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# JOINT PRODUCTION OF COMMODITIES

Neri Salvadori and
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An Elgar Reference Collection

Published by
Edward Elgar Publishing Limited
Gower House
Croft Road
Aldershot
Hants GU11 3HR
England

Edward Elgar Publishing Company
Old Post Road
Brookfield
Vermont 05036
USA

**British Library Cataloguing in Publication Data**
is available

ISBN 1 85278 198 X

Printed in Great Britain by Galliard (Printers) Ltd, Great Yarmouth

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# Acknowledgements

The editors and publishers wish to thank the following who have kindly given permission for the use of copyright material.

Basil Blackwell for articles: N. Salvadori and I. Steedman (1988), 'Joint Production Analysis in a Sraffian Framework', *Bulletin of Economic Research*, 165–95; I. Steedman (1976), 'Positive Profits with Negative Surplus Value: A Reply to Wolfstetter', *Economic Journal*, **86**, December, 873–6; R. Franke (1986), 'Some Problems Concerning the Notion of Cost-Minimizing Systems in the Framework of Joint Production', *The Manchester School*, **54** (3), September, 298–307.

Editions Economica for excerpts: I. Steedman (1984), 'The Empirical Importance of Joint Production' and Ch. Bidard (1984), 'Choice of Technique in Joint Production' from *La Production Jointe: Nouveaux Débats*, Ch.Bidard.

Gustav Fischer Verlag for article: B. Schefold (1978), 'Fixed Capital as a Joint Product', *Jahrbücher für Nationalökonomie und Statistik*, **192**, 415–39.

Nuova Casa Editrice Cappelli for article: H. D. Kurz (1986), 'Classical and Early Neoclassical Economists on Joint Production', *Metroeconomica*, **38**, 1–37.

Springer-Verlag, Vienna for articles: B. Schefold (1978), 'Multiple Product Techniques with Properties of Single Product Systems', *Zeitschrift für Nationalökonomie*, **38** (1–2) 29–53; B. Schefold (1978), 'On Counting Equations', *Zeitschrift für Nationalökonomie*, **38** (3–4), 253–85; G. Duménil and D. Lévy (1984), 'The Unifying Formalism of Domination: Value, Price, Distribution and Growth in Joint Production', *Zeitschrift für Nationalökonomie*, **44** (4), 349–71; Ch. Bidard (1986), 'Is von Neumann Square?', *Zeitschrift für Nationalökonomie*, **46**, 401–19; N. Salvadori (1988), 'Fixed Capital within the Sraffa Framework', *Zeitschrift für Nationalökonomie*, **48** (1), 1–17.

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In addition the publishers wish to thank the Library of the London School of Economics and Political Science for their assistance in obtaining these articles.

# Introduction

This volume of readings presents 12 contributions to the study of joint production from a standpoint directly inspired by Sraffa's *Production of Commodities by Means of Commodities*. Whilst these essays range widely from historical and empirical matters to highly formal analysis, they all share this common inspiration. All the essays have been previously published but not always in English; (further contributions can be found in Steedman, 1988, vol. 2).

**The significance of joint production**

Much economic analysis has been based on the assumption that each productive activity produces only a single commodity. Moreover, it has not infrequently been suggested that this is a perfectly adequate basis for economic analysis, the study of joint production systems being, it is implied, the study of a curiosum, or a search for generality for its own sake. There are, on the contrary, several good reasons for rejecting such a view, not only in general but even, more specifically, from a revived 'classical' approach to political economy, deriving from Sraffa's work.

(i) Much 'mainstream' economic theory takes joint production in its stride: to cite just two famous works, consider Hicks' *Value and Capital* or Debreu's *Theory of Value*. Much theory cast in the activity-analysis mould takes it for granted that joint production must (and can) be allowed for and, of course, the von Neumann model, which is so central to much growth theory, does the same. Nor has the position changed in this respect with the more recent use of 'dual' formulations: cost function, revenue function and profit function formulations of production theory all allow for joint production. Now, if joint production is in fact of empirical importance – as it is; see (iv) below – any revived 'classical' approach which seeks to challenge and even to displace the current 'mainstream' approaches must, necessarily, demonstrate that it can take joint production issues in its stride just as readily as do those 'mainstream' approaches.

(ii) While much 'mainstream' theory permits joint production, as we have just noted, not all of it does and it has been found, indeed, that that can be shown to be a serious weakness. It is known, for example, that (other than in special cases) the presence of joint production prevents a meaningful 'reduction to dated labour terms'; which means immediately that all attempts to construct a 'neo-Austrian' approach to economic theory are open to highly damaging criticism (see H. Hagemann and H. D. Kurz 1976). It has also been shown that, in the presence of joint production, a 'primary-factor-price-frontier' can be *upward* sloping, even when *no* produced inputs are used and *all* the primary inputs are paid *ex post* (so that there

are no interest charges of any kind). This, in turn, undermines both various familiar marginalist comparative statics results – concerning shifts in demand or in factor supplies, or the imposition of tariffs – and some of the theory of Hicksian technical progress (see I. Steedman, 1982, 1985). Recognition of joint production, therefore, allows one to extend the 'classical' critique of various marginalist theories.

(iii) Conversely, however, joint production has often been used as the starting point for criticism *of* the 'classical' approach. In Book III, Chapter XVI of his *Principles of Political Economy*, J.S. Mill (1891, p. 387) considered some of the effects of joint production and wrote that, in determining the values of jointly produced commodities, 'we must revert to a law of value anterior to cost of production, and more fundamental, the law of demand and supply. He called that chapter, 'Of Some Peculiar Cases of Value'. Not surprisingly, Jevons seized on this in Chapter V of his *The Theory of Political Economy*.

> On some other occasion I may perhaps more fully point out the fallacy involved in Mill's idea that he is reverting to *an anterior law of value*, the law of supply and demand, the fact being that in introducing the cost of production principle, he had never quitted the laws of supply and demand at all. The cost of production is only one circumstance which governs supply, and thus indirectly influences values. Again, I shall point out that these cases of joint production, far from being 'some peculiar cases', form the general rule, to which it is difficult to point out any clear or important exceptions' (Jevons, 1970, p. 209).

Wicksell too, in the first substantive chapter of his *Lectures on Political Economy* (Volume I), insisted that,

> It happens in many cases, even where a commodity is manufactured under competitive conditions, that its costs of production *cannot be separated* or imputed because its production proceeds simultaneously and in combination with that of other goods.... Such cases, which have been given by Marshall the technical name 'joint supply', are mentioned also by Mill in his chapter, 'Some peculiar cases of value', but, as the chapter heading indicates, Mill regarded them as exceptions to the rule. In reality (as Jevons remarked) they occupy a large, perhaps the largest, part of the field of production (Wicksell 1967, p. 26).

An extensive discussion of the role of joint production in both classical and early neoclassical economics will be found in Chapter 2 by Heinz Kurz.

(iv) Had Jevons and Wicksell been wrong about the empirical importance of joint production, it would perhaps have been possible to maintain that a single-products theory was perfectly adequate to deal with most genuine and important economic questions – and that generality is not to be pursued too far for its own sake in a subject such as political economy. But the brute *fact* is that Jevons and Wicksell were not wrong: as soon as one begins to consider productive processes at the level of detail *necessary* for a Sraffa-based analysis of prices and distribution, one finds that joint production is, *empirically, extremely widespread.* A large number of real

world examples, drawn from a wide range of industries and types of activities, is presented in Chapter 1 by Ian Steedman.

We now turn to a discussion of some more formal aspects of the Sraffian analysis of joint production. But we may note at once that our discussion can be relatively brief, since Chapter 3 is indeed a recent survey of the field by the present authors.

**Joint production contrasted with single production**

The following results are valid for single production but need not hold in general joint production models:

(i) all products are separately producible and, as a consequence, a system of production is always square and labour values are always positive;
(ii) a basic commodity can be defined as a commodity which enters directly or indirectly into the production of all the commodities in the system of production; the distinction between basics and non-basics is important since basics have a number of properties which are not shared with non-basics;
(iii) the Standard commodity exists and consists of positive amounts of basics only;
(iv) the profit rate reaches a finite and unique value, R, when the wage rate equals zero and the corresponding prices of basic commodities are positive; R is called the 'maximum rate of profit';
(v) R is the lowest positive real number such that the price equations are satisfied with a zero wage rate;
(vi) if the profit rate is between zero and R the prices of basic commodities vary as it varies, in general, but remain positive and finite;
(vii) the relationship between the wage rate and the profit rate is decreasing irrespective of the numeraire chosen;
(viii) prices in terms of the wage rate are increasing and convex functions of the profit rate for each system of production;
(ix) a cost-minimizing system of production is proved to be any system which can pay the higher wage rate (profit rate) for a given profit rate (wage rate) and it is determined independently of the requirements for use;
(x) if there exists a system with prices all positive at the given profit rate (wage rate), then there exists a cost-minimizing system of production and in this system all prices are positive;
(xi) if two different systems are both cost-minimizing at the given profit rate (wage rate), then they have a common price vector.

The fact that these results do not always hold if joint production is allowed has led a number of authors to investigate the hypotheses and the assumptions stated. As already mentioned, these issues are surveyed in Chapter 3 but we may now draw attention to some of the fuller discussions to be found in other chapters. For example, Bertram Schefold, in Chapter 4, explores the conditions under which a joint production system

possesses the same economic properties as a single product system. It is quite natural to assume that a single production system is square. But why should one make this assumption with respect to a joint production system? Should it not be possible, in such a system, to have fewer processes than products? This issue is studied in two quite different ways in Chapter 5, by Ian Steedman, and in Chapter 6, by Christian Bidard. Turning our attention from quantities to prices, we may note that Chapter 7 by Gérard Duménil and Dominique Lévy includes a valuable discussion of the conditions under which all commodity prices within a given system are positive.

A focal point of the contrast between single and joint production systems has become the centre of discussion in more recent years: the question of choice of technique. Both Chapters 4 and 5 deal with some problems connected with choice of technique, but it was only in Chapter 8, by Bertram Schefold, that the problem of choice of technique came to be treated as a problem of great interest *per se*. Not surprisingly in this relatively early discussion of the issue, the simplifying assumptions were made that commodities are consumed in proportion to a given vector and that the economy is growing at a uniform rate equal to the profit rate. By implication, Schefold thereby drew attention to the role of 'requirements for use' referred to in (ix) above. For present purposes, these 'requirements of use' may be interpreted as the pattern of net output, which, as is well known, has no bearing on the choice of technique when there are only single product processes.

The significance of requirements for use for the choice of technique in joint production systems was considered explicitly by Salvadori (1982, 1985, both reprinted in Steedman, 1988, vol. 2), and some outstanding issues are considered further in Chapter 10 by Reiner Franke in the present volume. In Chapter 9, by contrast, Christian Bidard develops an alternative approach, which might be interpreted as specifying a restriction on the nature of technology which renders it unnecessary to take account of requirements for use.

## Fixed Capital

The importance of the pattern of net output is also reduced when, rather than considering general joint production systems, we consider only fixed capital systems involving no 'pure' joint products, i.e. the case in which the only joint products are used machines. Bertram Schefold, in Chapter 11, begins by analysing systems in which each process produces one final good (perhaps a new machine) and not more than one old machine. Moreover machines are assumed to be non-transferable, i.e., no old machine produced jointly with a particular final good can be utilized in the production of any other final good. Chapter 12, by Neri Salvadori, allows that more than one used machine may be employed in a given process. Of course, non-transferability of used machines is still assumed, since it is known that to allow transferability of used machines is to reintroduce the problems of general joint production systems.

* * *

Having read the papers in this volume, the reader might well feel that some of these

discussions have moved a long way from the treatment of joint production found in Sraffa's *Production of Commodities* and, indeed, in certain respects they have so moved and have even led to the rejection of certain statements made by Sraffa in connection with joint production. It remains the case that Sraffa's great work is the source of all the contributions presented in this volume.

Neri Salvadori and Ian Steedman
March 1990

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# Part I
# The Significance of Joint Production

# Contents

# Joint Production of Commodities

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## THE EMPIRICAL IMPORTANCE OF JOINT PRODUCTION*

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The presence of joint production introduces additional complexities into more than one kind of economic theory. In 'standard' theory, for example, it is one source of the non-validity of the non-substitution theorem; it leads to the breakdown of such familiar single-products theory as the inverse relation of real factor returns, of the Rybczynski theorem and of the Stolper-Samuelson theorem; and it gives rise to the free disposal (of outputs) assumption, which is a most embarrassing assumption. In Marxian theory, joint products force a choice between either accepting additive but negative values, surplus value, etc., or abandoning the traditional additive value accounts. While in Sraffa-inspired theory, joint production can lead to 'complex' Standard Commodities; upward sloping wage-profit frontiers; alternative techniques each of which is the cheaper in terms of its own prices; the dependence of basics prices on the production conditions of non-basics; various difficulties in determining whether a commodity is basic or non-basic; and pressing questions about the determination of output levels and its independence of/dependence on the determination of natural prices. It is well known, nevertheless, that writers as far apart in time as Stanley Jevons (The Theory of Political Economy, 1871) and Frank Hahn (The Economic Record, 1975) have cited joint production as a difficulty for Ricardian and 'neo-Ricardian' theory, respectively.

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* I am grateful to H.J. Abrams, J. Butlin, D. Colman, I. Dobbs, H-D Kurz, W. Thomas and W. Tyson - and to the participants at a seminar in Bremen University, at the Nanterre Colloque, and at the Trieste International Summer School - for very valuable advice and comments.

2

The purpose of this essay is to urge that theorists of all styles should always treat joint production as the normal case; that theorists of all kinds should abandon the common (not ubiquitous) practice of treating single-products as the norm and mentioning joint production, if at all, only as a footnote complication. This is urged not on the grounds that joint products can give rise to interesting theoretical issues - though they can - but on the grounds that joint production simply is, as a matter of fact, very common. Since the results of single products theory by no means always carry over in a straightforward way to joint production theory, it follows that lack of attention to joint production is a serious failing of any theory. This emphasis is not a matter of seeking theoretical generality for the sake of generality but of seeking to make theory adequate to its tasks.

The empirical importance of joint production will be illustrated in the next two sections, first by means of specific examples of joint products processes and, second, by a consideration of various phenomena which undoubtedly exist but which could not do so in a world of single product activities. It will be seen that in neither section does the argument have anything to do with the (no doubt very useful) theoretical device of treating an 'aged' machine as a joint product, along with the 'obvious' product. On the other hand, some (not all) of the examples will give rise to questions about the definitions of 'products' and of 'processes'; these questions will be taken up briefly in a later section but it may be noted at once that 'product' does not necessarily mean something saleable. On the contrary, a non-economic criterion is precisely what is required here, in order that subsequent economic questions should not be begged. Roughly speaking, any detectable physical consequence of the operation of a process will be regarded as a product of that process.

I am not sure that it is possible to present a mere list of empirical