than the rate of profit. But Wicksell himself failed to recognise the implications which this had for his own analysis[3/] and Ackerman's work was ignored until recently.[4/]

As a consequence Wicksell continued to believe that capital intensity was an inverse function of the rate of profit. ' ... If we consider society as a whole ... the progressive accumulation of capital must be regarded as economical as long as any rate of interest, however low, exists .....

1/ See chapter IX, section (ii).

2/ Wicksell (1901), pp. 172-184. It is also impossible for reswitching to occur in such a model and the wage is always inversely related to the rate of profit. See chapter X, section (iii).

3/ Wicksell (1923), p. 293.

4/ Ferguson and Hook (1971)

We should, therefore, expect a continual accumulation of capital .... and, at the same time, a continual fall in the rate of interest'.[1/]

Since Wicksell other economists have anticipated these difficulties in neoclassical productivity theory.[2/] But their importance for undermining this body of theory was not generally seen until after the work of Sraffa, when neo-Ricardian and neo-Keynesian economists conducted a comprehensive and rigorous critique upon the basis of Sraffa's results.

(viii) The Determination of the Rate of Profit by the Supply and Demand for Capital

The arguments of sections (iii) to (v) show serious defects in neoclassical productivity theory. However, these arguments do not appear to undermine its central tenet, the determination of the rate of profit through the supply and demand for capital. The arguments certainly destroy the views neoclassical economists held about the operation of these forces but if their analysis had been kept at a high level of abstraction it would appear to remain impregnable to the criticisms so far discussed.

1/ Wicksell (1901), p. 209.

2/ Fisher (1907), Shove (1933), Lange (1936), Metzler (1950), Malinvaud (1953), Robinson (1953), (1956), Champernowne (1953) and Swan (1956).

Indeed, this is the case[1/]. Nevertheless, the analysis which seeks to determine the rate of profit through the supply and demand for capital is seriously defective. Independently of capital reversal, of the inequality between the marginal product of capital and the rate of profit, and of the possibility that the wage and rate of profit may vary directly, neoclassical theory is not tenable. It is not methodologically possible to regard the rate of profit as being determined by the demand and supply of capital.

In neoclassical theory supplies and demands represent the plans of optimising agents regarding choices over commodities. It is these supplies and demands, or choices, which determine the endogenous variables. If capital is specified to be value capital then it does not possess the attribute a commodity must possess for determination by supply and demand to be valid. It cannot, except in special cases, be defined independently of endogenous variables. The unit of measurement is dependent on equilibrium prices and these prices are in general endogenous variables. It is, therefore, not possible to regard economic agents as forming plans (demands and supplies) for capital, the interaction of which then determines its price, the rate of profit. The logical structure of determination requires that the determinants be exogenous and this is impossible in the case of the demand and supply of capital.

1/ Garegnani (1970) argues that this is not so. However, since his argument is levelled at all neoclassical theory and not just that of the productivity theorists, consideration of it is postponed until chapter XII.

Consequently, whatever validity exists in the neoclassical theory of capital productivity must be confined to the relationships which it establishes between economic variables: the capital intensity of an economy, the wage and rate of profit. We have seen, however, that the Sraffa-based critique shows these to be guaranteed only in special cases.

CHAPTER IX

THE AUSTRIAN THEORY OF CAPITAL AND PROFIT

(i) Austrian Economics

Austrian economics is typically viewed as a particular variant of neoclassical theory. This is sensible in that many characteristics of the latter are exhibited in Austrian theory. Emphasis is placed on economic agents being optimising choice-makers and from this are derived demand and supply relations the balance of which defines an equilibrium.[1/] Austrian economics, however, has a number of distinctive attributes which separate it from other neoclassical schools and these are sufficiently important to warrant a separate treatment.

One such characteristic has been the emphasis Austrian economists have placed on the uniqueness of social science and more particularly on the importance of individual subjectivity. This is particularly true of Menger,[2/] Mises[3/] and Hayek.[4/] It has manifested itself in two principle ways, firstly, in an opposition to all theories of value based on a foundation other than that of utility and especially toward those based upon non-subjective costs of production. Secondly it has led to the development of 'methodological individualism', a method that requires all concepts of social theory to be clearly traceable back to individual action.[5/] This, however, has been a source of some internal disagreements within the Austrian school. In

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1/ See chapter VII, section (i).
2/ Menger (1871).
3/ Mises (1949).
4/ Hayek (1955).
5/ See, for example, Lukes (1968), Rizzo (1978) and Eggar (1978).

particular Menger's criticisms of Bohm-Bawerk's capital theory centred on what he considered its erroneous aggregative structure.[1/] It is also the case that much of Hayek's work on capital theory[2/] follows that of Bohm-Bawerk and it may, therefore, be said that in this area some Austrians 'forget' this methodological principle.

Coupled with this first characteristic has been the Austrians' deep suspicion of deterministic economics. This has sometimes led to hostility toward the use of mathematical methods. Menger, Mises and Hayek, in particular, have all emphasized the importance of uncertainty and expectations in economic life and have considered that they cannot be modelled appropriately by mathematical relations.[3/] This emphasis on the importance of uncertainty is shared by a number of post-Keynesians like Robinson[4/] and Shackle.[5/] But Austrian economists differ from these post-Keynesians in that they do not see this as undermining the applicability or importance of equilibrium economics. However, this position has not significantly affected the development of Austrian theory in the sphere of capital and profit. Determinism is a characteristic of the work of Bohm-Bawerk, Wicksell and Hayek. The point is of some relevance to this chapter, nevertheless, because Bohm-Bawerk opposed the mathematical methods of the Walrasian school and sought to distinguish his theory by its 'causal' basis.[6/]

1/ Schumpeter (1954), p. 847.

2/ Hayek (1931), (1939), (1941).

3/ See, for example, Borch (1973), Menger (1973) and Lachman (1976)

4/ Robinson and Eatwell (1973).

5/ Shackle (1972).

6/ 'Both Jevons and the Austrians were in the habit of expressing themselves in causal chains .. this was inadmissable ... (and reflects) ... a glaring inability to understand the logic of interdependence', Schumpeter (1954), p. 922.

This meant that although he was concerned with developing a general equilibrium system he did not do so as explicitly as the Walrasians and as a consequence his theory is less well integrated.[1/]

A third characteristic of Austrian economics has been the enthusiasm for a capitalist economic system composed of competitive markets and a hostility to socialism. This is particularly true of Mises,[2/] Hayek,[3/] Wieser[4/] and many modern Austrians.[5/] It affects Austrian capital theory primarily through Bohm-Bawerk whose work was formulated as an alternative to, and critique of, Marx.

The major distinguishing characteristic of Austrian economics relevant to this chapter, however, is the emphasis on 'time'. There is virtual unanimity among Austrian economists in this respect and it leads to the classification of Jevons and Wicksell as Austrians because of their similar orientation. Moreover, it is this aspect that Hicks has drawn attention to in labelling his current approach to capital theory as neo-Austrian.[6/] Essentially the Austrian view is that economic decisions and processes have a time structure from which it is inappropriate to abstract. This is true of decisions and processes in general but it is particularly important in the area of production.

1/ Schumpeter (1954), pp. 918-923.
2/ Mises (1920).
3/ Hayek (1935).
4/ Wieser (1888).
5/ See, for example, Spadaro (1978).
6/ Hicks (1970), (1973a), (1973b), (1975), (1976).

(ii) Capital, Production and Time

Throughout the history of capital theory, much controversy has been generated regarding the 'essence' of capital. The Austrians conceived of this essence as resulting from capital goods being 'produced means of production' distinguishable from labour and land which were classified as 'original'.[1/] Coupled with this distinction was the Austrian emphasis on capitalistic production requiring time.[2/] Capitalistic production requires that the production of capital goods precede the production of consumption goods . It is the hallmark of Austrian capital theory to link these two characteristics together. As such, capital theory becomes the study of intertemporal production structures. The Austrians were, of course, aware that capital could be conceptualised in alternative ways but they argued that it was inappropriate to do so.[3/]

1/ This distinction is difficult to make precise. It is perhaps more appropriately phrased by saying that in the Austrian view the supply of 'original' factors is not subject to an economic decision. See Gaitskell (1936), (1938). It should also be noted that in this context 'produced' has a wider meaning than when used in chapter II above, p.14. As used in the Austrian sense it simply means that the commodity's supply is the result of a production process.

It is this characteristic that led Bohm-Bawerk to emphasize that capital goods should not be treated on a par with original factors (land and labour) as they were treated by the productivity theorists dealt with in chapter VII; and it is this aspect which forms the basis for Knight's main criticism of Austrian capital theory. Knight (1933) denied that such a distinction between 'original' and 'produced' factors could be sensibly made. Instead all factors should be seen as produced. This point is important for if it is correct it becomes impossible to talk about different degrees of 'roundaboutness' and this plays a key role in most Austrian capital theory. In this chapter and the following one we ignore this matter and assume that the Austrian distinction can be sensibly made.

2/ Capitalistic production is a term used to refer to production involving capital goods, independently of an institutional structure.

3/ See, for example, Wicksell (1911)

Bohm-Bawerk states the Austrian position as follows. 'We put forth our labour in all kinds of wise combinations with natural processes. Thus all that we get in production is the result of two, and only two, elementary productive powers - Nature and Labour, ... There is no place for a third primary resource.'[1/] But through 'these primary productive powers man may make the consumption goods he desires, either immediately, or through the medium of intermediate products called capital. The latter method demands a sacrifice of time, but it has the advantage in the quantity of the product, and this advantage, although perhaps in decreasing ratio, is associated with every prolongation of the roundabout way of production'.[2/]

Thus, in the Austrian view there are two types of 'original' productive power, labour and land. In fact, Bohm-Bawerk simplified his analysis by abstracting from land and regarding labour as homogeneous. Other Austrians have often followed this lead. Capital goods are goods produced with the aid of original factors and are used as intermediate inputs in the production of consumer goods. Capitalistic production is, therefore, indirect or 'roundabout' production. It is undertaken because it is more productive of consumption goods than is direct production.

In order to isolate the intertemporal nature of capitalistic production, Austrian economists have tended to work with specific types of models. They have been prone to use one-sector models in which there is a single final output, conceived as an aggregate value magnitude or as a homogeneous consumption commodity, but in which there exist many production

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1/ Bohm-Bawerk (1888), p. 79.

2/ Bohm-Bawerk (1888), p. 91. See also, Wicksell (1893), pp. 20-21; Wicksell (1901), p. 150, 154; Wicksell (1900), p. 108 and Wicksell (1911), p. 185.

processes by which the output can be produced.[1/] Each such process involves a sequence of 'original' factor inputs applied at various dates. They may be divided into four general types.

(1) The most general is the flow input - flow output process. Original factors are applied at various dates and produce outputs which also occur at various dates.

(2) A specialisation of (1) is the point input - flow output process. Here there is no flow of original factor inputs. Instead they are applied at one date only, although outputs occur at various points in time.

(3) An alternative specialisation of (1) is the flow input - point output type of process. Inputs occur at various dates but output results only at a single date.

(4) The most restrictive special case is to combine the special attributes of (2) and (3) into a point input - point output process.

The earliest Austrian capital theorists, Jevons, Bohm-Bawerk and Wicksell, concentrated their analysis on the latter two types. They were, however, aware of the general framework and did attempt some conceptualisation of the other types of processes, believing that their approach could encompass them all.[2/] Nevertheless, this concentration of analysis on types (3) and (4) meant that fixed capital was excluded from the formal analysis. Fixed capital, within the single-sector framework, implies that inputs yield outputs at more than one

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1/ Such a model is by no means equivalent to the one-commodity model discussed in chapter VII. As we will see in chapter X, section (i), implicit in such an Austrian model are heterogeneous produced commodities in the form of intermediate products or capital goods.

2/ See, for example, Bohm-Bawerk (1888), Book VI, chapters VII and VIII, and Jevons (1871), pp. 231, 238-239.

point in time. It is not durability, per se, that is analytically relevant. It is that fixed capital necessarily leads to intertemporal joint production, the production of the final output at various points in time resulting from one set of inputs.[1/]

Moreover, in considering processes of the third type the early Austrians usually made a number of assumptions concerning the sequence of inputs. Menger classified goods in terms of a linear or vertical ordering and this became typical of much later work. Consumption goods were called goods of 'lowest order' and their means of production were called goods of 'highest order'. In the first (or highest) stage of production,

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1/ It is this concentration on circulating capital processes which links the early Austrians' analysis to a tradition prior to the marginal revolution. They followed the conceptualisation of capital as 'advances' which had been so pronounced in the work of the physiocrats and classical economists. See Schumpeter (1954), pp. 465, 469, 564, 636-637; Stigler (1941), pp. 200, 220 and Jevons (1871), pp. 226-7. The primary difference was that the Austrians, unlike these forerunners, did not accept that the time sequence of production was technologically fixed. They recognised the possibility of substituting 'original' factors for 'roundaboutness'. Hicks (1973a), pp. 12-13, goes further and argues that the link of capital to time has been the dominant view in economic theory and in business practice.

The analytic rationale for this conceptualisation was repeatedly questioned by the productivity theorists, especially Clark (1894, 1895) and Knight (1933). They argued that, in a stationary state, production was synchronised with consumption so that no explicit consideration of time structure was needed. Current consumption could be viewed as if it was a function of current inputs. On this matter see also Schumpeter (1954), pp. 565, 907; Blaug (1978), pp. 196, 549, Stigler (1941), pp. 296, 313; Kuenne (1963), pp. 239-243 and Kaldor (1937), pp. 170-173. Hicks (1974) places the different conceptualisations of capital in a broader perspective.

original factors were seen as producing capital goods of the highest order. These, together with further inputs of original factors, produce other capital goods of second 'highest order'. At the final stage of production, original factors and commodities of second 'lowest order' produce the consumption good (the good of 'lowest order'). Each good, therefore, can be assigned an index indicating its stage in the structure of production.[1/]

It is in terms of this time based framework that Austrian capital and profit theory works. The theorists sought to establish the intertemporal nature of capital, to show the relationship of time structure and valuation, between time structure and capital intensity, and between time structure and distribution.

(iii) Roundaboutness, Period of Production and Equilibrium

The basic structure of Austrian theory was formulated by Bohm-Bawerk.[2/] He accepted the utility theory of Menger[3/]

1/ Such a structure is often called 'triangular' reflecting the form which its input matrix takes. It is to be distinguished from that of Sraffa's representation of production in that no basic commodity exists. Assuming the existence of at least one basic means that there is necessarily a 'whirlpool' production structure and it is naturally no longer linear for no commodity can be indexed by a stage of production. We return to this point in chapter X, section (i).

2/ Bohm-Bawerk (1888).

3/ As one of the three founders of utility theory in the context of the marginal revolution, Menger is distinguished by his explicit application of the theory to factors of production. Consumption goods alone generate utility but, if these goods are produced, Menger realised that their utility may be imputed to the inputs by which they are produced through a process of hypothetical marginal variation. Utility theory thereby became a general theory of subjective value.
Despite the defects in Menger's concept of utility Schumpeter (1954), pp. 914-917, describes this aspect as a 'stroke of genius'. We can see this even more clearly today. Formally, imputation theory may be regarded as anticipating the duality results of mathematical programming.

and married it with an advances conception of capital which he derived from Jevons.[1/] On this basis he developed a theory of profit as an explicit alternative to, and refutation of, Marxian exploitation theory.[2/] The theory is most appropriately seen as covering two levels of abstraction. Firstly, there is a theory of profit or 'agio' of universal application, independent of institutional structure. Secondly, there is the application of this general theory to the institutional structure of capitalism.

The former is presented in terms of utility theory and orientates on time preference. Economic agents, for various reasons, are assumed to have a time preference for present consumption relative to consumption in the future.[3/] Consequently intertemporal exchange ensures that a premium accrues to those who trade present for future consumption. Two principal conclusions derived from this analysis are that profit arises from exchange and that it is a universal economic category which is not historically specific to capitalism. Marx's theory is thereby questioned at its foundations.

Applied to the institutions of capitalism, it is the strength of workers' time preference for present consumption relative to that of capitalists' which ensures profit for the latter. Capitalists can advance consumption goods to workers in the form of wages, engage them in roundabout production processes, and thereby receive a premium on advances made.

1/ Jevons (1871), pp. 226-229.

2/ See Rogin (1956), chapter 14 and Rothchild (1973).

3/ Bohm-Bawerk's 'three grounds' for such time preference have been severely criticised. See, for example, Blaug (1978), pp. 527-534; Rogin (1956), chapter 14; Kuenne (1971), pp. 25-43 and Stigler (1941), pp. 25-43. However, the general thrust of his ideas has been extremely influential, especially through the work of Fisher.

It is in the analysis of roundabout production processes that Bohm-Bawerk builds on Jevons, and, in applying the general theory of profit to the institutions of capitalism, it is on the production structure that Bohm-Bawerk concentrates.

Technically efficient production processes are ordered by their degree of roundaboutness. The more roundabout production processes are more productive of consumption goods per unit of original factor input, but are subject to diminishing returns. An increase in roundaboutness relative to the inputs of original factors increases final output, but such increments to increasing roundaboutness decrease.[1/]

Pivotal to this conception is a definition of the degree of roundaboutness. Bohm-Bawerk's principal measure is the 'average period of production'.[2/] Assuming constant returns to scale, any production process of the flow input-point output type can be represented as follows:

$$f_t + f_{t-1} + f_{t-2} + \ldots + f_1 \rightarrow c \qquad (1)$$

f_i is the input of labour i periods prior to when final output accrues ($i = 1 \ldots t$). c represents one unit of final output.[3/] The average period of production of such a process is defined as [4/]

$$T = \frac{\sum_{i=1}^{t} f_i i}{\sum_{i=1}^{t} f_i} \qquad (2)$$

1/ Bohm-Bawerk (1888), pp. 20, 84-85, 91, 99, 260-262, 269-270, 355. See also Jevons (1871), pp. 240-241.

2/ Bohm-Bawerk defines the intertemporal aspects of roundaboutness in terms of various concepts but his central measure is an 'average period of production'. See, for example, Gaitskell (1936) and (1938)

3/ The intermediate capital goods produced by the labour inputs do not figure explicitly. Such inputs are instead reduced to labour inputs. The above formulation follows Bohm-Bawerk in abstracting from land.

4/ This formula also applies to processes of the point input-point output type. In this case the average period is equal to the absolute period, t.

The numerator represents the sum of the original factor inputs weighted by the time in which they remain in production. The denominator is the unweighted sum of these factor inputs. Therefore, T expresses the 'average' period that labour inputs are required in the production process before the emergence of final output.[1/]

Bohm-Bawerk maintains that roundaboutness and capital intensity are directly related.[2/] He, therefore, uses T both as a measure of roundaboutness and capital intensity. To do so, however, implies that profit accrues on the basis of simple interest, not compound interest. If profit is calculated on the basis of simple interest then T is equal to the capital-labour ratio when capital is measured in wage units or 'command over labour'.[3/] This can be shown as follows.

The equilibrium value of output associated with the process when operated under competition is equal to its cost of production including profit. This cost of production is equal to

$$\sum_{i=1}^{t} wf_i (1 + ir) \qquad (3)$$

where w is the wage rate and r is the rate of profit. The wage bill is equal to

$$\sum_{i=1}^{t} wf_i \qquad (4)$$

1/ See Bohm-Bawerk (1888), pp. 88-90 and Jevons (1871), pp. 229-231.

2/ Bohm-Bawerk (1888), p. 325, Jevons (1871), pp. 229-231. See also Stigler (1941), pp. 201-204.

3/ In Robinson's terminology this represents 'real' capital intensity. See Robinson (1956)

Total profits are, therefore, equal to

$$\sum_{i=1}^{t} wf_i (1 + ir) - \sum_{i=1}^{t} wf_i = rw \sum_{i=1}^{t} f_i\, i \qquad (5)$$

If K represents the value of capital on which profits are paid at the rate of r then profits equal rK. Consequently,

$$K = w\sum_{i=1}^{t} f_i\, i \qquad (6)$$

Dividing (6) through by (4) we have

$$K^* \Big/ \sum_{i=1}^{t} f_i = \sum_{i=1}^{t} f_i\, i \Big/ \sum_{i=1}^{t} f_i = T \qquad (7)$$

where K* is measured in wage units.

Bohm-Bawerk deduced from this that, in equilibrium, increasing roundaboutness and increasing capital intensity would be associated with a falling rate of profit.[1/] It follows that, using comparisons of equilibrium to represent a process of accumulation, capital deepening would be associated with a falling rate of profit in the absence of technical change. Furthermore, as the rate of profit declined the wage rate would rise. Bohm-Bawerk could, therefore, talk in terms of a demand function for capital in much the same terms as the productivity theorists.[2/]

These relationships have been formulated into a general equilibrium system in various ways. Bohm-Bawerk's own formulation concentrates on the production sector of the economy.[3/] The following assumptions hold:

1/ Bohm-Bawerk (1888), p. 401. See also Jevons (1871), pp. 240-245.

2/ See chapter VII, section (iv).

3/ Bohm-Bawerk (1888), Book VII, chapter II - chapter V.

1. There exist a number of technically efficient productive processes each of a different degree of roundaboutness. Each can produce final outputs and can be represented as a set of dated labour inputs prior to output.
2. There are diminishing returns to increasing roundaboutness.
3. There is a given labour force made up of homogeneous 'labourers'.
4. Competition and maximising behaviour prevail although profit is assumed to accrue on a simple interest basis.
5. There is a fixed wage fund or amount of capital measured in value terms.

   Final output is also measured in value terms.[1/2/]

The equilibrium is determined by two conditions, firstly, the condition that the supply of labour be equal to the demand for labour. Secondly, the processes in which labour is employed maximise profits.

The rate of profit in such an equilibrium is related to the marginal product of roundaboutness. 'The rate of interest ... is limited and determined by the productiveness of the last extension of the process economically permissable, and of the further extension economically not permissable; in this way that unit of capital, which makes this extension of process possible must always bear an amount of interest less than the surplus

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1/ Schumpeter's remark on this is as follows: 'Bohm-Bawerk ... started with a theory of individual behaviour and with a theory of exchange based upon it; but, on the highest floor of his building, there is almost nothing left but aggregates such as (value of) the sum total of wage goods, (value of) total output, and an aggregative 'period of production' to boot'. Schumpeter (1954), p. 998.

2/ Bohm-Bawerk uses the terms 'subsistence fund' and 'capital' as interchangeable. See, for example, Bohm-Bawerk (1888) pp. 401-402.

return of the first named and more than the surplus of the last named ... The figures which represent the productiveness of the last permissable and the first non-permissable extension come usually very close to each other ... Indeed, assuming that these two marginal limits are very near each other, one of them may even be left out of account without serious inaccuracy and the law is simply formulated thus: the rate is determined by the surplus return of the last permissable extension of production'.[1/]

Such an equilibrium is best seen as representing a stationary state[2/] and from comparisons of such equilibria Bohm-Bawerk deduces 'In a community interest[3/] will be high in proportion as the national subsistence fund is low, as the number of labourers employed by the same is great, and as the surplus returns connected with any further expansion of the production period continue high. Conversely interest will be low the greater the subsistence fund, the fewer the labourers and the quicker the fall in surplus returns ... How is it in actual life? Exactly as our formula predicts, and thus experience gives that formula the most complete verification'.[4/]

Bohm-Bawerk's model has been reformulated by subsequent economists. Furthermore they have also sought to integrate the relationships of Austrian capital theory more comprehensively and more rigorously.[5/]

1/ Bohm-Bawerk (1888), pp. 393-394. See also Jevons (1871) pp. 240-241.

2/ See Stigler (1941), pp. 206-207.

3/ It is clear from the context that by 'interest' Bohm-Bawerk means the rate of interest. See Bohm-Bawerk (1888), p. 401.

4/ Bohm-Bawerk (1888), p. 401. Jevons drew the same conclusions (see Jevons (1871), p. 245), as did Wicksell: see above, pp. 157-158.

5/ See, for example, Wicksell (1901), Book II, chapter 2, Kuenne (1971), pp. 51-63, Dorfman (1959a) (1959b), and Hirshleifer (1967).

(iv) Wicksell and the Average Period of Production

Wicksell was Bohm-Bawerk's great follower. He accepted the conceptualisation of production structure in terms of time and built his capital theory on this basis. However, he did so in a more rigorous fashion than Bohm-Bawerk and also sought to cast the Austrian vision into an explicit general equilibrium framework on a par with the Walrasian.[1/]

The essential elements of Austrian capital theory were thereby reformulated into a more precise body of analysis. It was cast into an explicit context of a stationary state,[2/] marginal productivity relations were properly deduced for particular models[3/] and certain erroneous aspects of Bohm-Bawerk's treatment exposed.

It is in terms of this latter aspect that Wicksell's work is crucial for assessing the logic of Austrian theory. A major criticism Wicksell levied against Bohm-Bawerk was the failure of his average period of production to reflect capital intensity when profit was computed, in a manner consistent with maximising behaviour, on the basis of compound interest. This can be seen as follows for the process represented in relation (1). The equilibrium value of output is equal to

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1/ Wicksell (1893), pp. 20-21, (1901), pp. 149-50, 171, Wicksell (1900), p. 108, and Wicksell (1911), p. 185.

2/ Wicksell (1901), p. 104.

3/ Wicksell (1901), pp. 172-184.

$$\sum_{i=1}^{t} wf_i (1 + r)^i \qquad (8)$$

The wage bill is given by (4) as

$$\sum_{i=1}^{t} wf_i \qquad (4)$$

Total profits are, therefore, equal to

$$\sum_{i=1}^{t} wf_i (1 + r)^i - \sum_{i=1}^{t} wf_i \qquad (9)$$

The value of the capital stock is

$$\frac{1}{r} \sum_{i=1}^{t} wf_i (1 + r)^i - \sum_{i=1}^{t} wf_i \qquad (10)$$

Dividing (10) by (4) gives the capital labour ratio, with capital measured in wage units, as

$$\frac{\sum_{i=1}^{t} f_i (1 + r)^i - \sum_{i=1}^{t} f_i}{r \sum_{i=1}^{t} f_i} \qquad (11)$$

This is not equal to T as given by equation (2). (11) is a function of the rate of profit while (2) is independent of the rate of profit.

However, the significance of this result is not unambiguous without specifying the role which the concept of capital intensity played in Austrian theory. If it is required that roundaboutness be a measure of capital intensity, then Bohm-Bawerk's concept of the average period of production will have to be reformulated and will also be a function of the rate of profit. Many economists have so interpreted roundaboutness and thus taken this path.[1/]

1/ See, for example, Hicks (1939), pp. 217-220, Weisacker (1971), p. 33, Steedman (1972), pp. 37-39 and Blaug (1978), pp. 542-543.

But a second, less damaging interpretation, is one which recognises Bohm-Bawerk to be wrong in identifying roundaboutness with capital intensity. Instead, the two should be regarded as separate categories. One relates to an index of the ratio of produced means of production to original factors, and the other to an index of the time structure of production. Such an interpretation is made by Schumpeter. He writes 'In his Rate of Interest Irving Fisher asked the question why that weighted average should be considered the "correct" method of measuring the period of production ... it should have been easy to answer. In fact it should never have been asked: for the formula simply defines something which Bohm-Bawerk chose to call the period of production'.[1/]

It is this second interpretation which would seem to be more sensible. The first requires that the average period of production serves a dual function, to be a concept summarising the time structure of production and a concept of capital intensity. No rationale for this has been provided, apart from the fact that Bohm-Bawerk, following Jevons, considered that the average period of production could serve both purposes and thereby related the rate of profit to both roundaboutness and capital intensity. The second interpretation is, therefore, the position taken in the subsequent chapter in which we subject Austrian theory to the analysis of Sraffa.

1/ Schumpeter (1954), p. 906. See also, pp. 631-631 and 898-899. This interpretation is also suggested by Wicksell (1911), p. 178.

CHAPTER X

AUSTRIAN THEORY AND SRAFFA'S 'PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES'

(i) The Two Frameworks

Austrian theory is in various ways not amenable to an evaluation in terms of Sraffa's analysis. This is particularly true regarding the subjective elements inherent in Austrian theory: the analysis of agents' preferences, the theory of time preference and the emphasis on uncertainty and expectations. There is no element of subjectivity in Sraffa's analysis and, therefore, it has no implications for Austrian theory in this area. However, the Austrian analysis of profit in a capitalist economy did not emphasize these elements. Instead concentration was placed upon technology and especially on the relation of roundaboutness to profit. Even here, though, there are certain problems, for the Austrian conception of technology appears to be very different from that of Sraffa. An appreciation of the substance of these differences is essential if we are to assess the weight which may be attached to a critique founded on Sraffa.

There is one matter on which the Austrian and Sraffa frameworks are in accord: namely, a distinction between 'original' factors and 'produced' factors. This is central to the early Austrian conception of Jevons, Bohm-Bawerk and Wicksell and it has been retained in the later work of Hayek and Hicks. It is also implicit in Sraffa: labour and land are not considered produced commodities. Beyond this, however, there would appear to be significant differences. This is manifested most notably in the different ways in which production structure is

conceptualised. In the Austrian case it is represented as a longitudinal structure, 'a one-way avenue that leads from "factors of production" to "consumption goods" '[1/] over varying lengths of time. Sraffa explicitly rejects this in favour of a cross-section conceptualisation 'of the system of production and consumption as a circular process'[2/] covering a single period of time. Nevertheless, in many cases this difference is more apparent than real.

In the Austrian case, it is only original factor inputs and final consumption goods that are explicitly considered. Intermediate produced commodities, which the original factors produce prior to the output of consumption goods, do not appear. However, these produced means of production exist and may be considered explicitly without changing production relationships. In doing this we get a representation of technology which resembles that of Sraffa.

For example, consider the Austrian process represented by relation (1) in the previous chapter

$$f_t + f_{t-1} + f_{t-2} + \ldots + f_1 \rightarrow c \qquad (1)$$

This may be rewritten as

$$\begin{aligned} f_t &\rightarrow a_{t-1} \\ a_{t-1} + f_{t-1} &\rightarrow a_{t-2} \\ a_{t-2} + f_{t-2} &\rightarrow a_{t-3} \\ &\ldots\ldots\ldots\ldots \\ a_1 + f_1 &\rightarrow c \end{aligned}$$

This indicates that f_t directly produces an intermediate capital good a_{t-1}. This, together with a labour input f_{t-1}, produces

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1/ Sraffa (1960), p. 93.

2/ Sraffa (1960), p. 93.

another intermediate capital good a_{t-2} and so on. This reconstruction is, in fact, simply an example of the point dealt with in chapter II concerning the decomposition of a process into sub-processes.[1/] No information is lost in doing so; in fact there is a gain. In every period labour inputs are producing an 'output', but in the Austrian representation it is not specified what this 'output' is, other than being an intermediate capital good. In Burmeister's words 'it is as if the economy were contained in a black box'.[2/] In the reconstruction they figure explicitly and can, therefore, be the subject of explicit analysis. All the reconstruction does formally, however, is to rename the Austrian 'stages' of production and call them industries or processes. The input subscripts no longer stand for different time dates but for different processes.

This reformulation of an Austrian process is, however, not exactly equivalent to a Sraffa system where each commodity is produced by a single process. The technology dealt with has a linear structure so there is no basic commodity. We have seen that Sraffa's analysis is based on the assumption that in every economic system there is at least one basic commodity.[3/] Nevertheless, this is not a serious difficulty standing in the way of evaluating Austrian theory in terms of Sraffa's results. This is so for three reasons.

Firstly, Austrian capital theorists were aware that a linear production structure is a special case. In particular, Bohm-Bawerk fully accepted that circularity of production relations or 'whirlpool' structures could exist but believed they did not undermine his results.[4/] Assuming, for the moment,

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1/ See chapter II, section (iii).

2/ Burmeister (1974), p. 416.

3/ See chapter II, section (iii). Linearity can be undermined without simultaneously implying that there is a basic commodity. For example, if a_{t-3} entered as a input into a_{t-2} linearity would no longer exist but there would still be no basic commodit

4/ Bohm-Bawerk (1894a) (1894b). Also, see section (iii) below.

that this is true, it means that the Mengerian conception of production structure is useful only for simplyfying the argument, but is not essential to the Austrian position.

Secondly, even if there had been no recognition by Bohm-Bawerk of circularity in production relations, it would be a poor theory indeed which could not adapt to deal with this. It would, therefore, be legitimate to examine Austrian theory in terms of Sraffa's analysis.

Thirdly, although Sraffa's results are all derived from systems in which there exists at least one basic, many of these results do not require this assumption. They continue to hold even when it is relaxed. This holds true for all the critical results dealt with in the following sections.

There are two other minor matters which also need to be mentioned. A characteristic of the equilibrium which Sraffa examines is the uniformity of prices, wages and rate of profit. This is central to the results he develops.[1/] The evaluation of the Austrian theory poses no difficulties on this score, however. The theorists of this tradition made the same assumption. It is, therefore, possible to take a Sraffa system as representing the production relations of an Austrian equilibrium. Moreover, even if the Austrians had never made this assumption it would not necessarily matter. Austrian theory was largely developed in the context of a stationary state and the uniformity assumption is appropriate in this context. Given a steady state equilibrium, whether stationary, progressive, or decaying, it is always possible to find a price system involving such uniformity which will sustain that equilibrium.[2/]

Finally, predominant in Sraffa's analysis is the assumption that wages are paid in arrears. This appears to come into

1/ See chapter XII.
2/ See Bliss (1975), pp. 88-91 and Dixit (1977)

direct confrontation with Austrian theory for, as was pointed out above, [1] it is part of the tradition in which capital represents 'advances'. However, this difference is of no substance whatsoever. Payment in advance within the Austrian framework means payment in advance of the output of the consumption good. Payment in arrears within the context of Sraffa's analysis means payment at the end of the single production period. In Austrian terms it would constitute payment in advance except in the process which directly produced the consumption good. Even this minor difference may be eradicated, for it is easy to reformulate the Sraffa results relevant to Austrian theory, assuming the payment of wages in advance for all production processes.

It follows from what has been said that the Austrian theory of capital and profit is fully susceptible to analysis in terms of Sraffa's framework.

(ii) The Austrian Conceptualisation of Production Structure

Of most importance to the evaluation of Austrian theory is the operation of reduction to dated labour. As we have seen, [2] 'reduction' is an operation 'by which in the equation of a commodity the different means of production used are replaced with a series of quantities of labour, each with its appropriate "date" '. [3] Austrians have always expressed production processes in this form without enquiring as to whether it is generally possible to do so. In the case where

1/ p. 167.
2/ Chapter II, section (v).
3/ Sraffa (1960), p. 34.

each commodity is produced by a single process, Sraffa shows that the reduction can be accomplished. Furthermore, he demonstrates that an analysis in terms of a 'reduced' process gives the same results as that applied to the non-reduced process from which it is derived.[1/] In doing so he provides some support for the legitimacy of the Austrian conceptualisation of production as 'a one-way avenue that leads from "factors of production" to "consumption goods" '.[2/] But the same analysis can be used to directly undermine the generality of this conceptualisation. The source of the difficulty lies in joint production.

Assume that the production system which we observe is a Sraffa system of the form

$$A + f \rightarrow B$$

where A in the input matrix, B the output matrix and f the vector of direct labour requirements. Is it possible to 'reduce' this system to an equivalent one in which each commodity appears to be produced by a series of dated labour terms? This is what is required by Austrian theory. We have already seen, however, that it may not be possible to do this in a meaningful way.[3/] Sraffa provides an example relevant to the Austrian case 'We now turn to inquire to what extent the complications that arise with Joint Products in general apply to the particular case of Fixed Capital. First as regards 'reduction'.

The equations for fixed capital make it easy to see how an attempt to effect the 'reduction' of a durable instrument to a

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1/ Sraffa (1960), pp. 34-40

2/ Sraffa (1960), p. 93.

3/ Chapter II, section (v).

series of dated quantities of labour will in general fail. To take the simplest case, suppose that a machine has a life of two years and its efficiency is constant. The equations would be[1/]

$$(M_0P_{mo} + A_gP_a + \ldots + K_gP_k)\ (1 + r) + L_gw = G_{(g)}P_g + M_1P_{m1}$$

$$(M_1P_{m1} + A_gP_a + \ldots + K_gP_k)\ (1 + r) + L_gw = G_{(g)}P_g.$$

Now the first step towards the 'reduction' of the one-year-old machines M_1 to a series of labour terms is to subtract the second equation from the first so as to isolate M_1, leaving it as the sole product on the right-hand side. As a result of this there appears a similar quantity M_1 among the means of production; it has, however, a negative sign and its price is multiplied by $(1 + r)$.

This is by itself sufficient to show that we are engaged in a blind alley: for when we come to the 'reduction' of the negative term containing M_1, there will appear among its residual means of production a positive M_1; and so, with successive steps, M_1 will constantly re-appear, alternately positive and negative, and in each case multiplied by a higher power of $(1 + r)$. This will make it impossible on the one hand

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1/ Sraffa's notation has been retained in this quotation. $A_g \ldots K_g$ represent the inputs of commodities A ... K in the production of g. M_0 is the quantity of a new durable capital good required to produce g. M_1 is a quantity of this capital good when it is 'one year old'. L_g represents labour inputs and G_g the outputs of commodity g. $P_a \ldots P_k$ are the prices of commodities A ... K. P_{MO} is the price of the capital good when new and P_{M1} is its price when it is 'one year old'.

for the residual aggregate of commodities to tend to vanishing point and on the other for the sum of labour terms to tend to a limit. (This conclusion, based on the assumption of constant efficiency, holds a fortiori when the product of a machine diminishes with age; but it would cease to be true and the 'reduction' to dated labour terms, some positive and some negative, would become possible if the annual product were to increase with age.)'[1/] Even in the latter case, however, since some of the terms represent negative quantities 'no reasonable interpretation could be suggested'.[2/]

This example relates to a 'machine' and as a consequence, it could be argued, is extraneous to the Austrian case which centres on the 'reduction' of consumption goods. But, of course, there is no reason to assume that capital goods are well defined separate commodities from consumption goods. The same commodity can serve in both roles. Moreover, there is nothing in this example which dictates that M_1 has to be interpreted as a durable capital good. It could be taken to represent a case of pure joint production and the conclusions would still stand.

It is here that we should note an ambiguity in Austrian theory. In dealing with flow input-point output processes and point input-point output processes, the dated labour components obviously characterise both the process and the consumption commodity produced by that process. In the above case involving joint production, however, we have assumed that the Austrian theory on this matter related to commodities. Would it make any difference to ask the same question for production

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1/ Sraffa (1960), pp. 67-68.

2/ Sraffa (1960), pp. 57-58.

processes? In short, is it possible to transform each process of the Sraffa joint production system into an equivalent formulation in which the produced means of production are replaced by dated labour quantities? The answer is, however, the same. If any process employs as means of production a commodity the production of which takes place jointly with other commodities the same problems as above can arise. They are merely postponed one stage. The appearance of negative labour quantities and the non-convergence properties remain unchanged.

There is, therefore, substance in Sraffa's remark, 'the ... picture of the system of production and consumption as a circular process ... stands in striking contrast to the view ... of a one-way avenue that leads from "factors of production" to "consumption goods" '.[1/] Not all production structures which can be represented as a set of 'circular' processes can be meaningfully translated into the 'one-way avenue' form. In other words, Wicksell is wrong when he states that all 'capital goods, however different they may appear, can always be ultimately resolved into labour and land ... '.[2/] This strikes at the very foundation of Austrian theory. Without representation in terms of dated original factors none of the superstructure can stand. There is no possibility of measuring roundaboutness and no possibility of associating roundaboutness with other economic categories, accumulation, distribution or the rate of profit.

1/ Sraffa (1960), p. 93.
2/ Wicksell (1901), p. 149.

Even if the difficulty of 'reducing' a production process as a whole does not arise, this does not imply that it will be possible to represent the production of a particular output in terms of dated labour. Again the difficulty is due to joint production which may arise simply because there are elements of fixed capital in the system. Take, for example, a flow input-flow output production process. There is a flow of labour inputs at various dates and a flow of outputs at various dates. From one such process alone there is no way of associating particular inputs with particular outputs. All that one can say is that the inputs, taken together, jointly produce outputs.[1/2/]

(iii) The Degree of Roundaboutness and the Rate of Profit

In the case where each commodity is produced by a single process, Sraffa's analysis indicates that reduction to dated labour can always be performed. However, this does appear to pose a problem for Austrian theory in that the existence of at least one basic commodity implies that the series of dated labour magnitudes is infinite.[3/] Bohm-Bawerk, on the other hand, worked in terms of a finite series and computed the average period of production in such terms. This raises the

1/ Kaldor (1937), p. 159.

2/ All the arguments of this section hold equally for the case where profit is paid on the basis of simple interest instead of compound interest. Bohm-Bawerk's 'approximation' through simple interest is, therefore, redundant.

3/ The substance of this point was made by the critics of the Austrians at a very early stage. See, for example, Gaitskell (1936) and Blaug (1978), p. 544. However, it has frequently been stated in terms of 'historical' quantities of labour. But the matter has nothing to do with historical time. The Austrian series of labour inputs is a series derived from the current technology. It is not a series necessarily relating to real time.

possibility that the average period may not be a finite magnitude which is required if it is to measure roundaboutness. In order for it to be a finite magnitude in the case involving an infinite series of dated labour terms, these quantities must decrease more rapidly than the time factor by which they are weighted increases. Nevertheless, this is no real problem for, providing the economy is viable,[1] such a convergence will always occur.[2/3]

Sraffa's analysis, however, can be used to show that no measure of roundaboutness can play the role assigned to it in Austrian theory. More specifically, the possibility of re-switching shows that there is no necessary monotonic association between the degree of roundaboutness, however measured, and the rate of profit. Furthermore, this result is all the more

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1/ See above, p.14.

2/ See, for example, Pasinetti (1977a), pp. 89-91. Pasinetti shows that the infinite series of dated labour quantities

$$\sum_{i=1}^{\infty} f_i \alpha^i$$

for an $\alpha > 1$ converges. It follows that the series

$$\sum_{i=1}^{\infty} f_i \, i$$

converges since there is some finite i for which $\alpha^i > i$. Hence the numerator of Bohm-Bawerk's average period of production will be finite and, therefore, the whole expression will be finite.

3/ Even if this were not the case the implications are not clear-cut. There is, after all, nothing sacrosanct about Bohm-Bawerk's average period of production. The concept seeks to provide a measure of roundaboutness but if it fails to do so the definition of another measure is obviously not precluded.

destructive because of the fact that it holds quite independently of Sraffa's own conceptual framework. Except in certain special cases,[1] reswitching can occur even if attention is confined to the Austrian representation of processes. This can be shown as follows for flow input-flow output processes.

Assume that there is an economy made up of two such processes. Each uses homogeneous labour as input and produces a homogeneous consumption good as output. Each is technically efficient and inputs and outputs occur over various dates. Process 1 operates over n periods and process 2 over m periods. We can, therefore, represent process 1 by two vectors, a labour input vector $f^1 = (f_1^1 \ldots f_n^1)$ and a consumption good output vector $c^1 = (c_1^1 \ldots c_n^1)$. Likewise process 2 can be represented by the vectors $f^2 = (f_1^2 \ldots f_m^2)$ and $c^2 = (c_1^2 \ldots c_m^2)$. All vectors are semi-positive but not necessarily strictly positive.

In a competitive equilibrium both processes will have a present value equal to zero.[2] Therefore, for process 1, we can write

$$\sum_{t=1}^{n} (c_t^1 - w_1 f_t^1) R_1^t = 0 \qquad (1)$$

w_1 is the prevailing uniform wage and R_1 is the discount factor equal to $1/1 + r_1$ where r_1 is the uniform rate of profit. It is assumed that the wage is paid at the end of each period at the same time as output is sold.

1/ See below, pp.191-193.

2/ Throughout this section the 'present' is taken to be the beginning of period 1.

Analogously for process 2 we can write

$$\sum_{t=1}^{m} (c_t^2 - w_2 f_t^2) R_2^t = 0 \qquad (2)$$

At a switchpoint $w_1 = w_2 = w$ and $R_1 = R_2 = R$. Consequently reswitching will occur if the polynomial

$$\sum_{t=1}^{m} c_t^2 R^t \cdot \sum_{t=1}^{n} f_t^1 R^t - \sum_{t=1}^{n} c_t^1 R^t \cdot \sum_{t=1}^{m} f_t^2 R^t = 0 \qquad (3)$$

has more than one positive root. This cannot be excluded as a possibility, without appropriate restrictions being placed on the parameters. In general there is no reason why there should be a unique solution for economically meaningful cases.[1/]

To restrict the parameters to cases where both processes become point input-flow output processes is not sufficient to eradicate the possibility of reswitching. Doing this means that all elements but the first in f^1 and f^2 are zero so that (3) becomes

$$\sum_{t=1}^{m} c_t^2 R^t - f_1^1 R^1 - \sum_{t=1}^{n} c_t^1 R^t \cdot f_1^2 R^1 = 0 \qquad (4)$$

Without further restrictions on the parameters, this polynomial can still have more than a single positive root and thus reswitching can occur.[2/]

1/ For example, assume that $m = n = 3$, $c_1^1 = 1$, $c_2^1 = 10$, $c_3^1 = 6$, $c_1^1 = 2$, $c_2^2 = 5$, $c_3^2 = 12$, and $f_i^1 = f_i^2 = 1$ $(i = 1 \ldots n)$. In this case there will be reswitching because there are two switch points, at $r = 1$ and $w = 4\frac{2}{7}$, and at $r = 2$ and $w = 3\frac{6}{13}$.

2/ For example, assume that $m = n = 3$, $c_1^1 = 2$, $c_2^1 = 0$, $c_3^1 = 6$, $c_1^2 = 1$, $c_2^2 = 5$, $c_3^2 = 0$ and $f_1^1 = f_1^2 = 1$. In this case there will be reswitching because there are two switch points, at $r = 1$ and $w = 3\frac{1}{2}$, and at $r = 2$ and $w = 2\frac{2}{3}$.

The same holds true if the parameters are restricted so that both processes become flow input-point output processes. This is not sufficient to rule out reswitching. In this case all but the last elements in c^1 and c^2 become zero so that (3) becomes

$$c_m^2 R^m \cdot \sum_{t=1}^{n} f_t^1 R^t - c_n^1 R^n \cdot \sum_{t=1}^{m} f_t^2 R^t = 0 \qquad (5)$$

Again, without further restrictions on the parameters, this polynomial may not have a unique positive root and, therefore, reswitching can occur.[1/]

To restrict the parameters further so as to ensure that both processes are of the point input-point output type will, however, preclude reswitching. In this case (3) becomes

$$c_m^2 R^m \cdot f_1^1 R^1 - c_n^1 R^n \cdot f_1^2 R^1 = 0 \qquad (6)$$

which implies that

$$R = \left[\frac{f_1^2}{f_1^1} \cdot \frac{c_n^1}{c_n^2} \right]^{1/m-n} \qquad (7)$$

The term on the right-hand side can only have one positive root. Hence no reswitching is possible.[2/]

There are two other cases where it may be proved that reswitching cannot occur. Both are naturally special cases of flow input-flow output framework, but one is also a special case of the flow input-point output case, which is of particular importance historically for Austrian theorists.

1/ For example, assume that $m = n = 3$, $c_3^1 = c_3^2 = 1$. $f_1^1 = 2$, $f_2^1 = 0$, $f_3^1 = 6$, $f_1^2 = 1$, $f_2^2 = 5$ and $f_3^2 = 0$. In this case there will be reswitching because there are two switchpoint, at $r = 1$ and $w = \frac{1}{14}$, and at $r = 2$ and $w = \frac{1}{24}$.

2/ In cases where a point input-point output process co-existed with another process of a different type, however, reswitching would not be precluded. See Samuelson (1966) for a numerical example of a case where a point input-point output process co-exists with a flow input-point output process.

The first was developed by Hicks, involving what he calls 'simple profiles'. Assume process 1 is of the following type: there is a period lasting d weeks in which labour is applied at a constant rate but in which there is no output. This is called the construction period. It is followed by another period comprising week d+ 1 to week n in which labour is applied at a constant (but different) rate and in which output appears at a constant rate. This is called the utilisation period. Process 2 is of the same type and has identical construction and utilisation periods as process 1 but different rates of flow of inputs and outputs. In this case there can be no reswitching.[1/]

The second case involves flow input-flow output processes where the input flow is uniform per period, although different for the different processes. Assume that in process 1 f_1 labour input is applied in each period for n periods and in process 2 f_2 labour input is applied in each period for m periods. Further assume, without loss of generality, that the output of each process comprises one unit of the consumption good. Also assume $m > n$: this implies that $f_2 < f_1$, otherwise process 1 would dominate process 2 at every wage other than zero.

In an equilibrium involving process 1 we must have

$$w_1 f_1 \sum_{t=1}^{n} R_1^t = R_1^n \qquad (8)$$

For process 2 we must have

$$w_2 f_2 \sum_{t=1}^{m} R_2^t = R_2^m \qquad (9)$$

1/ Hicks (1973a), pp. 41-42.

At a switchpoint $R_1 = R_2 = R$ and $w_1 = w_2 = w$ so that

$$\frac{R^n}{R^m} = \frac{f_1}{f_2} \cdot \frac{\sum_{t=1}^{n} R^t}{\sum_{t=1}^{m} R^t} \qquad (10)$$

Therefore,

$$\sum_{t=1}^{m} R^t - \frac{f_1}{f_2} R^{m-n} \sum_{t=1}^{n} R^t = 0 \qquad (11)$$

or

$$R^m (1 - \frac{f_1}{f_2}) + R^{m-1} (1 - \frac{f_1}{f_2}) \ldots$$

$$+ R^{m-n+1} (1 - \frac{f_1}{f_2}) + R^{m-n} + R^{m-n-1}$$

$$+ R^{m-n-2} \ldots + R = 0$$

For reswitching to occur this equation must have more than one positive root. However, since $f_2 < f_1$ the coefficients change in sign once and only once, there can be no more than one positive root.

This case, together with the point input-point output case, was used extensively by the Austrians. As we have seen they both preclude reswitching but they are also very special cases. In order to construct a satisfactory capital and profit theory, reswitching needs to be excluded more generally. Without this there is no monotonic variation of roundaboutness, however measured, with the rate of profit.[1/]

Actually Bohm-Bawerk's attention was drawn to the possibility of reswitching by Fisher, who also provided a numerical example involving two processes, one a point input-flow output process and the other a point input-point output type. On the basis of this example, Fisher comments '... it is not true that

1/ The assumption of simple interest is important for the results of this section. It is possible to exclude reswitching if profi accrues on this basis. See, for example, Steedman (1972), pp.45- Consequently this assumption has real force because it leads to qualitatively different conclusions. Wicksell was, therefore, incorrect in assuming that simple interest did not lead to 'serious error'. Wicksell (1901), pp. 183-184.

one of the alternatives will be chosen if the rate of interest is high, and the other if the rate of interest is low ... (One) ... would, oddly enough, be the most economical if the rate of interest were either very high or very low, whereas the other alternative would be chosen in case the interest were at a more moderate level'.[1/]

Bohm-Bawerk noted this but did not comment upon it, 'presumably because he did not understand the profound implications of Fisher's observations'.[2/] Nor, given Fisher's 'oddly enough' qualification, did he himself. This does not reflect too badly on Fisher, however, for when Champernowne[3/] and Robinson[4/] rediscovered the same phenomenon they too considered it perverse and failed to see its significance. Consequently, although Sraffa may not be credited with the discovery of reswitching, it is true that its importance did not escape him in the same way as it did the earlier writers.[5/]

(iv) Capital Reversal

In the cases considered in the previous section reswitching is always associated with capital reversal although more generally it is possible to have capital reversal without reswitching. Capital reversal is damaging to the Austrian position since the Austrians, like the productivity theorists, believed

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1/ Fisher (1907), pp. 352-353
2/ Velupillai (1975), p. 680.
3/ Champernowne (1953).
4/ Robinson (1956).
5/ Sraffa (1960), p. 38.

they had established an inverse monotonic relation between capital intensity and the rate of profit, from which they deduced certain implications resulting from an accumulation process involving capital deepening.[1/] These need no longer stand once the possibility of capital reversal is allowed.[2/]

However, there is a difference between the relative importance of reswitching and capital reversal for the productivity theorists on the one hand and the Austrians on the other. The reason is that, unlike the productivity theorists, the Austrians deduced propositions regarding capital intensity from considerations involving production time structures and roundaboutness. Time structure and roundaboutness is primary and capital intensity secondary.

What is crucial to undermining the theory of the productivity theorists is capital reversal. This, quite independently of whether or not it is associated with reswitching, is the key because it alone destroys the basic relationship which productivity theorists sought to establish, namely the inverse relationship between r and the relative scarcity of capital. Capital reversal does not have a parallel significance for Austrian theory. It could be accepted as a possibility without the same fundamental consequence, for time structure and roundaboutness are the primary tools of conceptualisation here. However, while these can survive capital reversal they cannot survive reswitching.[3/]

1/ See chapter IX, section (iii).

2/ See, for example, Samuelson (1966), and chapter VIII above.

3/ It also follows that, since reswitching destroys any monotonic relation between the rate of profit and roundaboutness, it undermines the possibility of relating the rate of profit to the marginal product of roundaboutness.

(v) The Relation of the Wage and Rate of Profit

The Austrians shared the belief, held by Ricardo, Marx and the productivity theorists, that comparing equilibria of economies with the same technology would always show an inverse relation between the wage and rate of profit. Sraffa's analysis, which indicates that this relationship may not hold if there are joint production processes,[1/] is, therefore, relevant as a criticism of Austrian economists, just as much as it is of the others.

It is true that an inverse relationship between the wage and rate of profit will occur in systems made up on point input-flow output processes or flow input-point output processes or point input-point output processes. It will also occur in systems made up of any combination of these different types of processes. This is because the factor price frontiers of such systems will have negative slopes throughout, as the wage-profit curves of these types of process are always negatively sloped.

The wage-profit function of a point input-flow output process is

$$w = \sum_t c_t R^{t-1} \Big/ f_1$$

For a flow input-point output process the function is

$$w = \frac{c_n}{\sum_t f_t R^{t-n}}$$

1/ Sraffa (1960), pp. 61-62.

and for a point input-point output process it is

$$w = \frac{c_n R^{n-1}}{f_1}$$

In each case $dw/dr < 0$ throughout.

However, in the case of a flow input-flow output process, the inverse relationship between the wage and rate of profit cannot be guaranteed. The wage-profit relation of such a process is

$$w = \frac{\sum_t c_t R^t}{\sum_t f_t R^t}$$

In this case it cannot be shown that dw/dr is negative throughout.

The above discussion, as in the previous sections where the possibility of the wage and rate of profit moving together has been noted,[1/] has been formal. At this stage, however, it is possible to analyse the matter more thoroughly and enquire into the economic relationships which lie behind the mathematics.

Sraffa's analysis shows that a direct relationship between changes in the wage and rate of profit should not be regarded as perverse on intuitive grounds. In any system, a rise in the wage, measured in any numeraire, must reduce aggregate profits. But it should not be expected that such a wage increase would reduce the <u>rate</u> of profit. In general, a change in distribution leads to a change in the equilibrium prices of commodities including the prices of the means of production which form capital. Consequently both the numerator (aggregate profits) and the denominator (the value of capital) of the ratio, which

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1/ See chapter IV, section (iv), chapter VI, section (vi) and chapter VIII, section (v).

will define the rate of profit, change with a rise in the wage. Sraffa's analysis of these price movements shows that there is no a priori reason for expecting these changes to always reduce the value of this ratio. The conceptualisation of production processes in terms of dated inputs and dated outputs, however, allows economic understanding to progress beyond this.

If output per worker fluctuates so that there are changes in the sign of the terms $\left[\frac{c_{t+1}}{f_{t+1}} - \frac{c_t}{f_t}\right]$ we can consider the producer who operates such a process as engaging in borrowing and lending transactions. When the labour productivity of a particular period is relatively low, borrowing is required to pay wages and profits at the prevailing rates. When the labour productivity of a particular period is relatively high, more revenue is received than is absorbed in profit and wage costs. It, therefore, becomes possible for the producer to gain as a lender from an increase in the rate of profit, given the wage, more than he loses as a borrower. However, since the present value of these 'deficits' and 'surpluses', totalled over the whole process, must equal zero under competition, in this case a higher rate of profit requires a higher wage to be paid rather than a lower wage.[1/] The following provides a numerical example of this direct variation of the rate of profit and the wage.

Assume that there is a system composed of an Austrian flow input-flow output production process extending over four periods. Labour inputs are $f_1 = 1$, $f_2 = 2$, $f_3 = 3$ and $f_4 = 4$.

1/ See Nuti (1970), pp. 319-322, Hicks (1973a), pp. 14-26 and Burmeister (1974).

Outputs are $c_1 = 1$, $c_2 = 0{\cdot}5$, $c_3 = 6{\cdot}5$ and $c_4 = 2$. The wage-rate of profit equation is, therefore,

$$w = \frac{1 + 0{\cdot}5R + 6{\cdot}5R^2 + 2R^3}{1 + 2R + 3R^2 + 4R^3}$$

Various values of w and r which satisfy this equation are presented in Table 1 and the wage-profit curve is drawn in Figure 1.

w	r
1·0000000	0·0000000
1·0035522	0·1520737
1·0035523	0·1534025
1·0035519	0·1547344
1·0024361	0·2500000
0·9959939	0·4285714
0·9826255	0·6666667
0·8865979	4·0000000
0·8862627	4·3191489
0·8862593	4·3475936
0·8862600	4·3763441
0·9051860	9·0000000
1·0000000	∞

TABLE 1

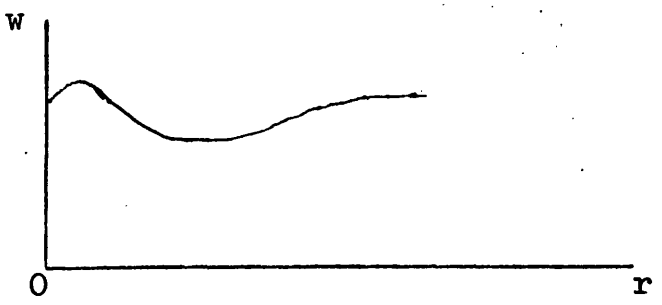

Figure 1.

(vi) The Determinants of Equilibria in Austrian Theory

The Austrians did not only concern themselves with establishing relationships between roundaboutness, capital intensity, the wage and rate of profit. They also sought to close their system by postulating sufficient exogenous data and relationships to allow the endogenous variables to be determined.[1/] In doing so, however, they, like the productivity theorists, took as exogenous the magnitude of value capital or the value of the 'subsistence fund'. This is methodologically illegitimate. Such values are endogenous variables as they are dependent on the distributional variables which are endogenous. Therefore, the Austrians, like the productivity theorists, even in the absence of the considerations dealt with in previous sections, failed to close their models and determine any of the magnitudes which make up a general equilibrium.

(vii) A Note on More Recent Austrian Theory

Austrian economics, as we have already seen, involves more than a theory of profit. This is true even if attention is limited to the Austrian analysis of production structure. This comes to the fore most notably in the work of Hayek and Hicks.[2/]

Hayek sought to use the Austrian time-structured framework to analyse the dynamics of accumulation in a monetary economy, with particular reference to explaining cyclical fluctuations. However, irrespective of the defects specific to this analysis,[3/] as a general theory it is necessarily flawed because of its Austrian basis. While it is true that Hayek rejects Bohm-Bawerk's

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1/ See chapter IX, section (iii).

2/ Hayek (1931), (1939), (1941) and Hicks (1970), (1973a), (1973b), (1975) and (1976).

3/ See, for example, Sraffa (1932) and Smithies (1941).

concept of the average period of production, he does not jettison the Austrian conception of production structure, measures of roundaboutness, the notion of capital intensity of a process and the Austrian beliefs concerning the relationships between the wage, rate of profits, roundaboutness and capital intensity. The same commitment to traditional Austrian theory is also manifest in the work of other contemporary Austrian theorists[1/]. This being the case, the implications of the Sraffa-based critique extend far beyond the confines of the Austrian theory of profit.

The work of Hicks, however, is in a different class altogether. He rejects most of traditional Austrian concepts and he recognises the possibility of reswitching, of capital reversal and the possibility that the wage and rate of profit may not be inversely related. What he takes from the Austrian tradition is only the view of an economy as composed of a set of processes in which dated labour inputs produce dated outputs of consumption goods; and, unlike the early Austrians, he uses this framework for the purpose of analysing disequilibria.

' ... I am very sceptical of the importance of ... "steady state" theory. The real world (perhaps fortunately) is not, and never is, in a steady state; it has adventures which are much more interesting ...

A "steady state" theory is out of time; but an "Austrian" theory is in time. It is in time that it belongs. It can have time and change taken out of it, as was done by Wicksell, in

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1/See, for example, Rothbard (1970) and Garrison (1978).

his "stationary state" version, and as was done in the "steady state" version that I have just been giving; but if we treat it in that manner we deprive it of its strength, for we are stating it in a form in which it loses its peculiar virtues. A steady-state theory works in terms of reciprocal determination; but a theory which belongs in time should not be operating with the third of Kant's categories. It should be working in terms of the second - in terms of cause and effect.

A causal analysis, at least of economic problems, must take the following form. We take our stand at a base date (call it T = 0). Everything that has happened before that date, in the past, is taken as given. We compare two alternative paths that extend into the future. Along one of those paths some new "cause" is not operating; along the other it is. The difference between the paths is the effect of that cause. The difference itself extends over time, so that there are "short-run" and "long-run" effects. But merely to distinguish between short-run and long-run is not sufficient; it is the whole of the difference between the paths which is the effect of the cause.

The Austrian theory (especially, perhaps, in its revised form) is very well adapted for the study of causal problems, in this sense. There is a wide variety of such problems that can be studied with its aid. I can do no more, here, than give an example.

Let the cause, the effect of which we are to study, be an invention. The paths which are to be compared are that followed by the economy when the invention has occurred, and

that which would have been followed if it had not occurred. (Since the second of these paths is inevitably a theoretical construction, causal analysis of this type is bound to be, at least in part, theoretical.) The base date, from which we operate, is that at which the invention is adopted. I shall retain my former simplifications, of the single input (labour) and the single output (corn).'[1/]

Hicks' work is, therefore, not subject to the criticisms outlined in sections (iii) - (vi). Nevertheless, the criticism of section (ii) still has force. In using an Austrian representation of a production process, those factors precluding reduction to dated labour quantities have to be assumed away. There is nothing erroneous in doing so, particularly in the development of new analysis which initially requires the examination of simplified cases. However, it will at some stage prove necessary to move beyond these simplifications and in doing so the Austrian basis must be jettisoned.

1/ Hicks (1973b), pp. 203-4

CHAPTER XI

WALRASIAN GENERAL EQUILIBRIUM ANALYSIS AND THE THEORY OF PROFIT

(i) Introduction

The most fundamental development in neoclassical economics during the last third of the nineteenth century is now widely accepted to have been the general equilibrium analysis of Walras.[1/] Schumpeter's sentiments, for example, are typical. ' ... Economics is a big omnibus which contains many passengers of incomensurable interests and abilities. However, so far as pure theory is concerned, Walras is in my opinion the greatest of all economists. His system of economic equilibrium .... is the only work by an economist that will stand comparison with the achievements of theoretical physics.'[2/]

Walras founded no personal school during his own lifetime comparable to that of Menger or Marshall.[3/] But since the nineteen thirties the significance of his work has become increasingly recognised and his ideas have been developed by neoclassical theorists of the highest calibre.[4/] Moreover, the Walrasian school has increasingly placed emphasis upon the logical rigour

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1/ Walras (1874).

2/ Schumpeter (1954), p. 827.

3/ Schumpeter (1954), p. 829.

4/ Modern classics of the Walrasian tradition include Hicks (1939), Samuelson (1947), Debreu (1959) and Arrow and Hahn (1971)

by which conclusions are reached[1] and stressed that general equilibrium analysis provides a framework in which all neo-classical economics can be developed. Consequently, Schumpeter referred to Walras' early work as the 'Magna Charta of exact economics';[2] and, as such, the development of Walrasian analysis provides the key test for Sraffa's 'critique of economic theory'.[3]

In this chapter Walras' early work on the theory of profit is analysed together with the major improvements which have been made subsequently and which have culminated in the work of Debreu. The following chapter examines arguments based upon Sraffa's analysis, which seek to reveal flaws in the Walrasian framework.

(ii) The Problems Considered by Walrasian Analysis and the Theory of Profit

Walrasian general equilibrium theory focuses attention on the interrelationships between the elements that make up an economy which is coordinated by a price system. This means that Walrasian analysis is necessarily complex and within its framework it is not possible to explain one particular phenomenon like profit, without at the same time going a long way to explain many other phenomena. We can, however, clearly delineate the problems with which Walrasian theory has been concerned from the outset.

1/ The shift in emphasis can clearly be seen by comparing Hicks (1939) with Debreu (1959). The empirical relevance of Debreu's conclusions is best seen as indirect, i.e. in terms of a counter-factual method. See Howard (1979), pp. 16-17, 168-173.

2/ Schumpeter (1954), p. 568.

3/ Sraffa (1960), p. vi. See also chapter XII, section (i).

Firstly, under what circumstances may an equilibrium of supply and demand be shown to exist? More specifically, when can it be ensured that there is a set of prices, such that, if economic agents were to maximise on the basis of these prices, the total demand and supply for each commodity would allow each agent to realise their plans?

Secondly, given that an equilibrium exists, what may be said about the comparative static properties of equilibria? In other words, what will be the effect on the equilibrium values of the endogenous variables if there are certain types of changes in the exogenous components which determine equilibrium values?

Thirdly, given that an equilibrium exists, what conditions ensure that it is unique? To show that an equilibrium is unique is to show that there is one, and only one, set of relative prices, set of demands and set of supplies at which all markets are cleared.

Fourthly, given that an equilibrium exists, under what circumstances will it be stable? What conditions ensure that when an economy is out of equilibrium there is a movement to equilibrium?[1/]

Fifthly, what is the relationship between competitive equilibria and efficient resource allocation?

The solution to each of these problems is of fundamental importance to all neoclassical theory. An existence proof establishes the logical consistency of theory structured in terms of an equilibrium of demands and supplies. For neoclassical theory to possess any causal properties the

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1/ There are in fact various concepts of stability employed in Walrasian theory. See Howard (1979), pp. 57-59.

possibility that an equilibrium can exist must be established. Providing economic processes converge to equilibria, comparative static propositions allow predictions of how the endogenous variables will ultimately change as the exogenous data change and, moreover, do so without delving into the complexities of dymanics. The analysis of uniqueness is of importance for assessing the causal import of neoclassical theory. A theory which seeks to determine the endogenous variables of equilibrium will not be fully deterministic unless equilibrium is unique. Uniqueness is also crucial for comparative statics. If it is to be possible to make clear-cut statements about the equilibrium effects produced by changes in exogenous elements, the analyst must know which equilibria to compare. Without uniqueness this is problematic. Stability analysis indicates the likelihood that equilibria will be established. In doing so, it indicates what weight we may allow propositions about equilibrium patterns to bear. Stability analysis is also important for the method of comparative statics. If equilibria are not stable, quantities and prices will not converge to those values predicted on the basis of comparisons. The analysis of efficiency shows areas where market forces may not be relied upon to generate results that are desirable.

In any area of economic enquiry the analysis of these problems is, therefore, of paramount significance and the theory of profit no exception. All neoclassical theories of profit are theories of profit in equilibria. They seek to show the determinants of equilibrium profits, the relation between these profits and other variables and how these profits change

as exogenous elements change. A distinctive character of Walrasian theory lies in building up analysis from first principles. As we have seen in the previous four chapters, other neoclassical theorists took a great deal for granted and the consequences of doing so proved fatal. However, the attempt to ground neoclassical theory in a logically watertight framework has not proved easy. There has been a long process of criticism and development. In the following sections this development is considered with reference to the work of Debreu. Furthermore, in doing so we concentrate on those aspects which are fundamental and come within the orbit of Sraffa's critique. This means concentrating on the problems of existence and comparative statics.

(iii) Walras' Analysis of Existence and the Theory of Profit

Walras develops his general equilibrium analysis sequentially through a series of successively more complex models. He begins by developing a theory of exchange, assuming that the amounts of exchangeable commodities are constant.[1/] Production activities are then incorporated.[2/] The commodities of the previous model are now viewed as products and their quantities, therefore, become variables. However, the quantities of the productive resource services are considered to be given and it is only these services, not the stocks which generate them, that are priced. The next stage[3/] incorporates the production and pricing of these stocks and it is here

1/ Walras (1874), parts II and III.
2/ Walras (1874), part IV.
3/ Walras (1874), part V.

that a theory of profit emerges. Finally, the assumption of numeraire money, adopted in all the previous models, is relaxed and genuine money is incorporated.[1/] The penultimate part of the Elements[2/] introduces variable coefficients of production and, therefore, marginal products, together with land and rent.

In all cases, Walras attempts to prove the existence of an equilibrium by ensuring that the specification of each model yields exactly the same number of equations as unknowns (endogenous variables). It was believed that such an equality was the relevant consideration in ensuring that an equilibrium existed and that the equilibrium values of the endogenous variables could be determined.

It is expositionally and analytically convenient in outlining Walras' theory of profit to follow his own procedure, by first developing a model where profit is absent[3/] and then extending it to allow for profit.[4/] The first model is made up of the following components.

1. Each consuming agent has an initial endowment of productive resource services. The stocks of productive resources which generate these services are not explicitly considered.
2. Each consuming agent has a marginal utility function for each commodity. This, together with a budget constraint,

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1/ Walras (1874), part VI.
2/ Walras (1874), part VII.
3/ This is mainly drawn from Lesson 20.
4/ This is mainly drawn from Lesson 24.

determines the consumer's demands and supplies. The budget constraint requires the value of these demands and supplies to sum to zero for all sets of prices.

3. There are n types of productive resource services and m types of consumer good.

4. There are m processes of production with constant returns to scale for the consumer goods. These are represented by mn technical coefficients of production, a_{ij}, which indicate the amount of the ith productive service required for the production of one unit of the jth consumption good.

5. A consumption good, m, is chosen as numeraire and its price set equal to unity.

There are, therefore, m + n markets and the problem of existence is to show that each can be in equilibrium simultaneously. There are 2n + 2m - 1 endogenous variables to be determined in this equilibrium: m - 1 prices of consumption goods, m quantities of consumption goods traded, n prices of productive services and n quantities traded.

The condition for utility maximisation by a consumer is stated in terms of the equi-marginal rule. This gives rise to n + m - 1 equations.[1/]

$$\phi_i (q_i - o_i) = p_i \phi_m (d_m) \quad i = 1, .., n$$

$$\phi_j (d_j) = p_j \phi_m (d_m) \quad j = 1, .. , m - 1$$

ϕ_s (s = i,j) represents the marginal utility function for good s, p_s (s = i,j) is the price of good s, q_i is the quantity of the ith productive service held in initial endowments, o_i are the quantities of these services demanded (if negative) or

1/ The condition for commodity m need not be specified as it is an identity.

supplied (if positive) and d_j represents the demand for consumer good j.[1/]

Together with the budget constraint this gives m + n equations in m + n unknowns, o_i, d_j and d_m. These unknowns are expressed as functions of prices, thus yielding the consumer's supply and demand functions.

$$o_i = f_i (p_i, p_j) \qquad i = 1, \ldots n. \quad j = 1, \ldots m - 1$$
$$d_j = f_j (p_i, p_j)$$
$$d_m = f_m (p_i, p_j)$$

Letting $O_i = \Sigma o_i$, $D_j = \Sigma d_j$, $D_m = \Sigma d_m$, through aggregation via $F_t = \Sigma f_t$ (t = i, j, m) we have two sets of equations which will be satisfied in equilibrium.

$$O_i = F_i (p_i, p_j) \quad i = 1, \ldots, n. \quad j = 1, \ldots, m - 1 \qquad (1)$$

and

$$D_j = F_j (p_i, p_j) \quad i = 1, \ldots n. \quad j = 1, \ldots, m - 1 \qquad (2)$$
$$D_m = F_m (p_i, p_j)$$

System 1 consists of n equations and system 2 of m equations.

There are two other sets of equations that must be satisfied in equilibrium. The supply and demand for each productive service must be equal and the prices of consumer goods must equal their costs of production.

$$\sum_j a_{ij} D_j + a_{im} D_m = O_i \qquad i = 1, \ldots, n. \quad j = 1, \ldots, m - 1 \qquad (3)$$

$$\sum_i a_{ij} p_i = p_j$$
$$\sum_i a_{im} p_i = 1 \qquad (4)$$

System (3) consists of n equations and system (4) of m equations.

1/ This is essentially Walras' own notation although the use of subscripts is different.

Systems (1), (2), (3) and (4) total to 2m + 2n equations. But they do not form a functionally independent set. One may be derived from the others if each agent obeys a budget constraint.[1/] Walras' procedure is then to assume that there are 2m + 2n - 1 independent equations and, since these are exactly equal in number to the number of unknowns, to deduce that the unknowns can be determined and equilibrium exists.

Walras' theory of capital and profit consists of a simple extension of this system to include trading in productive resources.[2/] Again, the principle on which the model is constructed is the equality between the number of equations and number of unknowns. The following conditions are assumed.

1. There are h types of capital goods and the production coefficients for these goods, $\hat{a}_{ik}$, are fixed.
2. Consumers are now allowed to make intertemporal choices or, in Walras' terms, are allowed to save.[3/] Saving is integrated into utility maximisation. This is accomplished by introducing a new commodity called 'perpetual net

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1/ See, for example, Howard (1979), pp. 35-36 and Walras (1874), p. 241.

2/ 'In the preceding pages we have determined the prices of the various types of income, but we have not yet determined the prices of capital goods yielding these incomes in the form of uses and services. The determination of the prices of capital goods is the third major problem of the mathematical theory of social wealth.' Walras (1874), p. 267.

3/ There are certain minor problems associated with Walras' treatment of savings which are ignored here. See Montgomery (1971), pp. 282-283.

income', e, which is a composite good made up of a claim to one unit of numeraire in each future period.[1/] The savings of a consumer consist of demand for e, d_e, and the consumer's initial endowments now include e. The price of e, p_e, is the reciprocal of the profit rate, i.e. $p_e = {}^1/r$. As we will see, d_e represents the demand for capital goods.[2/]

Utility maximisation by a consumer now includes choices over commodity e and its price, p_e, becomes an argument in the equations of systems (1) and (2). Utility maximisation, therefore, yields a new demand function for each consumer and these are aggregated to provide an equation representing the total demand for e.

$$D_e = Fe\ (p_i, p_j, p_e) \quad i = 1, \ldots, n. \quad j = 1, \ldots m - 1 \qquad (5)$$

In equilibrium the following three conditions must also hold.

The costs of production of new capital goods must equal their prices.

$$\sum_{i=1}^{n} \hat{a}_{ik}\, p_i = p_k \qquad k = 1, \ldots, h \qquad (6)$$

The prices of new capital goods must equal the capitalised net incomes resulting from the flow of productive services provided by the capital goods.

$$p_k = \frac{p_i - (u_k + v_k)\, p_k}{r} \qquad k = 1, \ldots, h \qquad (7)$$

p_i is the price of the productive resource generated by the

1/ This utility theory of savings was introduced only in the fourth edition of the Elements (1900). Previously Walras simply assumed a given savings function. See Jaffe (1942), p. 43.

2/ Consumers 'save their income in the physical form of capital goods ... [which] ... are lent to ... [producers] ... through capital service markets.' Morishima (1977), p. 73.

capital good k while u_k and v_k are depreciation and insurance coefficients which are assumed to be exogenous. The units of measurement of the capital goods and of their services are chosen in such a way that one unit of a capital good yields a flow of one unit of service in each time period.

Aggregate savings must equal aggregate investment

$$D_e\, p_e = \sum_{k=1}^{h} D_k\, p_k \qquad (8)$$

Systems (5), (6), (7) and (8) provide 2h + 2 new equations. These are equal in number to the new unknowns: h prices of new capital goods, h quantities of new capital goods traded, the rate of profit which is equal to $1/p_e$ and the magnitude of savings D_e. On Walras' criterion, then, equilibrium exists and all endogenous variables, including the rate of profit, are determined.

Walras sometimes wrote as if the rate of profit was determined by savings and investment.[1/] 'New capital goods are exchanged against the excess of income over consumption; and the condition of equality between the value of new capital goods and the value of the excess gives us the equation required for the determination of the rate of net income ...' [2/] But we should interpret this as a convenient, albeit misleading, summary of the theory. As a general equilibrium theorist he would have to maintain that all endogenous variables are determined simultaneously and all equations are required in this determination.

1/ This, of course, is what Keynes (1936) took to be the 'classical' theory of interest.

2/ Walras (1874), p. 269. See also pp. 42 and 46.

Also the elements of Walras' theory of capital and profit are not distinguished with regard to their time reference. This indicates that they relate to the same period and the equilibrium is for a single period only. Walras was, in fact, explicit on this matter. '... Equilibrium ... will be established effectively by the reciprocal exchange between savings to be accumulated and new capital goods to be supplied within a given period of time, during which no change in the data is allowed'.[1/] Thus, in the period considered, the endogenous variables are determined by the exogenous components which include consumers' initial endowments. But when the economy enters a new period these endowments will change, if net investment has occurred. Consequently the equilibrium state will change. Continuing in such a manner, we have a series of equilibria and, according to Walras, we are in a position 'to pass from the static to the dynamic point of view.

In order to make this transition we need only suppose the data of the problem ... to vary as a function of time. The fixed equilibrium will then be transformed into variable or moving equilibrium which re-establishes itself automatically as soon as it has been disturbed.'[2/]

This completes the outline of Walras' theory of general equilibrium, capital and profit. In the next section certain limitations of Walras' theory of profit are considered, together with more recent developments which circumvent these limitations. In section (v) important defects of Walras' theory of general equilibrium as a whole are dealt with. It is also shown how these have been overcome in Debreu's analysis.

1/ Walras (1874), pp. 282 - 283.

2/ Walras (1874), p. 318.

(iv) Limitations of Walras' Theory of Capital and Profit

There are a number of important limitations inherent in Walras' theory of capital and profit.

Firstly, equations (4) and (6) contain no rate of profit. This either implies that all inputs receive payment at the end of the period or that production is instantaneous.[1/] Walras chooses the second alternative.[2/] As Morishima notes, this is a 'drastic simplification'.[3/] Moreover, it implies that the time period to which the whole model relates is an instant in time, because new capital goods are assumed not to become available as inputs until the following period.[4/] This in turn implies that the rate of profit determined by the model is an instantaneous rate. As such, it should form part of the costs of production.

Secondly, equations (7) utilise depreciation coefficients which are assumed to be exogenously specified. This is only appropriate to special types of capital goods.[5/] Typically, depreciation charges will be a function of the rate of profit and should, therefore, be considered as endogenous variables. As noted in chapter II,[6/] this requires that capital goods be dealt with in terms of a joint production framework. This is totally absent from Walras' work.

1/ Wicksell (1901), p. 171.
2/ Walras (1874), p. 242.
3/ Morishima (1977), p. 195.
4/ Walras (1874), p. 283.
5/ Morishima (1977), pp. 196-198.
6/ Section (iv).

Thirdly, equations (7) also indicate that the current or spot prices of productive services form the basis for the production of capital goods. However, as the stocks of capital goods change, so too will the equilibrium and, therefore, possibly, these spot prices. Walras should, therefore, have allowed for expected capital gains and losses in equations (7).[1/] He did not do so and thereby implied that agents' expectations were static and held with certainty, i.e. that current prices were confidently expected to rule in all future periods.[2/] This implies that agents do not learn by their mistakes but continue to act in ways that produce the same mistakes. Although this does not contradict the assumed rationality of agents it is unreasonable behaviour. Moreover, unless expectations are realised, the rate of profit determined by Walras' model is only an expected rate of profit and not the rate which will actually prevail. To determine the latter the temporary equilibria of subsequent periods would have to be specified.

Fourthly, it is assumed that the demand for capital goods arises from intertemporal utility maximisation by consumers. This implies that intertemporal preferences exist. But, if preferences concerning commodities at different times are known, then the demands for the commodities which directly satisfy wants can be specified. Why then are the markets in Walras' model limited to spot markets, to markets for currently available commodities? Why is there no intertemporal trading of commodities through the medium of future markets?[3/]

These are important limitations and they have all been overcome by subsequent developments in general equilibrium

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1/ Montgomery (1971), p. 280.

2/ Wicksell (1901), pp. 226-227.

3/ We return to this point below, pp. 245-246.

theory: most notably in the theory of dated commodities, as developed by Debreu.[1/2/] Time is divided into a finite number of periods or dates.[3/] Commodities are distinguished by their relevant physical characteristics and by their date of availability.[4/] Thus, for example, an orange at date t is considered to be a different commodity from an orange at date t + 1. It is assumed that agents make consumption and production plans involving all commodities and all dates. The definitions of consumption sets, production sets, preferences, initial endowments and budget constraints are specified accordingly.[5/] Demands and supplies are thereby defined for all commodities at all dates. Since equilibrium requires the clearing of all markets, each commodity is priced in equilibrium.

Markets involving goods with a date in the future are called 'futures' or 'forward' markets, to distinguish them from markets for currently available goods, called 'spot' markets. However, since the definition of equilibrium also involves the

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1/ Debreu (1959).

2/ There have been two major strands in the development of neo-classical general equilibrium theory since Walras. Both stem from Hicks (1939). The first has been concerned to refine the model of temporary equilibrium. The second is the development of models involving a full complement of futures markets. It is this second strand which is considered in this chapter, as it is most relevant to the topic of this thesis. For a 'modernisation' of Walras' own temporary equilibrium theory see Diewert (1977) and Morishima (1977).

3/ Debreu (1959), p. 29.

4/ Debreu also distinguishes commodities by their locational and 'state of the world' characteristics. However, we leave aside these complications as they are of limited relevance to the theory of profit.

5/ See Howard (1979), p. 51.

simultaneous clearing of all markets, this means that all transactions must occur at the present. In other words agents trade in all commodities at one instant in time. They make choices not only regarding goods in the first period but also goods in all future periods. Since it has been assumed that agents have choice sets and preferences defined over all commodities, there is no difficulty here from a logical point of view.[1/]

The prices of future commodities would be interpreted as 'present-value prices'. For example, the price of oranges in period 6 would be the amount agents had to pay now (the decision instant), for the delivery of one orange five periods hence. Transactions involving the exchange of commodities at different dates are 'borrowing' and 'lending' transactions. Lending means supplying commodities at some date in exchange for commodities at some later date. Borrowing involves the converse: supplying commodities at, say, date t in exchange for commodities at date t - 1.

An economy which we have just described is usually called intertemporal, and likewise an equilibrium it possesses is called an 'intertemporal equilibrium'. However, this term is somewhat misleading in that there is no sequence of trading through time. Any equilibrium that exists does so at an instant of time in the first period. This makes clear the ex ante nature of equilibrium. Equilibrium is one of plans, of planned demands and planned supplies.

1/ Market economics are not characterised by a full complement of forward markets. However, if it is assumed that agents obey their budget constraints, that agents know their choice sets, that preferences are complete and that there are no transactions costs, then it follows that demands and supplies for commodities with delivery dates in the future will exist. These assumptions are pervasive throughout neoclassical theory and it follows that in such circumstances it is the absence of futures markets from models which is questionable and not their existence.

This conceptualisation overcomes the limitations of Walras' own formulation. Equations (4) and (6) would still hold for those goods that were produced in non-negative quantities in any period.[1/] But, since in the inter-temporal model prices are present value prices, it is not implied that profits are absent from costs of production or that the production period is instantaneous. The proper treatment of capital goods in terms of joint production processes fits naturally into this theory. Each commodity is specified by physical characteristics and date of availability, so that correct depreciation charges will automatically be manifest in the different prices. Since there is a full complement of forward markets there is simply no role for price expectations or for the commodity e. Rates of profit which are determined by the theory are, therefore, not simply anticipated rates of profit, but rates which will be realised providing the equilibrium is attained.

(v) Defects of Walras' Theory of General Equilibrium

As we have seen, [2/] Walras stated the existence problem in terms of an equality between the number of equations and unknowns. It was believed that such an equality would ensure that the unknowns could be determined so that equilibrium could be shown to exist. It is now known that this procedure is mathematically invalid and, moreover, is of limited relevance to the problem of proving the existence of economic equilibrium.

1/Equations (4) and (6) would not, however, form part of the specification of equilibrium conditions in the Debreu model. See section (v) below and Morishima (1977), pp. 86-89.

2/Section (iii).

The equality between the number of equations and unknowns is neither a necessary or a sufficient condition for the existence of a solution to such equations;[1/] and, even if mathematical restrictions are placed upon the equations to ensure that at least one solution exists, this is of slight economic importance. A proof that economic equilibrium exists requires that the solution values of the unknowns are economically feasible. It must, therefore, rule out the possibility of negative quantities occurring. Furthermore, even if this problem does not arise in an equation set that represents an economic model, it does not overcome the fact that any such model is of limited economic significance to general economic equilibrium. Equations are not the appropriate mathematical relations to represent an equilibrium. There are certain commodities for which the supply perpetually outstrips the demand although no economic agents' plans need remain unfulfilled. This would be the case if the price of such commodities equalled zero and agents could freely dispose of surpluses. Walras' procedure assumes at the outset that all commodities are scarce. It thereby assumes that the endogenous variables lie within a certain range of values. This is methodologically inadmissable. It is only exogenous data that can be so constrained.

This indicates another defect in Walras' procedure. Walras normalised prices by setting the price of one commodity equal to unity. Such a commodity is called a numeraire and it was believed that this procedure was innocuous owing to agents'

1/ See Dorfman, Samuelson and Solow (1958), chapter 13, Stackleberg (1933) and Arrow (1968) and (1974).

choices being homogeneous of degree zero in absolute prices.[1/] However, this is not true. It may be that the equilibrium requires the commodity picked as numeraire to be a free good. In this case the prices of all other commodities would become undefined.

All of these limitations to Walras' theory of general equilibrium were overcome in subsequent developments. During the nineteen thirties mathematically correct procedures were adopted to prove existence;[2/] and, since the nineteen fifties, a large number of existence proofs have been developed on a mathematically sound basis.[3/]

These proofs have also taken into account the fact that solutions to a set of mathematical relations are of no significance unless the solutions represent meaningful economic activity. This has been achieved by ensuring that the assumptions on which existence has been proved do not allow negative quantities into a solution set.[4/]

Furthermore, and again beginning in the nineteen thirties, the definition of equilibrium has been changed to allow for the possibility of free goods which are not known to be free

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1/ Howard (1979), p. 34.

2/ By Wald (1936) and Neumann (1937). See Arrow (1968) and (1974).

3/ The Brouwer and Kakutani fixed point theorems have become the standard mathematical tools for proving these existence theorems. Debreu (1959) utilises the Kakutani theorem. Apart from Debreu (1959), existence proofs have also been provided by Arrow and Debreu (1954), Gale (1955), McKenzie (1959), Debreu (1962) and Arrow and Hahn (1971).

4/ The simplest way that this can be achieved is by assuming at the outset non-negativity constraints on quantities. See, for example, Dorfman, Samuelson and Solow (1958), chapter 13. However, this is only one way in which solutions can be guaranteed to be economically meaningful. It is not a procedure adopted by Debreu (1959), for example.

apriori.[1] This has been accomplished by stating the definition of equilibrium in terms of weak inequalities. Rather than requiring supply to exactly equal demand on each market, the weaker condition of no excess demand has been utilised. In other words the equilibrium condition becomes $E_i \leq 0$, for all i, where E_i represents the excess demand for commodity i.[2] Coupled with this has been the adoption of more appropriate normalisation procedures. For example, provided there are assumptions which ensure that at least one price is positive and none are negative, the normalisation condition $\sum_i p_i = 1$ overcomes the difficulty stated earlier.[3]

The developments in general equilibrium theory since Walras have also been characterised by a search for generality. A measure of this progress can be made by comparing Debreu's assumptions with those of Walras. Walras' formulation made a number of restrictive assumptions which Debreu shows to be redundant to a proof of existence. Walras assumed that consumer demands and supplies were derived from cardinal and additive utility functions, that these demands and supplies were single-valued functions and that returns to scale in technology were constant. Debreu, by contrast, uses much weaker assumptions in his proof of existence. Consumer preferences are only required to be complete, transitive,

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1/ See Schlesinger (1933) and Arrow (1968) and (1974).

2/ See Howard (1979), pp. 37 and 44, for the role which this condition plays in Debreu's proof of existence. See also p. 225.

3/ This is Debreu's procedure. He assumes free disposal, non-reversibility in production and non-satiation in consumption, which ensures that at least one price is positive and none are negative in equilibrium. See Howard (1979), pp. 36-46.

reflexive, continuous and convex.[1/] These assumptions, and those covering producers, do not imply that agents choices are single-valued functions of prices although they do not preclude them from being such.[2/] The assumptions on technology are such as to rule out increasing returns to scale, but do not imply constant returns to scale.[3/] A proof based upon these more general assumptions is a great advance theoretically. Economists lack detailed information about the characteristics of consumers' tastes and technological relationships. Consequently it is a real boon to have a theory which holds under relatively weak assumptions.

The conclusions of the existence analysis carried out by modern general equilibrium theorists can be briefly summarised as follows. There are three conditions which must be met. Agents' choices must exist. These choices must vary continuously with prices and the value of these choices must always sum to zero in aggregate.[4/]

The first requirement is an obvious one since Walrasian general equilibrium theory is a theory of supply and demand.[5/] However, there is no requirement that choices have to be unique for a given price vector. The second requirement can be illustrated with a simple example. Consider the production set in figure 1.

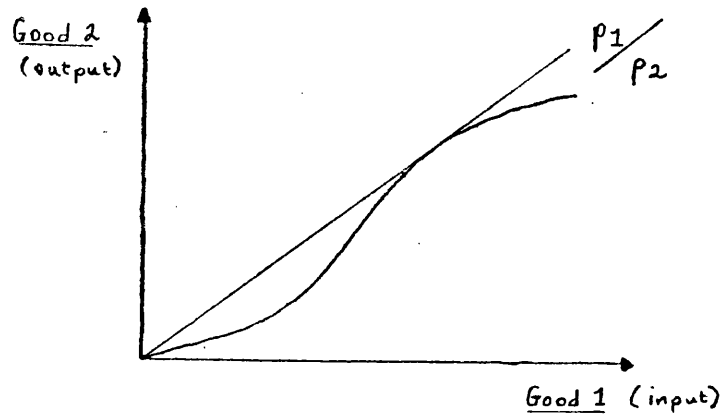
1/ See Debreu (1959), chapters 3,4 and 5, and Howard (1979), pp. 29, 36-46.

2/ See Howard (1979), pp. 46-47.

3/ See Howard (1979), pp. 44-45.

4/ Symbolically this condition requires $\sum_i p_i E_i = 0$ and is usually called 'Walras' Law'.

5/ Debreu meets this requirement by assuming that the maximising behaviour of agents is constrained by closed choice sets. See Howard (1979), pp. 38-46.



At a p_1/p_2 greater than that indicated in the figure, the profit-maximising output would be zero and when relative prices passed through the critical level there would be a sudden discontinuous increase in the demand for commodity 1 and the supply of commodity 2. There is, therefore, a gap 'in which an inequality between supply and demand can be fitted.'[1/2/]

The third requirement is straightforward. Without it there would be the possibility of a positive value of excess demand or excess supply at any price set. This would obviously contradict the condition of equilibrium which requires $E_i \leq 0$ for all i with $p_i = 0$ if $E_i < 0$.[3/]

These are the conditions required to ensure that an equilibrium exists. Whether they are regarded as 'reasonable' or 'unreasonable' depends on the theoretical structure which governs our perception of the world. As far as modern general

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1/ Arrow and Hahn (1971), p. 169.

2/ Debreu ensures continuity by assuming commodities are perfectly divisible, that consumption sets are bounded, that preferences are continuous and choice sets are convex. See Howard (1979), pp. 38-46.

3/ Debreu ensures this by assuming maximisation subject to budget constraints, non-satiation in consumption and the possibility of zero production levels. See Howard (1979), pp. 38-46.

equilibrium theorists are concerned, they see the most unreasonable assumptions to be those underlying continuity.[1/]

(vi) Comparative Statics

Walras' comparative static analysis was relatively sparse.[2/] Moreover, he sometimes stated propositions without proper analysis of the complex issues involved.[3/] Modern Walrasians have repaired this defect and in doing so have concluded that the postulates of Walrasian theory 'are too weak to allow much headway'.[4/] ' ... The kind of parameter changes for which predictions become possible are pretty limited'.[5/] ' ... The information provided by the foundations of the models, profit and utility maximisation, are insufficient to give us definite answers ...'[6/] However, the ' ... negative lesson is ... useful, for it points to the dangers of partial analysis, in which it is often possible to get quite definite predictions of the consequences of a given parameter change.'[7/] In the following chapter an important example of these general principles is given in relation to a Sraffa-based critique of Walrasian theory.

1/ See, for example, Arrow (1968), pp. 382-383.

2/ See Hicks (1939), pp. 2 and 60 and Morishima (1977), pp. 7 and 97-99.

3/ See Collard (1973).

4/ Arrow and Hahn (1971), p. viii.

5/ Arrow and Hahn (1971), p. 245.

6/ Arrow and Hahn (1971), p. 261.

7/ Arrow and Hahn (1971), p. 262. See also Bliss (1975), pp. 33, 85.

(vii) The Distributional Properties of a Debreuvian Intertemporal Equilibrium of Supply and Demand

In section (iii), Walras' theory of general equilibrium and profit was dealt with, and in sections (iv) and (v) the improvements which have been made subsequently were outlined. These have important implications for the theory of profit beyond those matters considered in section (iv). Here these implications are spelt out by analysing the distributional properties of an intertemporal equilibrium.

1 Causal structure

There is a clear continuity with Walras' work as regards the causal structure of modern general equilibrium theory. The classification of elements into exogenous and endogenous remains the same. The commodities available, consumer preferences, technology and initial endowments, together with maximising behaviour, determine the endogenous variables, prices and quantities traded. There is a good reason behind this stability of causal structure. ' ... In the general equilibrium analysis of ... Walras, the content of the historical discipline of theoretical economics is practically exhausted. The things which are taken as data for that system happen to be matters which economists have traditionally chosen not to consider as within their province'.[1/]

2 Marginal products

The development of neoclassical economics is frequently referred to as the 'marginalist revolution' because of the emphasis placed upon the construction of theory by means of marginal concepts. Walras' general equilibrium theory is

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1/ Samuelson (1947), p. 8.

rightly considered a part of this revolution.[1/] But this aspect does not characterise Debreu's theory. Marginal concepts are not required in its formulation. However, these concepts may be utilised to explain the properties of an intertemporal equilibrium and it is useful to do so.

In equilibrium agents cannot improve upon their choices. For any producer this means no feasible input-output vector exists which is associated with more profit. This implies that certain relationships between marginal rates of substitution, marginal rates of transformation and relative prices will characterise equilibrium <u>if such marginal concepts can be defined</u>. In such circumstances the representation of equilibrium by means of marginal relationships follows from maximisation behaviour.

So far as distributional matters are concerned the relevant marginal relationship is that of the rate at which an input can be transformed into an output. We define this rate of transformation as the rate at which it is technically efficient for a producer to transform an input into an output when other inputs and outputs are held constant at some level. It becomes a marginal rate when it is written as a partial derivative, $\partial y_1 / \partial y_2$ where y_1 is an output and y_2 an input. In this form it is usual to call it the marginal physical product of y_2 in the production of y_1.

1/ As we have seen in section (iii) Walras specified consumers' tastes in terms of marginal utilities. Technological relationships were not specified in terms of marginal products. However, in part VII, Lesson 36, of the <u>Elements</u> Walras did introduce marginal concepts into production. See also Jaffe (1954), pp. 549-553.

These marginal concepts may not be derivable, or, as it is usually stated, they may be undefined. Assuming that commodities are perfectly divisible it is required that the boundaries of production sets be continuous and differentiable. These conditions are more restrictive than those required to ensure the existence of an equilibrium. Differentiability is not required by Debreu's proof.

Assuming continuity the equilibrium price of any factor of production must bear distinct relationships to marginal physical products. This is represented in the following inequalities for the case of labour and an output y_1.

$$\left(\frac{\partial y_1}{\partial l}\right)_- \geq \frac{w}{p_1} \geq \left(\frac{\partial y_1}{\partial l}\right)_+$$

$(\partial y_1/\partial l)_-$ represents the left-hand marginal physical product. It indicates the rate at which y_1 decreases as the labour input is reduced an infinitesimally small amount. $(\partial y_1/\partial l)_+$ represents the right-hand marginal physical product. It indicates the rate at which y_1 increases as the labour input is increased by an infinitesimally small amount. p_1 is the price of y_1 and is assumed to be positive. w is the wage rate and is measured in a fictional unit of account, as is p_1. w/p_1 therefore represents the wage measured in y_1.

The inequalities can be restated in terms of marginal <u>value</u> products. If we multiply through by p_1 in the above inequalities, we obtain

$$p_1\left(\frac{\partial y_1}{\partial l}\right)_- \geq w \geq p_1\left(\frac{\partial y_1}{\partial l}\right)_+$$

The multiplication of a marginal physical product by the price of the output gives a marginal <u>value</u> product. These inequalities state that the equilibrium wage rate lies between the left-hand and right-hand marginal value products. They indicate

that no 'small' change in the employment of labour can increase profits.

Provided that there is continuity these two sets of inequalities must characterise equilibrium for a profit-maximising producer. Similar inequalities must also hold for all other input-output pairs, i.e. y_1 and 1 can represent any output and any input. If the differentiability condition is met, so that the boundaries of production sets are smooth then the marginal product associated with any input, for any positive level of employment, can be defined for the commodities it produces. For such inputs the above inequalities collapse to sets of equalities and they receive a price equal to their marginal products.

What is the causal significance of marginal products? In particular, is it valid to say that marginal products determine factor prices? To answer such questions we need to consider the structure of the Debreu model. The exogenous elements of that model, i.e. those which are assumed given a priori, are (i) consumers' consumption sets and preferences, (ii) consumers' initial endowments, and (iii) producers' technologies. These, together with the behavioural assumptions of maximisation, may be said to determine the equilibrium values of the endogenous variables (which include factor prices) in the following sense. Assuming that the exogenous elements are compatible with the existence of at least one equilibrium, then the exact forms which these elements take determine the set of equilibria which exist. They therefore determine the values of the endogenous variables in these equilibria. Provided the boundaries of the producers' production sets are continuous, concepts of marginal

products can be formulated in the way outlined above. The marginal physical products are embedded in the technology of producers. They are not required to be made explicit in the construction of the theory but we may describe producers' technology through them. Consequently they may be regarded as a representation of the exogenous technological elements of the model. Thus it is legitimate to say that marginal physical products are a determinant of equilibrium factor prices. However, this cannot be repeated for marginal value products. These are endogenous variables because their magnitudes depend on the set of equilibrium prices.

3 Own rates of interest [1/]

Debreu's theory of general equilibrium can be explained independently of any mention of profit rates. The theory determines all equilibrium prices. Coupled with information about initial endowments and agents' choices, all distributional magnitudes are determined for every time period. However, just as marginal products may be implicit in such a theory, so are profit rates. Marginal physical products, if they can be defined, are embedded in the specification of technology, and marginal value products are given by these once prices are known. Profit rates, if they can be defined, are implicit in a price set. Once we have an equilibrium we can calculate all relevant equilibrium profit rates. There is no need to consider the distribution of income in such terms, but no further theory is required in order to be able to do so.

1/ The term 'own rate of interest' is used in this section rather than the term 'own rate of profit' as the former is the established terminology.

Commodities are differentiated in two respects: physical specification and date of availability. If there are T periods, then each physically defined commodity has T prices, one for each date. Assume that there is a physically specified commodity that has a non-zero price on all dates. Designate this as commodity 1. It is conventional to define the 'own rate of interest' of commodity 1, between any two dates t and $t + \alpha$ (where α is some integer greater than zero but such that $t + \alpha \leq T$), as follows:

$$r^1_{t,t+\alpha} = \frac{p_{1,t} - p_{1,t+\alpha}}{p_{1,t+\alpha}} = \frac{p_{1,t}}{p_{1,t+\alpha}} - 1$$

$p_{1,t}$ and $p_{1,t+\alpha}$ are the present-value prices of commodity 1 on the dates t and $t + \alpha$ respectively. For example, if T = 3 and the prices of good 1 were $p_{11} = 6$, $p_{12} = 4$ and $p_{13} = 1$, then we would have the following own rates of interest:

$$r^1_{1,2} = \frac{6}{4} - 1 = \frac{1}{2}$$

$$r^1_{1,3} = \frac{6}{1} - 1 = 5$$

$$r^1_{2,3} = \frac{4}{1} - 1 = 3$$

The superscript denotes the commodity, and the subscripts the dates between which the rate is calculated. If there are T periods there will be

$$\frac{T!}{(T-2)! \times 2}$$

own rates of interest for good 1.

What does the concept of an 'own rate of interest' mean? The rate between t and $t + \alpha$ for commodity 1 indicates the extra amount of that commodity which can be received by an agent at date $t + \alpha$ for every unit given up in period t. Each agent is a price-taker and confronts the whole price set at the

decision date (date 1). Thus, for an agent who faced the prices in the numerical example above, that agent could receive an extra $\frac{1}{2}$ of a unit of good 1 by postponing delivery of one unit of good 1 from the present period to the next period. The agent could receive an extra 5 units, per unit surrendered in the first period, if delivery is deferred for two periods to date 3. And if one unit is given up at date 2, an extra 3 units can be received one period hence. Own rates of interest therefore indicate the rate at which agents can lend and borrow a good between any two dates.

Some own rates of interest can be negative. However, if all prices are non-negative, then all defined interests rates are greater than, or equal to, -1. Some, or all, interest rates may be undefined, in the sense that they will not exist. This will be the case in the above if $p_{1,t+\alpha} = 0$, for division by zero is not defined. In the rest of this section we will assume that all prices are positive so that such interest rates can always be computed (and will lie between -1 and ∞).

The above illustrates that the own rate of interest of good 1 between any two consecutive dates need not be equal to that between any other two consecutive dates. For them to be equal we would require:

$$\frac{p_{1,t}}{p_{1,t+1}} = \frac{p_{1,t+1}}{p_{1,t+2}} = \frac{p_{1,t+2}}{p_{1,t+3}} = \ldots = \frac{p_{1,T-1}}{p_{1,T}}$$

In general there is no reason to expect an equilibrium price set to have such a property. One can easily imagine, for example, that taste patterns and technological change operate in such a way as to produce changing rates.

A set of own rates of interest can be constructed for each physically specified commodity in just the same way as was done for good 1 above. If there are n physical commodities and T periods, there will be nT prices and $nT!/(T-2)! \times 2$ own rates of interest. Consequently there will be a set of 'own wheat rates of interest', 'own iron rates of interest', and so on. Furthermore, for any pair of consecutive periods the own rate of interest of different physical commodities need not be the same. For them to be the same between any two dates, t and t + 1, we would require:

$$\frac{p_{1,t}}{p_{1,t+1}} = \frac{p_{2,t}}{p_{2,t+1}} = \frac{p_{3,t}}{p_{3,t+1}} = \ldots = \frac{p_{n,t}}{p_{n,t+1}}$$

This implies that

$$\frac{p_{i,t}}{p_{j,t}} = \frac{p_{i,t+1}}{p_{j,t+1}}$$

where i and j are any two commodities. There is no reason to expect that an equilibrium set of prices will have this property of constant relative prices. It is easy to imagine cases where the exogenous elements of the model are such that in equilibrium relative prices change over time.[1/]

It may seem 'peculiar' for own rates of interest on different goods to differ between the same two dates. How can it be that an equilibrium is characterised by all agents maximising, yet these same agents can get different interest rates on their loans, depending on the commodity they choose to

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1/ Many economic theorists have made this basic point. See, for example, Koopmans (1957), pp. 113-115, Malinvand (1972), pp. 231-234 and Bliss (1975), pp. 50-55.

borrow and lend in terms of? That there really is no contradiction can be seen in two ways.

First, since the equality of own rates of interest between the same two dates requires relative prices to be unchanged, it is sufficient to imagine an example where in equilibrium these relative prices do change. This is easy to do. Consider the case where, between two dates, the only technical change occurring is one that reduced all the inputs required to produce one unit of commodity 1 by a half. It would be difficult to believe that the time preference of consumers' tastes would be such as to stop the price of good 1 falling relative to at least some others. As such the own rate of interest of good 1 would be higher than these other goods.

Second, agents maximise in terms of prices that they face. Consumers choose a consumption bundle and producers an input-output bundle. Assume that there are two goods and two periods. Say the prices were $p_{11} = 1, p_{12} = 1\frac{1}{2}, p_{21} = 1$ and $p_{22} = \frac{1}{2}$. The own rate of interest of good 1 between the two dates would be $-\frac{1}{3}$ and the corresponding own rate of interest of good 2 would be 1. Now assume that an agent has an initial endowment of good 1 in the first period and that the agent receives no utility from good 2 in any period. Choice for the agent then involves deciding the relative consumption levels of good 1 in the two periods. Given any feasible level of consumption in period 1, can the agent increase the consumption of good 1 in period 2 by trading in good 2, rather than just trading in good 1? The different rates suggest there might be. In other words which of the following is the best strategy?

(i) Buy good 2 in the first period, lend it at an 'own' rate of interest of 100 per cent, and then purchase good 1 in period 2 with the proceeds.

(ii) Lend good 1 until period 2, thereby receiving a negative rate of interest equal to 33⅓ per cent.

No matter which set of trades is adopted, the agent cannot increase the consumption of good 1 in period 2, per unit of good 1 given up in period 1. In both cases, for every unit of good 1 in period 1 used to increase consumption in the future, the agent receives two-thirds of a unit of good 1 in period 2. The same situation will be true for any other set of prices. It is no advantage for any agent to trade in the commodity with the highest (or lowest) own rate of interest. Having chosen a commodity bundle, no matter what system of trades leads to that bundle, its cost will always be the same.

This completes the analysis of the distributional relations inherent in a Debreuvian intertemporal equilibrium. In the next chapter various critical arguments stemming from Sraffa's 'Production of Commodities' are considered.

CHAPTER XII

WALRASIAN PROFIT THEORY AND THE 'PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES'

(i) Introduction

The practitioners of modern Walrasian theory stress the importance of logical consistency in analysis rather than the direct empirical applicability of the propositions derived.[1/] This is partially explained by the fact that these theorists have been concerned with analysing the conditions under which the propositions developed by non-Walrasian economists may be rigorously deduced.[2/] Lying behind this activity has been the view, increasingly pervasive amongst neoclassical economists in the twentieth century, that Walrasian analysis can provide a comprehensive theoretical framework for neoclassical economics as a whole. In terms of this view the neoclassical theory of capital productivity, the Austrian theory of capital and Marshallian partial equilibrium theory are seen as involving specialisations of the assumptions lying behind modern Walrasian theory.[3/] Thus, if Sraffa's analysis were to expose a flaw in modern general equilibrium theory the implications for

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1/ See, for example, Debreu (1959), p. x.

2/ This concern is exhibited, for example, in the quotations from Arrow and Hahn (1971) in section (vi) of chapter XI. See also Hahn (1973a) and (1973b).

3/ See, for example, Schumpeter (1954), Koopmans (1957), Samuelson (1962), Arrow and Hahn (1971), Malinvaud (1972), Arrow and Starret (1973), Burmeister (1974), Klundert and Schaik (1974), Bliss (1975) and Dixit (1977).

neoclassical economics as a whole, and not just for the theory of profit, would be immense and far more important than anything else discussed in this thesis.

A Sraffa-based critique of Walrasian theory, and particularly of Walrasian profit theory, has been developed by a number of theorists. This critique has three major elements. Firstly, it is argued that the existence of an equilibrium of demand and supply is far more problematic than established existence proofs indicate. Secondly, it is maintained that even when an equilibrium of demand and supply can be shown to exist this is of no relevance for the theory of profit. Thirdly, there is an argument which states that the comparative static propositions of Walrasian theory are incorrect or, at best, seriously misleading. In sections (iii) to (v) of this chapter each of these matters is investigated. Before doing so, however, it is informative to consider how Sraffa, and those who have built up a critique of Walrasian theory on the basis of Sraffa's analysis,[1/] understand the nature of the theory they criticise.

(ii) Walrasian Economics and Marginalism

In the preface to the 'Production of Commodities by Means of Commodities', Sraffa states that it is 'a peculiar feature of the set of propositions now published that, although they do not enter into any discussion of the marginalist theory of value and distribution, they have nevertheless been designed to serve as a basis for a critique of that theory'.[2/]

1/ For example, Garegnani, Pasinetti, Robinson, Harcourt, Roncaglia and Eatwell.

2/ Sraffa (1960), p. vi.

A notable feature of this quotation is that the phrase 'the marginalist theory of value and distribution' is exceedingly vague. However, if we take its terms seriously, there is no way in which modern Walrasian analysis would form part of the theory Sraffa aimed to attack. Modern Walrasian theory is not marginalist. As has been pointed out above,[1] no marginal concept is required in its construction and although the relationships holding in a Debreuvian equilibrium can often be expressed in marginalist terms there is no need to do so.[2]

1/ pp. 227-228.

2/ It is also important to note that the analysis of chapter VIII, which undermines the marginal productivity relationships proposed by neoclassical productivity theorists, has no implications for the marginal productivity results discussed in section (vii) of chapter XI. This is because of a difference in definition. In chapter VIII the marginal product of capital was defined as the (limiting) ratio of the increment of output to the increment of capital, when we compare two systems of production that are operated at different rates of profit. These different rates of profit give rise to different wage rates and equilibrium prices. In other words, the marginal product of capital was defined as $\lim_{\Delta k \to 0} \frac{\Delta q}{\Delta k}$ with r and w allowed to vary. Consequently 'capital' has two dimensions, prices and quantities, and a 'change' in capital will, in general, involve a change in both. This the marginal product of capital is not defined by the partial derivative $\partial q / \partial k$, where r and w are held constant, which in turn means that prices are held constant. However, this partial derivative formulation is the 'appropriate' definition of the marginal product of capital in a Walrasian analysis, for it follows the definition of other marginal products. Furthermore, if we calculate its value by differentiating $q = rk + w$ as above (p.152) we find that $\partial q / \partial k = r$ because the differentials dr and dw are equal to zero, given the assumed constancy of w and r. It should also be noted that this concept of a marginal product of capital is 'sensible'. Assuming differentiability, it is understandable why it would be equal to r in equilibrium for it is an implication of profit maximisation. This cannot be said for the marginal product of capital concept of the productivity theorists. This concept cannot be related to the maximising behaviour of individual agents.

There is, however, considerable evidence to suggest that those theorists who have sought to undermine all forms of neo-classical economics on the basis of Sraffa's work have not realised this. For example, Garegnani defines 'modern value and distribution theory' as ' ... theory based on the marginal method that has held almost undisputed sway over economic thought since the last quarter of the nineteenth century. At its heart lie the twin concepts of 'marginal utility' (i.e. the increment of satisfaction derived from a unit-increment of consumption of a particular good) and 'marginal product' (i.e. the increase in output associated with a unit-increment of the 'factor of production' applied). By correlating a decrease in utility and marginal product with an increase in the good and the factor of production respectively, this theory has sought a rational foundation able to sustain the notion of 'demand' for 'factors of production' (traditionally, labour, capital and land) - demand which is supposed to determine, by coming together with the corresponding 'supply', the return on the various factors of production. This coming together or 'equilibrium' of the demand and supply of factors of production involves, in turn, similar equilibria on the output markets, thereby determining the price of various products.'[1/]

This view is by no means exceptional.[2/] It follows that the Sraffa-based critics of Walrasian theory have a fundamental misconception as to the nature of the theory they seek to undermine. It should, therefore, come as no surprise that their critique is lacking in substance.

1/ Garegnani (1978c), p. 71.

2/ For example, see Roncaglia (1977), (1978), Harcourt (1972) and Pasinetti (1969), (1973) and (1977a).

(iii) The Existence of an Equilibrium of Demand and Supply

Garegnani has argued that the existence of an equilibrium of demand and supply depends critically upon assuming the absence of capital reversal.[1/] He argues as follows. The 'core' of traditional theory in all its versions is 'the idea that in a competitive economy, wages and interest are governed by the demand and supply for "capital" and labour'.[2/] This theory 'rests in fact on a single premise. This premise is that any change of system brought about by a fall of r must increase the ratio of "capital" to labour ... "capital" being the value of physical capital in terms of some unit of consumption goods, a value which is thought to measure the consumption given up or postponed in order to bring the physical capital into existence'.[3/] Consequently, with the recognition of capital reversal as a definite possibility we 'undermine the ground on which rests the explanation of distribution in terms of demand and supply for capital and labour'.[4/]

Garegnani provides an argument, based upon the example presented in section (iii) of chapter VIII, which seeks to substantiate these points. 'The relation between r and K - the traditional 'demand function' for capital (saving) - was based on two assumptions: (a) that in the situation defined by each level of r, the labour employed is equal to the supply of it at the corresponding level of w; (b) that the composition of consumption output is that dictated by consumer demand at the

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1/ Garegnani (1970a). See also Garegnani (1966) and Harcourt (1971), (1972) and (1977a).

2/ Garegnani (1970a), p. 247.

3/ Garegnani (1970a), p. 271.

4/ Garegnani (1970a), p. 274.

prices and incomes defined by the level of r. We shall now grant these assumptions, but we shall restrict the choice of the consumers by supposing at first, zero net savings (i.e. in each situation, the capital goods are consumed and reproduced in unchanging quantities year by year). From these assumptions, and from what we saw about changes in the systems of production ... it follows that K may fall or rise, as r falls.

To clear the ground, we must now grant traditional theory two further assumptions in addition to (a) and (b): namely that (c) a tendency to net saving (i.e. a fall in consumption) appearing in the situation defined by a given level of r, brings about a fall of r; (d) as r and w change, with systems of production and relative outputs changing accordingly, net savings realized in the economy can still be meaningfully defined, and can be measured - however broadly - by the difference between the K of the final and that of the initial situation.

Let us now imagine that the economy is initially in the situation defined by the level r* of the rate of interest, with K* as the amount of capital. Then a tendency to positive net savings appears (i.e. consumption is reduced). We assume that, after a time, the tendency to net saving disappears so that, if a new equilibrium is ever reached, the level of consumption will become that of the situation which corresponds to the new lower equilibrium value of r.

We must now ask whether - as r falls from r* to some level $\bar{r}$ because of the initial tendency to net saving - a new situation can always be found with an additional quantity of capital ΔK representing the net savings which the community intended to make during the period. The form of the relation

between r and K implies that such a new situation cannot always be found: however high r* is, and however small ΔK, there may well not exist any lower rate of interest r at which $K = K^* + \Delta K$ ... (see figure 1 below).[1/] ... r may fall to zero or rise to its maximum ... without bringing to equality the quantities supplied and demanded of the two factors. ... The natural conclusion is that, in order to explain distribution, we must rely on forces other than 'supply' and 'demand'. The traditional theory of distribution was built, and accepted, in the belief that a fall of r - and increase in w - would always raise the proportion of 'capital' to labour in the economy: the theory becomes implausible once it is admitted that this principle is not always valid'.[2/]

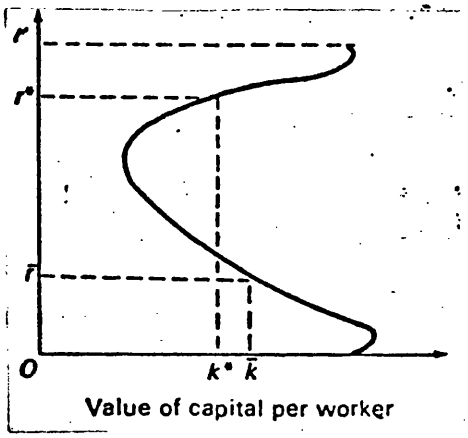

Figure 1

1/ The model underlying figure 1 was outlined in section (iii) of chapter VIII. The relation between K and k is a linear one given the assumption that the labour force in each system is constant. Therefore, a demand for an amount of K can be easily reinterpreted as a demand for k.

2/ Garegnani (1970a), pp. 275-278.

It is true, of course, that an equilibrium of demand and supply may not exist. What is notable about Garegnani's argument, however, is that it does not relate to those matters which modern Walrasians, like Debreu, take as critical to ensuring existence. It was pointed out above[1/] that, if choices are determinate, if these choices vary continuously with prices and if there can never be a non-zero value of excess demands in aggregate,[2/] then the existence of an equilibrium is unproblematic. Garegnani's argument makes no reference to these three matters and thereby implies that the established existence proofs are defective. There are, however, three serious flaws in Garegnani's argument.

Firstly, capital reversal is irrelevant to the point Garegnani seeks to prove. Accepting, for the moment, the concepts in terms of which he argues, what is important is whether or not the 'demand curve of capital' is continuous and whether or not it intersects the horizontal axis. If there is a 'hole' in the demand curve or if there is a maximum 'demand for capital' at an r=o, then there will not be an r which will equate the 'demand' for capital with every 'supply'. Whether or not the 'demand curve for capital' has a positive slope over some range, however, is irrelevant to that question.[3/]

1/ Chapter XI, section (v).

2/ i.e. Walras' Law holds.

3/ Accepting the concepts of Garegnani's argument, capital reversal is only relevant to questions of the uniqueness and the stability of equilibrium. In the 'one-commodity model' of chapter VII, section (iv), the Inada conditions ensured that equilibrium exists, is unique and stable.

Secondly, and more importantly, the argument has no force at all in relation to modern Walrasian theory because all commodities are entities defined independently of prices and measured in physical units. Consequently 'value capital' could not be considered a commodity in modern Walrasian theory and there is no demand or supply of value capital to consider in determining the conditions which ensure the existence of equilibrium. Nor does this imply that Debreuvian theory implicitly assumes a non-capitalistic economy. Produced means of production can exist and in every time period rates of return will be equalised.[1/] The assumptions which are made by Debreu define choices adequately from a logical point of view and all endogenous variables are determined.[2/]

The same defence against Garegnani's argument can also be made for Walras' own theory of capital and profit. It is true that Walras does explicitly conceptualise equilibrium in terms of an equality of value capital magnitudes which are based upon agents' choices for perpetual net income.[3/] But this formulation is not essential to the substance of Walras' analysis. Instead, it can be taken to represent an analytical shortcut. The concept of 'perpetual net income' can be regarded as a device whose sole purpose is to simplify analysis. Its

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1/ See section (iv) below.

2/ Also, since 'value capital' is not a commodity in modern Walrasian theory, capital reversal cannot bear upon the questions of uniqueness and stability of equilibria in this theory.

3/ It is, however, important to note that Walras' equality between the demand and supply for value capital relates to an investment and saving equality. More importantly, Walras' demand function for perpetual net income is directly derived from agents' choices. Garegnani's demand function, on the other hand, is not. It is the locus of points showing the changing value of capital in various stationary equilibria. Consequently, Walras' concepts are by no means the same as those involved in Garegnani's argument.

function is twofold. It dispenses with the need to analyse consumer choices over physically specified commodities which are not currently available; and it obviates the need to analyse a consumer's selection of a portfolio of physical capital goods in the current period, which is one means by which future choices are implemented. This complex of decisions is collapsed into a single decision, involving the demand for perpetual net income. The use of this device provides sufficient equations to determine the unknowns but there need be no implication that agents' choices are actually made in terms of value capital.[1/] Walras' formulation of general equilibrium can certainly be criticised. But the important criticisms are those that have already been discussed.[2/] and are independent of the points raised by Garegnani.[3/]

Thirdly, to seek a determination of the rate of profit in terms of the demand and supply of value capital, as Garegnani conceives these concepts, is to commit a serious methodological error. Quite independently of capital reversal, of whether the

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1/ This interpretation of Walras' model is suggested by Schumpeter (1954), pp. 1017-1018. Morishima also notes that while in modern theory 'a market is assumed to lie behind each equation ... there is no specific market behind the Walrasian equation between aggregate savings and aggregate investment. It is a macroeconomic equilibrium condition which reflects equilibrium in many markets.' Morishima (1977), p. 6.

2/ See chapter XI, sections (iv) and (v).

3/ However, Walras did formulate propositions, similar to those of neoclassical productivity theorists, concerning the relation between aggregate value capital and the rate of pofit. See Walras (1874), Lesson 36, and Collard (1973).

'demand curve' is continuous and of whether this curve intersects the horizontal axis, such a theory is flawed. This is because the demand and supply for value capital are not capable of being derived solely from the exogenous components of the theory. Consequently, the demand and supply for value capital cannot meet the requirement of being determinants of any endogenous variables. In short, the problem is not, as Garegnani implies, to do with the position and shape of the demand curve for value capital. The real problem is to do with the very concept itself.[1/]

(iv) Profits and Equilibrium

A second Sraffa-based criticism of Walrasian theory is concerned with the concept of equilibrium employed in this framework. It is argued that the 'market clearing' conception of equilibrium inherent in neoclassical general equilibrium theory is not relevant to the study of profit in a capitalist economy. Instead, it is maintained that, insofar as a concept of equilibrium is useful, it is that of a 'long-period' equilibrium involving uniform prices, a uniform wage and a uniform rate of profit, and this latter notion is not the same concept as a market clearing equilibrium.

This criticism has been stated in various forms. The strongest claim is made in the writings of Robinson. She has repeatedly maintained that neoclassical theory has never 'succeeded in getting out a theory of profits'.[2/]

1/ See chapter VIII, section (viii).

2/ See, for example, Robinson (1973), p. 61. See also, Medio (1977), pp. 385 and 396.

A weaker, but nevertheless severe criticism of Walrasian theory is proposed by Eatwell, who asserts that Walrasian theory is consistent with unequal profit rates in different activities. The notion of equilibrium employed 'is essentially a notion of market clearing prices, defined by an instantaneous intertemporal equilibrium; consumption and production sets being constrained by an arbitrary initial endowment. As a result, whilst the price paid for any commodity is the same whatever may be its use (a long-run concept), the rate of return on produced means of production is not equalised (a short-run phenomenon). But this implies an extraordinary hybrid notion of equilibrium, for, typically the extent of the organisation of production required to equalise the price of non-produced inputs is the same as that required to equalise the rate of profit earned on produced inputs..... The prices defining such an equilibrium are not equivalent, in anyway, to long-run prices ... And the strength of the concept of long-run equilibrium derives from the belief that, even though the future is uncertain, the present disturbed by random events, and the forces of competition distorted by institutional, monopolistic and social factors, there is, in a rough and ready sense, a tendency for capitalistic competition to equalise the rate of profit in all sectors of the economy (and with it the prices paid for non-produced means of production). A long-run equilibrium, so defined, may thus serve as a guide to some of the fundamental distributional characteristics of the system.... The characteristics of the long-run equilibrium thus reflect fundamental characteristics of capitalism, in particular the tendency toward equalisation of the general rate of profit as capitalists attempt to maximise the return on their financial

wealth'. [1]

Garegnani states that such a 'long-period equilibrium' is essentially the concept with which classical economists worked but that it was jettisoned by Walrasian theorists because of the difficulties which supply and demand theory meets in generating a uniform rate of profit. More specifically, he states that the notion of long-period equilibrium is incompatible with 'treating each kind of "capital good proper" as a separate factor in given supply. With a capital endowment conceived in these terms, the forces of demand and supply can only reach a short period equilibrium, i.e. an equilibrium where the price of services or capital goods will not generally be compatible with a uniform rate of profit on the (actual or potential) supply price of the respective capital goods'.[2/3] The 'capital endowment of the economy can be a datum compatible with long-period equilibrium only if it is expressed as a value magnitude'.[4]

Harcourt puts the same point figuratively when he writes that Walrasian economists 'forget' that what they call a rate of profit 'is a completely different animal' from the classical rate of profit.[5] Harcourt also claims that the uniform prices of a long-period equilibrium are more 'fundamental' than market clearing prices.[6]

1/ Eatwell (1976), pp. 95-96.

2/ Garegnani (1976), p. 34. Wicksell (1901), p. 149 makes a similar point.

3/ Garegnani's use of the term 'short-period' is unfortunate. While Walras' concept of equilibrium can be regarded as such, the time scale of a Debreuvian equilibrium is unconstrained apart from the requirement that it be finite. Elsewhere, Garegnani explicitly calls Debreu's theory a 'short-period' theory. See Garegnani (1970b). This terminology is also used by Roncaglia (1978) and, as can be seen, appears in the quotation from Eatwell (1976) given above.

4/ Garegnani (1976), p. 35.

5/ Harcourt (1977a), p. 38.

6/ Harcourt (1972), p. 195. See also Harcourt (1977b), Clifton (1977), Nelland Laibman (1977), Roncaglia (1978) and Bharadwaj (1978).

In evaluating these claims, let us first consider the allegation that Walrasian analysis has no theory of profits. So far as Debreu's work is concerned, this charge is quite obviously nonsense. Debreu's existence proof[1/] shows that an equilibrium exists on specified assumptions. Consequently, the exogenous components 'determine' the endogenous variables which include prices and quantities traded. These specify the profits and rates of profit resulting in each line of activity. Consequently, there is a theory of profit.

Now consider Eatwell's statement that in a Walrasian equilibrium 'the rate of return on produced means of production is not equalised'. If this means that the rates of return to scarce capital assets, calculated on the equilibrium prices of those assets, are not equal, over the same time period, then it is incorrect. Assuming that all commodities are scarce and thus have positive prices, in an equilibrium all rates of return will be equal to the own rate of interest of the numeraire. This is true irrespective of what numeraire is chosen and irrespective of how relative prices change between periods. In other words, rates of return on different assets must be equal in equilibrium when they are expressed in terms of the same commodity. This follows simply from the assumptions of maximisation behaviour on the part of economic agents.

As we have seen, Garegnani makes a related point. He notes that in an intertemporal equilibrium, with a given initial endowment, 'the price of the services of the capital goods will not generally be compatible with a uniform rate of profit on the (actual or potential) supply price of the respective capital goods'. This is correct but irrelevant as a criticism of modern Walrasian theory. As an extreme example consider the following case. There is a physical capital

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1/ Debreu (1959), chapter 5.

good x, and the economy is initially endowed with a number of these goods. They can also be produced with other inputs. x can only be used together with other inputs to produce another good y. An equilibrium exists involving a positive own rate of interest of the numeraire for all periods, a positive price for all other inputs but zero price for y in all periods.[1/] Will the rate of return or profit calculated on the actual or potential supply price of good x be equal to this rate of interest? Obviously not. It will instead equal zero. It is, therefore, quite clear that given an initial endowment of certain reproducible assets there is no need for those assets to earn a uniform rate of return or profit on their 'supply' prices. In other words <u>there is no reason why the ratios of net rentals of different capital goods should equal the ratio of their 'supply' prices</u>. Capitalist competition and profit maximisation is a force ensuring this. Competitive profit maximisation implies that any scarce asset earns a rate of return equal to the own rate of interest of the numeraire, but <u>precisely because of this</u> the equilibrium price of the asset may be below its <u>reproduction cost</u>. [2/3/]

1/For example, this could be the case because y is an output of certain production processes, where it is produced jointly with other commodities on a scale such that supply exceeds the demand at any positive price, in all time periods.

2/ On this point Sraffa does not disagree. See Sraffa (1960), p. 78.

3/ Garegnani's argument, however, does highlight a limitation of Walras' own theory of profit. Walras requires, as part of his specification of equilibrium, that the price of each capital good equals its cost of production. See chapter XI, section (iii).

However, it is incorrect to state that 'the capital endowment of the economy can be a datum compatible with long period equilibrium only if it is expressed as a value magnitude.' If Walrasian theory takes the special case of an economy with constant returns to scale in all activities, and in which intertemporal consumption vectors chosen by consumers can be represented by linear Engel curves, then there will be a special set of initial endowments, which will allow the intertemporal equilibrium to be a 'long-period' equilibrium.[1/] In this case the vector of spot prices can be the same in each period, the price of each reproducible commodity is equal to its cost of production, the rate of profit in each period is the same and the magnitude of this rate of profit is independent of the chosen numeraire.

These points can be reaffirmed by considering the price vector of a Debreuvian intertemporal equilibrium. It was pointed out in chapter XI[2/] that such a price vector defines a multiplicity of rates of profit. Even between the same two dates, own rates of interest of different commodities need not be equal and the own rates of interest of the numeraire, for different pairs of consecutive dates, can be different. It is, however, possible for the own rates of interest of all goods to be equal between any two dates and for them to be the same for all pairs of consecutive dates. This would be so if the spot price of each commodity was the same at each date. In this case, the Debreuvian intertemporal equilibrium would be a 'long-period equilibrium'. Therefore, the concept of a 'long period equilibrium' can be regarded as a special case of Debreu's concept of intertemporal equilibrium. It follows that the rate of profit

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1/ Hahn (1975), p. 360.

2/ Section (vii).

associated with a 'long-period equilibrium' is not a 'completely different animal' from an 'own rate of interest' and that long-period prices cannot be regarded as more 'fundamental' than market clearing prices as Harcourt maintains. Furthermore, it is not clear how Eatwell could believe that a 'long-period equilibrium' can 'serve as a guide to some of the fundamental distributional characteristics' of a capitalist system, any better than Debreu's concept of intertemporal equilibrium from which it may be derived as a special case.

(v) Prices as 'Indexes of Scarcity'.

According to Pasinetti one 'essential analytical' element of neoclassical economics analysis is 'an explanation of prices as "scarcity indexes" and hence as "optimal allocators" of existing resources'.[1/] However, Sraffa's analysis has revealed that this is 'devoid of any foundation'.[2/] Capital reversal indicates that the rate of profit is not an 'index of scarcity'.[3/] Moreover, this is not exceptional. It also applies to the prices of inputs when these inputs are measured in physical units. The 'theoretical world of production of commodities by means of commodities is different from the traditional world of given scarce resources'.[4/] In the former 'world' 'the direction of change of input proportions is something that cannot be related unambiguously to the change of ... prices. This is a crucial point. The whole traditional theory had maintained precisely the contrary. We had been accustomed to think of

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1/ Pasinetti (1977a), p. 25.
2/ Pasinetti (1977a), p. 167.
3/ Pasinetti (1970), p. 429.
4/ Pasinetti (1977a), p. 168.

changes of technique and changes of input proportions as if they were the same thing. For we had been accustomed to expect that a change in a specific direction of the input proportions is always and necessarily associated with a change in the opposite direction of the corresponding relative prices. This traditional belief is false'.[1/]

This is an important argument. It is undoubtedly a widespread presumption among neoclassical economists that equilibrium prices do reflect relative scarcities and that the direction of substitution, in both consumption and production, is opposite to that of changes in corresponding relative prices.[2/] It is also true that, in the context of Sraffa's analysis the occurrence of such substitution patterns cannot be predicted.[3/] The implication of Pasinetti's argument is, therefore, clear. Either the comparative static propositions of neoclassical economics contain logical errors or they relate only to special cases and do not have the general validity they are believed to have.

However, these points are totally without force when levelled against modern Walrasian theory. The comparative static theorems derived from this theory do not imply that, in general, prices will reflect relative scarcities and that the direction of substitution is opposite to that of a change in relative prices. Furthermore, modern Walrasian theory has proved that the efficiency of a competitive equilibrium depends on the absence of externalities and public goods and not on prices

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1/ Pasinetti (1977a), pp. 168-169. See also Pasinetti (1977a), pp. 172-173, 177, 184-189, Pasinetti (1977b), Garegnani (1966), Roncaglia (1978), Bharadwaj (1978) and Garegnani (1978c).

2/ Of course, Giffen goods are known to prove an exception to this. However, this case has never been considered to be important, theoretically or empirically.

3/ See, in particular, Pasinetti (1977b).

being indexes of relative scarcities or the direction of substitution.

Modern Walrasian economists have proved the following comparative static proposition. If all commodities are gross substitutes[1/] and there is a parameter change in an equilibrium which is binary,[2/] so that the excess demand for commodity 1 becomes greater than zero and the excess demand for commodity 2 becomes less than zero, then in the new equilibrium the relative price of the first good will rise and that of the second will fall.[3/]

This theorem appears to be unexceptionable. However, not only may the theorem not hold if the assumption of gross substitutes is relaxed, but it does not imply that equilibrium prices reflect relative scarcities. Notice that the theorem does not state what parameter shifts are assumed to occur. It states only that, if such shifts increase one excess demand and reduce another, then the former's equilibrium price rises and that of the second falls. This leaves open the question of whether or not an increase in supply of one commodity will increase the excess demand for itself or for another commodity. But if the increase in supply of a commodity does lead to an increase in the excess demand for itself we know from this theorem that its price will rise relative to the others. We can illustrate this in the simplest of all general equilibrium models: namely a

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1/ Commodities are defined to be gross substitutes, if when the relative price of any one good is increased, the excess demand, at the new set of prices, for all other goods increases. If all goods are gross substitutes, at all sets of prices, then the equilibrium price vector will be strictly positive.

2/ A shift in the parameters of an economy is called a 'binary' change if the result is that the excess demand functions of only two commodities change. We cannot get a simpler case than this because of Walras' Law.

3/ Arrow and Hahn (1971), pp. 246-248.

pure exchange economy composed of two commodities and two agents.[1/]

In Figure 2 we have an Edgeworth box. Assume the initial endowments are initially given by point S and that the equilibrium is at E_1. Now let there be an increase in the supply of x_1 by Δx_1. The box therefore becomes larger. The indifference curves of consumer B remain in the same position. A's indifference map is shifted down by the distance of the increase. In other words the origin of A's map is now A'. Assume that all the new goods go to B so that the new initial endowment position becomes $S + \Delta S$.

What will happen to the relative price of x_1? In general we cannot say. As it is shown in the diagram the relative price of x_1 rises. This is quite possible. If consumer B receives all of Δx_1 and x_2 is an inferior good in B's preferences, then at the prices prevailing in E_1 consumer B's excess demand for x_1 increases and his excess demand for x_2 decreases. Consumer A's excess demands are unaffected by B's increase in endowments. Consequently there is an increase in the aggregate excess demand for x_1 and a decrease in that of x_2. By the comparative-static proposition just outlined the price of x_1 relative to that of x_2 must be higher in the new equilibrium E_2.

To economists trained in partial-equilibrium theory, this result probably seems peculiar because an increase in the supply of a commodity with a 'normal' demand curve will reduce its equilibrium price. Gross substitutability ensures that demand

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1/ A more general example is implicit in Malinvand (1972), pp. 113-117.

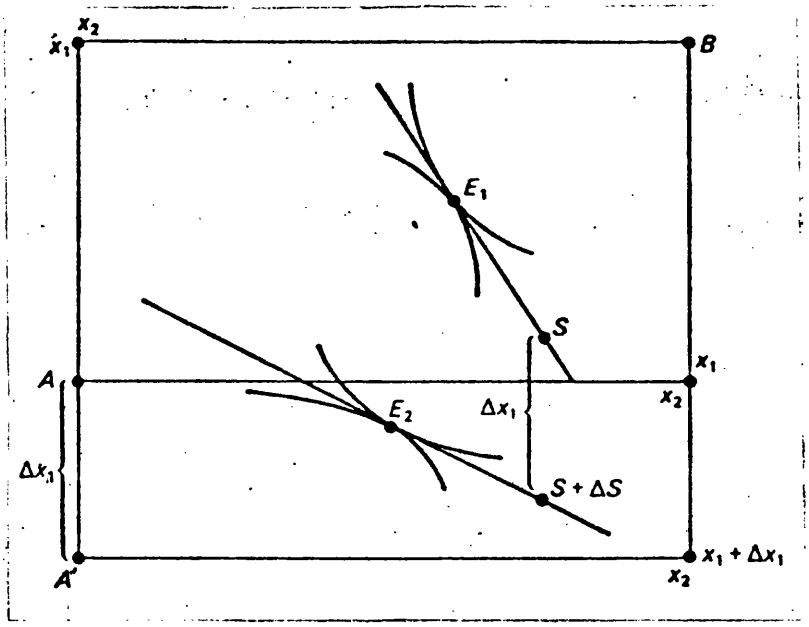

Figure 2

curves are 'normal' in this example.[1/] What then accounts for the difference in result? The answer is rather simple. In the partial-equilibrium setting an increase in supply is not assumed to affect the incomes of consumers. In the general-equilibrium setting an increase in supply is an increase in endowments, and

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1/ Euler's theorem on homogeneous functions states that if the function $f_i(p_1, \ldots, p_n)$ is homogeneous of the mth degree then it has the property

$$p_1 \left(\partial f_i / \partial p_1\right) + \ldots + p_n \left(\partial f_i / \partial p_n\right) = m f_i$$

Excess demand functions are homogeneous of degree zero in prices. Therefore, if f_i is such a function, $mf_i = 0$. By the definition of gross substitutes $\partial f_i / \partial p_j > 0$, for $i \neq j$.

The assumption that commodities are gross substitutes ensures that all equilibrium prices are positive (see footnote above on p.255). Therefore, $\partial f_i / \partial p_i < 0$.

In an exchange economy supplies are fixed so that demand curves are 'normal'.

therefore represents an increase in income. It is precisely because the general-equilibrium analysis allows for this effect that the result can differ from that of partial-equilibrium analysis. In doing so the example highlights the possible dangers inherent in the partial framework.[1/]

A parallel example can be given for an economy involving production. Assume that there is an increase in the availability of some factor of production. If owners of this resource increase their demand for a consumption commodity which utilises this resource sufficiently intensively in its production, either directly or indirectly, then at the initial equilibrium price vector the excess demand for that resource can increase, while the excess demand of some other good is reduced. As a consequence, the relative price of the resource rises in the new equilibrium. Again it may be said that prices do not reflect scarcities and the direction of substitution is not opposite to the movement of relative prices.[2/]

It can be seen from figure 2 that both competitive equilibrium, E_1 and E_2, are efficient because, in both cases, the marginal rates of substitution are equal. More generally, it is true that the proofs of the efficiency of competitive equilibria do not require assumptions which imply particular comparative static results. Thus the question of whether prices are 'optimal allocators' of resources is quite independent of whether these prices reflect relative scarcities.

1/ See chapter XI, section (vi).

2/ See Malinvaud (1972), pp. 125-130, Bliss (1975), chapter 4 and Arrow and Hahn (1971), pp. 252-254.

(vi) The Assumptions of Sraffa's Analysis and those of Modern Walrasian Theory.

The Sraffa-based critique of Walrasian theory which has been discussed in the previous three sections can be seen conclusively to fail. The question now arises, therefore, whether it is possible to use Sraffa's analysis in other ways to expose genuine flaws in Walrasian theory. The answer would appear to be negative. This is so for two reasons.

Firstly, there is no analysis presented by Sraffa which explicitly shows the established existence proofs and comparative static propositions of modern Walrasian theory to be defective. Indeed, Sraffa does not even explicitly analyse those conditions under which economically meaningful solutions exist for the economic systems and the values of the exogenous variables with which he works. Instead his analysis is carried out on the assumption that such solutions do exist.[1/]

Secondly, none of the relationships between economic variables which Sraffa presents could contradict the propositions of modern Walrasian theory. This is because the assumptions on which Sraffa's analysis is built are compatible with those underlying modern Walrasian theory. Indeed, it can be shown that in general Sraffa's assumptions are but specialisations of assumptions commonly employed in modern Walrasian theory. We can show this by considering each of the nine assumptions dealt with in section (iii) of chapter II.

Sraffa conceives of an economic system as a set of production processes. The economic systems analysed in Walrasian

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1/ See chapter II, section (iii) and below, pp. 265-266.

theory, on the other hand, are typically more comprehensively specified so as to include consumption activities, maximising economic agents and historically given initial endowments. The assumptions concerning these other matters are often restrictive. However, the conditions which are essential to ensuring the existence of an equilibrium of demand and supply do not require specific assumptions to be made regarding these matters. As we have already seen,[1/] all that is really required is that choices exist, vary continuously with prices and have an aggregate value which is zero. These properties may be assured with various assumptions. Furthermore, modern Walrasian theorists have undertaken the analysis of production equilibria in isolation from any specific assumptions about other elements in economic systems. This procedure is particularly pronounced in the work of Koopmans.[2/]

Sraffa's assumption that there is a common period of production can be easily incorporated into Walrasian models. Indeed, this assumption fits into the theory of dated commodities very naturally. However, the assumption that economic systems can be brought into a state of self replacement is not required. A Debreuvian competitive equilibrium can, but need not be, 'viable' in this sense precisely because commodities which are available at different dates can be conceived of as different commodities, even when they have the same physical characteristics. Since in a Debreuvian equilibrium there is no requirement that prices have to be uniform, positive prices,

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1/ above, pp. 224-225.

2/ See, for example, Koopmans (1957), Koopmans (1970), Dorfman, Samuelson and Solow (1958) and below pp. 265-266.

wages and rates of profit in all periods can exist even if the system is 'unproductive'.[1/]

Modern Walrasian theory eschews any assumption that wages and rates of profit are uniform. Instead these characteristics are deduced. If economic agents are optimising choice-makers, if there is competition and if there are no externalities, then, in equilibrium, homogeneous units of labour receive the same wage, and rates of return in production activities must all be equal.[2/]

The significance of these last two points is worth stressing. In a Debreuvian equilibrium there would be a uniform wage paid to each type of labour in each period although wages might change between periods. Similarly, each production activity would earn the same rate of profit over the same time period although over different periods of common length the rate of profit might not be the same. However, although prices may be uniform, there is no requirement that they have to be and indeed if there is any presumption to be made it is that they will not be.[3/] A price structure embodying the uniformity principle, which is the only type dealt with by Sraffa, is, therefore, a very special case.

1/ Pasinetti's statement on this point is, therefore, seriously misleading. He writes that if the economy were 'unproductive' 'we should be dealing with an economic system so technically backward that it could not generate a profit even with a zero wage rate. Such an economic system could clearly not survive; it would not be viable'. Pasinetti (1977a), p. 78. This statement is not incorrect because it implicitly assumes that economic systems are constrained to have a uniform price structure. However, no reason is given as to why this should be so. See section (iv) above and below, pp. 262-265.

2/ See section (iv) above.

3/ See chapter XI, section (vii).

Furthermore, the quantities traded in a particular Debreuvian equilibrium may be capable of being sustained by a number of price vectors. In other words, the prices associated with a set of equilibrium economic activities may not be unique. Nor may all the price vectors be of the same type. A set of economic activities may be sustained as a competitive equilibrium by a price system incorporating the uniformity principle and by a price system that does not involve uniform prices.[1/] This point also applies to a Sraffa system.[2/] This particularly highlights the problem of justifying the assumption that equilibrium prices are uniform. Sraffa can in fact easily do so because his stated purpose is purely critical. However, those who seek the foundation for a 'new economics' in Sraffa's work[3/] have never provided a rationale as to why prices should

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1/ See Dixit (1977), pp. 8 and 15-16.

2/ Take, for example, the system:

$$l_1 + k_1 p_1 (1 + r) = p_1$$
$$l_2 + k_2 p_1 (1 + r) = 1$$

where l_1, l_2, k_2 are all equal to 1 and $k_1 = 1/5$. For an $r = 1$, $w = 3/13$ and $p_1 = 5/13$. But if prices are unconstrained to be uniform then an $r = 1$ can be associated with a $w = 5/13$, a price of commodity 1, used as input, of $4/13$, and a price of commodity 1, as an output, of $33/65$.

3/ For example, Garegnani (1970), (1976), Eatwell (1977), Roncaglia (1977), (1978) and Pasinetti (1973), (1977a).

always be assumed to be uniform.

Sraffa's implicit assumption requiring that labour be used in all production processes, or, at least, in the production process of a basic commodity, is not required by modern Walrasian theory. The latter theory has no difficulty in incorporating such an assumption but it is formally unnecessary for results or existence. There is, however, a difference between Sraffa's analysis regarding the payment of wages and the assumptions common to neoclassical general equilibrium theory. In Debreu's analysis of intertemporal equilibrium, for example, there is one decision date and, therefore, one transaction date: namely the 'present'. Thus, wages are not assumed to be paid ex-post. However, there are no difficulties involved in reformulating the present value price system of a Debreuvian equilibrium into a set of spot prices, assuming that wages are paid at the end of a period for work done in that period. Nothing fundamental is changed in doing so.

The existence of basic commodities is perfectly compatible with the assumptions made by Walrasians about technology. The essential technical requirement to ensure the existence of an equilibrium of demand and supply is the absence of increasing returns to scale. The form which technological interdependencies have is irrelevant.[1/] This also means that fixed capital and joint production do not have to be assumed absent.

1/ Nell appears to deny this, See Nell (1967), pp. 198, 200 and 208. However, he gives no analytic reasons as to why technical interdependencies have to be excluded from any Walrasian theory, including that of Walras, and his understanding of modern Walrasian theory is generally decifient. See pp. 198-200.

However, the form which technical interdependencies take does have some bearing on the type of prices which may be associated with a competitive equilibrium. Take, for example, the following production processes,

$$l_1 + k_1 \geqslant c_1$$
$$l_2 + k_2 \geqslant c_2$$

where l_1 is the labour required to produce c units of commodity 1, l_2 is the labour required to produce c units of commodity 2, k_1 is the quantity of commodity 1 used as input into itself and k_2 is the quantity of commodity 2 used as an input into itself. Both commodities are non-basics. If the wage is paid in commodity 2 and uniform prices are assumed the rate of profit is determined by the production process of commodity 2 as $\frac{c_2 - wl_2}{k_2} - 1$. But the production process of commodity 1 will not be capable of realising this rate of profit if $c_1/k_1 < \frac{c_2 - wl_2}{k_2}$. Thus, if commodity 1 is to be produced in such circumstances the assumption of uniform non-negative prices must go.[1/]

The same point can be made for a technology involving basic commodities. Assuming that prices are uniform, the production conditions of the basics and the wage will determine the rate of profit. However, if a non-basic requires itself as an input such that its output - own input ratio, or self-reproduction ratio, is less than 1 + r, then it will be impossible for all prices to be non-negative. Consequently, if all commodities

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1/ Pasinetti (1977a) would say that these two production processes do not constitute an 'economic system'. However, to say this is to say nothing substantive, and is in fact a peculiar use of the term 'economic system'. After all, nothing precludes the two commodities from being perfect complements in consumption.

are to be produced, prices must cease to be uniform.[1/]

The major differences between Sraffa's assumptions and those commonly employed in modern Walrasian theory appear to lie in the treatment of determination and returns to scale. However, there really are no problems of comparability in these two areas.

As has been noted above,[2/] Sraffa assumes that all the systems he analyses are determinate whereas Walrasian theory has been concerned to deduce those conditions which will ensure existence and thereby determine all unknowns. Moreover, in carrying out this work Walrasian theorists have examined those conditions which are sufficient to ensure that a competitive equilibrium will have uniform wages, rates of profit and prices

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1/ Sraffa, in fact, deals with this second phenomenon under the title of 'self-reproducing non-basics' and he notes its implications. 'It is perhaps as well be be reminded here that we are all the time concerned merely with the implications of the assumption of a uniform price for all units of a commodity and a uniform rate of profits on all the means of production. In the case under consideration ..... (it will be impossible) ... for these conditions to be fulfilled. The ... (non-basic) ... could however still be produced and marketed to show a normal profit if the producer sold ... (it) ... at a higher price than the one which, in his book-keeping, he attributes to ... (it).. as means of production'. Sraffa (1960), p. 91. See, however, Sraffa (1962a), (1962b), Pasinetti (1977a), pp. 109-110, Roncaglia (1978), pp. 63, 103 and Zaghini (1967), where it is maintained that 'low' self-reproduction rates of non-basics are empirically unlikely. Such statements are similar in status to the defence adopted by some Austrian economists and productivity theorists that reswitching and capital reversal are not likely to occur empirically.

2/ See p. 259.

in each period, where these prices are equal to corresponding costs of production. The results are embodied in what have become known as non-substitution theorems.[1/] Modern Walrasian theory is, therefore, more comprehensive than that of Sraffa and provides analysis directly relevant to problems thrown up in the latter's framework.

Sraffa's analysis involves no assumption about returns to scale. Instead it is assumed that output levels are predetermined. In contrast, Walrasian theory treats outputs as endogenous variables and requires that returns to scale be non-increasing if equilibrium is to be guaranteed. The two types of analysis can be made comparable, however, if constant returns to scale are assumed in both. None of Sraffa's results are altered if this assumption is added and the assumption is perfectly consistent with the existence of an equilibrium of demand and supply.

Finally, it is pertinent to consider the substance of Sraffa's distinction between 'the picture of the system of production and consumption as a circular process' and 'the view presented by modern theory, as a one-way avenue that leads from

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1/ See, in particular, Mirrless (1969), Arrow and Starrett (1973) and Bliss (1975), chapter 11. Assuming only a given technology and a given rate of profit, then, for this type of equilibrium to be assured non-constant returns to scale, pure joint production and the existence of more than one non-produced commodity must be excluded. Thus, one reason why an equilibrium embodying the uniformity principle, with prices equal to costs of production, may not be realised lies in the influence of initial endowments. Sraffa deals with these only with regard to 'obsolete goods' and natural resources and not comprehensively with respect to all commodities.

"Factors of production" to "Consumption goods" '.[1/] Walrasian theory cannot legitimately be described in terms of either picture. There is a 'one-way avenue' insofar as production and consumption are influenced by initial endowments. However, the assumptions governing production allow circularity relations to exist and indeed to dominate the production and consumption activities of certain periods.

(vii) Conclusion

It would, therefore, appear to be the case that Sraffa's 'Production of Commodities by Means of Commodities' has no critical implications for the modern Walrasian theory of profit. The allegations made by theorists who have used Sraffa's analysis for this purpose cannot be supported and the economic relationships uncovered by Sraffa could be generated by suitable specialisations of the Debreuvian model of intertemporal equilibrium. Of course, this does not imply that modern Walrasian theory is above criticism. However, the weaknesses of this theory lie in areas which do not figure at all in Sraffa's work: namely, in the assumptions which are made about agents' behaviour, their choice-making abilities and the knowledge which they are assumed to possess about the economic environment.[2/] Sraffa makes no assumptions whatsoever about economic agents and these weaknesses of Walrasian theory concern matters of empirical relevance, not logical deficiency, and therefore lie outside the Sraffa framework.

1/ Sraffa (1960), p. 93.

2/ See Howard (1979), pp. 63-68 and 168-173.

CHAPTER XIII

CONCLUSIONS

Sraffa's 'Production of Commodities by Means of Commodities' has been used to show that Ricardian, Marxian, Austrian and neoclassical productivity theories of profit are seriously defective. The principal propositions of each theory are tenable only in special cases. This is especially true of the neoclassical theory of capital productivity, Austrian capital theory and Marxian exploitation theory. The validity of each of these is dependent upon extremely restrictive assumptions. Outside of such assumptions it is not necessarily true that profits, or the rate of profit, are determined by capital scarcity or by 'roundaboutness' or by exploitation. Ricardian theory suffers in the same way although it is somewhat more robust. The main propositions of this theory, namely, that the rate of profit is directly related to the productivity of inputs and is inversely related to the wage, are true, providing each commodity is produced by a single process. Nevertheless, these propositions were not established by Ricardo's own analysis. Sraffa's work, in fact, shows this analysis to be extremely confused and frequently redundant.

It is also important to realise that the Sraffa-based critique of these theories of profit has consequences which extend far beyond the field of distribution theory. The implications are most apparent for theories of profit

because Sraffa's propositions are predominantly concerned with the relation between the rate of profit and other economic variables. But the defects in these theories of profit lie deep within the economics from which they are derived. In every case, therefore, the critique is not one of tangential relevance but undermines theoretical foundations. The difficulties which neoclassical productivity theory, Austrian theory and Marxian theory meet stem from inadequate primary conceptualisation. The notions of aggregate capital, 'roundaboutness' and exploitation prove incapable of supporting the superstructure created on their basis. Similarly, Ricardo's tools of analysis were inappropriate to the theoretical tasks he undertook.

Furthermore, the criticisms of these theories of profit which have been developed in this thesis, and which have been derived on the basis of Sraffa's analysis, are essentially original to Sraffa. This can be seen to be true by comparing the evaluations of eminent historians of thought, such as Stigler,[1/] Blaug,[2/] and, above all, Schumpeter,[3/] with that presented in chapters IV, VI, VIII and X. Indeed, many of the best historians of thought who have written subsequent to, and in the light of, Sraffa's work have failed to see the full range and depth of Sraffa's 'critique of economic theory'.[4/] It is true that some of Sraffa's results were available prior

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1/ For example, in Stigler (1941), (1952) and (1958).

2/ For example, in Blaug (1958) and (1962).

3/ Schumpeter (1954).

4/ See, for example, Samuelson (1971), Dobb (1973) and Blaug (1978).

to 1960. For instance, Fisher had discovered reswitching, while Champernowne and Robinson rediscovered it together with capital reversal. But the significance of these phenomena was not appreciated and they were treated as 'perversities' of little import. It is also true that the work of other theorists could have been used to develop the criticisms derived from Sraffa. For example, the work of Leontief and von Neumann is relevant to the difficulties involved in 'reduction' and to uncovering indeterminate and 'perversely' signed labour values. However, it is with the hindsight provided by Sraffa that we can perceive this; the possibilities were not noticed before. Moreover, Sraffa's achievement lies not only in developing each of these critical pieces of analysis, but in integrating them into a unified conceptual framework of extraordinary abstraction and destructive power.

The subversion engendered by Sraffa's work does, however, have its limits. Walras' theory of profit emerges essentially unscathed from Sraffa's analysis. This is due to the fact that it is a theory of temporary equilibrium, which falls largely outside any criticism stemming from an analysis of those equilibria which are the subject of Sraffa's work. It is true that Walras' theory has important limitations but these mainly arise from considerations outside the province of Sraffa's analysis. Modern Walrasian theory, on the other hand, as a theory of full equilibrium, is potentially subject to a Sraffa-based critique. However, it proves totally

immune to such a critique and this is the most important result of all. Orthodox economic theory as a whole, and not just the theory of profit or distribution, has increasingly come to be based upon a Walrasian foundation. Of course, this does not imply that modern Walrasian theory is without faults. But, again, these lie outside the range which Sraffa's work can reach. They primarily concern matters of empirical relevance and pertain to the assumptions made about the nature of economic agents.

It is, therefore, clear that although Sraffa's book may be classified as a 'great work' of economic theory, it is restricted in its impact. It follows that it is false to believe that Sraffa has undermined 'modern value and distribution theory', let alone 'neoclassical economics as a whole', as neo-Ricardian and neo-Keynesian economists have argued. In fact the properties of 'long-period equilibria' or 'Sraffa equilibria' which these theorists focus on may be derived as special cases of Debreuvian equilibria. Consequently, the arguments which they produce for reconstructing economics on the basis of Sraffa's framework cannot carry conviction. There are good reasons for treating the results of modern orthodox theory with scepticism. Nevertheless, these reasons are not those which can stem from Sraffa's analysis.

Indeed, the converse is the case. Modern Walrasian theory highlights the limitations which will characterise any 'new economics' built upon Sraffa's framework. In particular, the assumption of price uniformity proves the essential weakness. The propositions which Sraffa derives hinge upon it. It allows the wage to be a function of the

rate of profit, it allows basics to take a primary determining role, and it allows the standard commodity to represent distributional relations independently of valuation. Without it, none of these properties can remain. This is no criticism of Sraffa. His stated purpose was critical and, in terms of the theory he sought to criticise, this was an appropriate assumption. However, this justification obviously cannot carry over to the construction of a 'new economics'. In such a context the assumption must be justified in new ways, but no justifications have so far been forthcoming which will stand up to thorough scrutiny. For this reason, and others discussed in the last chapter, there are, therefore, good analytic reasons for accepting the dominant position of modern neoclassical economics, in preference to any Sraffa-based alternative.

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THEORIES OF PROFIT FROM RICARDO TO DEBREU: AN ANALYSIS IN TERMS OF PIERO SRAFFA'S 'PRODUCTION OF COMMODITIES BY MEANS OF COMMODITIES'.

by M. C. HOWARD

Abstract

This thesis seeks to provide a critical examination of the Ricardian, Marxian, Austrian, Walrasian and neoclassical productivity theories of profit. The standard of evaluation which is adopted throughout is Piero Sraffa's 'Production of Commodities by Means of Commodities'. This is a work of major significance and provides a new perspective in terms of which criticism can be structured.

It is shown how Sraffa's results undermine the main propositions of the Marxian, Austrian and neoclassical productivity theories of profit. The Ricardian analysis of profit is also shown to be severely defective. Furthermore, it is argued that the destructive implications of Sraffa's work go far beyond the confines of profit theory and extend deep into the theoretical structures from which these analyses of profit derive. In each case the defects in these theories of profit, which Sraffa's work exposes, stem from inadequate primary conceptualisation and analysis. Consequently, it is schools of economic thought, and not just theories of distribution, which are undermined.

Walrasian theory, however, remains unscathed by Sraffa's work. Indeed, it is shown that Walrasian theory highlights some limitations of Sraffa's own framework and thereby questions the significance of those endeavours which seek to build a 'new economics' on its basis.