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**ECONOMICS**

# WILFRED EDWARD GRAHAM SALTER: THE MERITS OF A CLASSICAL ECONOMIC EDUCATION

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**Wilfred Edward Graham Salter:**

**The Merits of a Classical Economic Education**

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Abstract

During his honours research on an index of industrial production at the University of
Western Australia, Salter gained an understanding of the composite commodity theorem.
The applied work on the index of industrial production provided him with the analytic
foundations for his two famous contributions to economic theory, in capital theory and
international trade theory. In his Ph.D. thesis at the University of Cambridge he agreed
with Joan Robinson that it is impossible to measure the aggregate capital stock because
the assumptions of the composite commodity theorem do not hold in a general
equilibrium framework. But Salter was not bothered by the elusive nature of capital
because he saw no need to measure the capital stock in the first place. He developed a
vintage model of capital, in which technical progress occurs at the margin of the capital
stock, when new investment goods are installed. In the dependent economy model Salter,
however, accepted the aggregation of exportables and importables because in a small open
economy the terms of trade are unaffected by domestic economic policy. Thus, Salter
recognised that the capital stock is an invalid aggregate in a macroeconomic model, but
internationally traded goods are a valid aggregate in the dependent economy model. His
success as an economic theorist lies in the fact that he understood when to apply the
composite commodity theorem as an analytic tool, and when to avoid it.

1. Introduction

In 1953, Wilfred Edward Graham Salter submitted his honours thesis at the University of Western Australia, in which he constructed an index of industrial production for Australia. The thesis was well received by the faculty and, after some revisions, it was published in a monograph series of the Department of Economics. In this paper the connection between Salter's honours research and his pioneering contributions to economic theory and policy is considered. Salter was a gifted student who had the good fortune to be involved in a fruitful research project at the beginning of his professional career. During the honours year, he learnt to apply the analytic tools of economics, and he worked with new production data that had become available in many countries, including Australia, after World War II. Both, the analytic skills and the applied statistical work were critical for his Ph.D. research at the University of Cambridge and his distinguished career as an economist in the public service, which was tragically cut short at a young age.

Born in 1929, Salter spent his childhood during the Great Depression and he experienced World War II as a teenager.[1] From 1948 to 1953, he studied economics at the University of Western Australia, graduating with first-class honours. Frank Richard Edward Mauldon served as supervisor, and Salter also acknowledged the help of Frank Benson Horner, who worked at the New South Wales Bureau of Statistics in the early 1950s. After the honours thesis, Salter embarked on an ambitious, if not hectic, schedule of research and writing. The honours thesis is dated February 1953 and the revised thesis was published by the University of Western Australia Press in 1954.[2] In January 1953, Mauldon asked Salter and Ronald William Peters to conduct a feasibility study on regional income measures for Western Australia. In September, Salter submitted a preliminary report with sectoral income measures at the state level, leaving it to Peters to disaggregate the state figures to the regional level. Pointing out some limitations of his study, Salter (1953a, p. i) mentions that he had been forced to complete it "by a certain date", which was given by his departure for England in the second half of 1953.

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[1] More bibliographical information on Salter is provided by Swan (1963a), Dowsett and Peters (1964), Pitchford (2006) and Harcourt (1962, 2007).

[2] The title of the original honours thesis was 'An Examination of Some Problems of an Australian Index of Industrial Production'. The published version of the thesis carries a new title 'The Measurement of Australian Industrial Production'.

In the Department of Applied Economics at the University of Cambridge, Salter found a research culture that was conducive to his research interests. In 1954, he won the Stevenson Prize for the best graduate essay, and in 1955 he submitted his Ph.D. thesis on technical change and labour productivity. The supervisor, William Brian Reddaway, was an authority on the British index of industrial production who shared Salter's enthusiasm for applied statistical work. Salter was also helped by Laszlo Rostas, who was an expert on taxation and the measurement of productivity. A post-doctoral fellowship enabled Salter to spend the academic year 1955/56 at Johns Hopkins University, where he added American data to his thesis. At Johns Hopkins University he discussed his work with Fritz Machlup, an eminent Austrian-American economist, and his student Edith Elura Tilton Penrose, who is known for her theory of economic growth, which is based on the acquisition of knowledge by the firm.[3] Salter returned to Australia in September 1956 – only three years after he had left the country. He had used his time well since he had hastily submitted the report on income measures for Western Australia in September 1953. The revised honours thesis had been published, his graduate essay had won him the Stevenson Prize, the Ph.D. had been completed, and he had spent a productive postdoctoral year in America.

Back in Australia, Salter spent four years as a research fellow at the Australian National University, a still young institution that had been established ten years earlier. At the ANU Trevor Winchester Swan, the co-author of the Solow-Swan model of economic growth, and Ivor Frank Pearce took an interest in Salter's research on productivity and technical change. Two works published in this period established Salter's reputation as a first-rate economic theorist. In *Productivity and Technical Change* (1960), which was based on his Ph.D. thesis, he developed a vintage model of capital in which technical progress can take place only if there is investment. The second work is the article on 'Internal and External Balance: The Role of Price and Expenditure Effects', which appeared in the *Economic Record* in 1959. In this article Salter put forward a model of international trade for a small open economy – Australia – in which output is divided in internationally traded goods and non-traded goods. Salter's work on productivity and technical change and his model of international trade are commonly regarded as two independent contributions to economic theory. Andrea Maneschi (1997) writes that

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[3] In 2008, the *Australian Economic History Review* published an article by Carol M. Connell on Penrose's theory of economic growth.

"Admirers of Wilfred Salter can be divided into two distinct sets who appear to be unaware of each other, those who praise his work on productivity and technical change, and those who praise his Australian open-economy model." In this article it will be shown that both contributions of Salter to economic theory have a common source: his honours thesis, which gave him a firm understanding of John Robert Hicks' composite commodity theorem.

In 1960, Salter became an assistant secretary in the Prime Minister's Department in Canberra. It seems that he preferred public service and the involvement in the formulation and implementation of economic policy to academic research. One reason for his reluctance to pursue an academic career, which undoubtedly would have been distinguished, was his passion for national income and output data. In the mid-twentieth century, the collection of income and output data became an undertaking of national statistical offices. The League of Nations investigated the feasibility of national income and output statistics and, after World War II, national statistical offices adopted the new system of national accounting of the United Nations. In his honours thesis Salter constructed the first index of industrial production for Australia, and in the report that he submitted to Mauldon on the eve of his departure for England he estimated state income for Western Australia. But he quickly realised that universities lacked the resources needed for the construction of national economic data sets. Salter was not interested in an academic position because the public sector became the driving force behind the collection of quantitative economic information in the mid-twentieth century. In the report on income in Western Australia he commented:

> "During the course of this study it has become increasingly obvious that income studies cannot be carried out completely satisfactorily except in a well-equipped research bureau and by a team of research workers. Income research demands complete and detailed knowledge of virtually all statistics and their sources. An individual cannot hope to master completely the intricacies of all the figures he uses. … For these reasons, a University research worker can only hope to present a framework within which future effort can be directed." (Salter 1953a, p. i)

Salter's interest in quantitative economic information was not limited to Australia. Taking leave from the Australian public service in 1962, he joined the development advisory service of Harvard University to become an economic advisor to the government of Pakistan. He was attracted to Pakistan because it provided a laboratory for the theory of

technical change that he had developed in his Ph.D. thesis. Salter (1955/60) and Leif Johansen (1959, 1961) independently pioneered the vintage model of capital. In Salter's model machines that are installed now use new technology, whereas old machines that had been installed earlier incorporate obsolete technologies. New and old technologies coexist at the same point in time, with the owners of new machines earning economic (Ricardian) rents. One of the most striking features of a developing economy is the coexistence of new and traditional technologies. In Pakistan lorries coexisted with donkey carts, plantations coexisted with subsistence farming, and factories coexisted with street workshops that were run by artisans. Yet, Salter did not have the time to make a lasting mark on development economics. In 1963, he died in Lahore of heart failure, leaving behind two children and a wife who had loyally supported him during his studies, typing his honours thesis at the University of Western Australia.

## 2. Relative Prices and Economic Aggregates

In the first chapter of his honours thesis Salter discusses the conceptual difficulties that arise when different goods are aggregated to a quantity index. The three text boxes that are displayed in this article are the first three sections of Chapter I of the honours thesis. The same headings are used as in the honours thesis and the complete text of each section is reproduced. The text of these sections is virtually unchanged in the revised version of the honours thesis, which was published by the University of Western Australia Press in 1954. The same does not apply to other parts of the honours thesis, which Salter revised for publication.

Salter starts his analysis with the premise that the ultimate goal of economic activity is the satisfaction of human wants. Applying standard price theory, he notes that the 'utility dimension' of goods is reflected by prices. For this reason, economists are interested in the value of an economic aggregate, and not in its weight or some other physical dimension. It follows that "at one point or another, the price factor must be introduced if a measure [of industrial production] is to be economically significant." This argument is much deeper than the common quip that prices must be used 'because it is not possible to add apples and bananas'. According to Salter, a quantity index is an

economically meaningful measure because the price weights give it a 'utility dimension'. Text Box 1 displays the section on the problem of aggregation in Salter's honours thesis.

Text Box 1

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## I – THE PROBLEM OF AGGREGATION

The first problem may be stated as: How can we aggregate a series of different goods and services in some way that is economically significant?

While a transport engineer may be interested in their total weight or volume, to the economist the only significant aggregation is total value. This, of course, springs from the economist's point of view. We are interested in a "thing" not because of its size or weight but its ability to satisfy human wants. Our concern is its "utility dimension", which we approximate by price. Physical measures only have economic significance to the extent that they are a useful means of expressing price per unit.

The important point for our purpose is that economic measures of quantities cannot be divorced from prices. Whatever else we may do, at one point or another, the price factor must be introduced, if a measure is to be economically significant.

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In the next section, Salter considers the difficulties that arise when prices change. He observes that the value of an economic aggregate can change for three reasons: (1) the quantity of goods changes, (2) a change in tastes causes an adjustment in relative prices, and (3) the value of money changes. The price effects – items (2) and (3) – break the link between the value of the aggregate and the quantity of goods that it represents. A change in the value of the aggregate unambiguously reflects a change in the quantity of goods only if relative prices and the value of money remain constant. Salter elaborates "… if relative prices and the value of money are constant and the quantities have doubled, we can say that the economic significance of the aggregation of goods is twice as great." This section of the honours thesis is reprinted in Text Box 2.

Text Box 2

II – COMPARISONS BETWEEN AGGREGATES

For a comparison at one point of time few difficulties arise since the "utility dimensions" of goods are fixed and the relationship between utility and money is constant. Thus aggregates can be compared simply on the basis of their total values.

It is when we attempt a comparison over time that difficulties arise. Over a period three types of changes can occur that will affect the value totals.

(i) A change in the quantity of goods.

(ii) A change in "tastes" or the "utility dimension" of goods. This change is reflected in relative prices.

(iii) A change in the value of money or the "money-utility" relationship.

Changes (ii) and (iii) are reflected in price.

Thus while we can aggregate quantities of coal, apples and locomotives on the basis of period A's relative prices and value of money, and we can similarly aggregate quantities of the same goods at period B's relative prices and value of money, we cannot compare them. This is because there is no connecting link between the two sets of values. At least two of the three factors must be constant before a comparison can be made.

Thus if relative prices and the value of money are constant and the quantities have doubled, we can say that the economic significance of the aggregation of goods is twice as great.

If quantities and the value of money are constant and relative prices have changed, we can say the economic significance has increased or decreased by so much.

If quantities and relative prices are constant and the value of money has changed, we can use a comparison in the value totals to measure the change in the value of money.[2]

In practice all three changes occur over time. This means we cannot compare changes in the economic significance of quantities without making artificial assumptions about prices. To the extent these assumptions are artificial, any quantity index is only an approximation. Since we can make alternative assumptions (equally artificial) about prices, no unique measure of the economic significance of quantities is possible.[3]

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(2) Value of money only refers to its value within the aggregate under consideration, not to an overall general value of money for the whole economy.

(3) See R. Wilson (2) p. 11 for an extreme example of different results obtained by different approximations.

Finally, in the third section Salter tackles the aggregation problem from a somewhat different angle, enquiring in what sense an index of industrial production measures a 'real' change in production. He distinguishes between two distinct concepts of 'real': an index that uses the same prices for the aggregation of goods in every year is expressed in "base year prices", whereas an index that uses current prices for every year is expressed in "constant pounds (or dollars)". The first type of index is a Laspeyres index and the second is a Paasche index, which Salter introduces at this point:

$$P_{Laspeyres} = \frac{\sum P_0 Q_1}{\sum P_0 Q_0} \qquad\qquad P_{Paasche} = \frac{\sum P_1 Q_1}{\sum P_1 Q_0}$$

$Q_i$ indicates the output of some industry in year $i$ and $P_i$ is its price. Both indexes provide measures of the real change in production because prices are held constant, but the concept of "real" is ambiguous because base year prices are used in the Laspeyres index and current prices are used in the Paasche index. For this reason, the two indexes yield different values for the change in industrial production. In his honours thesis, Salter uses the Laspeyres index, which he transforms into a form that can be easily measured. Text Box 3 presents the section of the honours thesis that deals with the meaning of the term "real".

Text Box 3

III – THE MEANING OF THE TERM "REAL"

Index numbers of Industrial Production are in "real terms". In view of what has been said, it may prove profitable to enquire what exactly this means.

Obviously it cannot mean simply an aggregation of goods and services for as we have seen this is impossible except in terms of a set of prices.

We can mean a comparison over time between two aggregations of goods and services each totalled according to their appropriate set of prices, but with some allowance for changes in the value of money. It should be noted that value totals derived in this way need not be identical even if equal quantities of the same goods are compared.

Or we can mean a comparison between two aggregations of goods on the basis of one single set of prices. One aggregation of goods and services, at least, would have to be totalled on prices appropriate* to it.

The upshot seems to be that the term "real" can have various meanings which are not always distinguished in its usage. The better procedure seems to be to use the phrase "in constant pounds (or dollars)" if we mean the value of money is assumed constant but relative prices have changed, and the phrase "in 1938-39" prices" if we are using a fixed set of prices.

These phrases represent alternative concepts by which changes in industrial production may be compared.

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* "inappropriate" in the published version of the honours thesis.

Since relative prices change over time, a quantity index involves an error. Referring to the Laspeyres index, Salter (1953b, p. 5) notes that "the further from the base year a comparison is made, the greater is the likely error caused by aggregating goods and services on an inappropriate set of prices". And on the Paasche index he comments "Since such index numbers are not really comparable because of changes in relative prices, the further apart we attempt to make them the greater the error." The problem of relative prices in the aggregation of goods was naturally well known at the time Salter wrote his honours thesis. Wassily Wassilyovitch Leontief (1936, 1947) and John Hicks (1939/46) put forward the so-called composite commodity theorem, which – according to Hicks – holds that "a group of

goods behaves just as if it were a single good"[4] if relative prices between the goods do not change. Leontief's version of the theorem is more general, stating that the aggregation of goods is valid if the marginal rates of substitution inside the aggregate are independent of variables outside the aggregate. Hicks had considered the simple case where marginal rates of substitution (relative prices) are constant. It seems that Salter was not aware of Leontief and Hicks' work on the composite commodity theorem when he wrote his honours thesis, but he must have become aware of it during his Ph.D. research at Cambridge.

The list of references at the end of the honours thesis gives an indication of the applied research culture that Mauldon fostered in the Department of Economics at the University of Western Australia. Only nine works are listed, with a note that two of them include extensive bibliographies. In the introduction to the honours thesis, Salter mentions the United Nations report on 'Index Numbers of Industrial Production', which was released in 1950. In Chapter I, which deals with the aggregation problem, he refers to an article of Ronald Wilson (1947), who – like Salter – abandoned a promising academic career in favour of the Australian public service.[5] In the main body of the thesis where the index of industrial production is developed and estimated, Salter refers to two studies on output and productivity by Reddaway (1950), his future Ph.D. supervisor, and Carter, Reddaway and Stone (1948).[6] Finally, Salter (1953b, p. 15) mentions a method of measuring the output of an industry that was first proposed by Wilson (1937), although Fabricant (1940) and Geary (1944) "have been given the credit [for it] in overseas publications."[7]

A trait that served Salter well in his research was his ability to focus on the issue at hand. He did not get sidetracked, keeping his references short and to the point. In his honours thesis he did not mention the pioneering research on index numbers by Francis Ysidro Edgeworth, and he also omitted the article of Ragnar Anton Kittil Frisch (1936) on

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[4] Hicks (1946, Appendix to Chapters II and III, Item 10).

[5] King (2007) includes a biographical entry on Ronald Wilson.

[6] John Frederick Carter was a statistician and applied economist who served as the first Vice Chancellor of the University of Lancaster. John Richard Nicholas Stone received the Nobel Prize in Economics in 1984 for this pioneering work on the modern system of national income accounting.

[7] Solomon Fabricant conducted extensive research on productivity and economic growth. He spent most of his life as a Professor of Economics at New York University, and he was also a Director of the National Bureau of Economic Research. Several authors discuss the work of Robert Charles (Roy) Geary, an Irish statistician, in a volume edited by Denis Conniffe (1998).

the index number problem. Irving Fisher's *The Making of Index Numbers*, which was first published in 1922, is mentioned just once, in Chapter II of Part II of the honours thesis where the time reversal test for index numbers is used. Salter did not refer to these major works on index number theory because his research interests were applied, involving the construction of an index of industrial production for Australia. Besides, the established literature on index numbers mostly dealt with price indexes, whereas he was interested in the aggregation of production across industrial sectors and the construction of a quantity index. Chapter I of Salter's honours thesis would, however, have benefited from a reference to the works of Leontief (1936, 1947) and Hicks (1939/46) on aggregation and the composite commodity theorem.

## 3. Productivity and Technical Change

Salter arrived in Cambridge in 1953, the year when Joan Robinson started off the controversy about the measurement of the capital stock in the economy. Physical capital, which is used for the production of goods, consists of a myriad of objects and devices – shovels, computers, and so on. Like other economic aggregates, the value of the capital stock can be calculated by adding up the value of each single capital good in the economy. This is neither better nor worse than in the case of other economic aggregates – that is, a quantity index of the real capital stock is distorted if relative prices of capital goods change over time. The problem is not so much the measurement of the capital stock, but its use in the production function in macroeconomic models. The price of a capital good depends on the interest rate because it equals the present value of the flow of extra output that it produces during its life. As a consequence, the price of a long-lasting capital good falls relative to that of a short-lived capital good if the interest rate rises. Robinson (1953) pointed out that the inclusion of the capital stock in the production function is circular because macroeconomic models are used to determine the interest rate, and the interest rate is needed to determine the aggregate capital stock.

In the 1960s, the capital controversy raged between the two Cambridges, with Robinson and Piero Sraffa representing Cambridge, United Kingdom, and Paul Anthony Samuelson and Robert Merton Solow speaking for Cambridge, Massachusetts. After a long and often acrimonious debate, Samuelson (1966) and Levhari and Samuelson (1966) all but

conceded Robinson's point that the capital stock in the neoclassical production function cannot be measured (Geoffrey M. Hodgson, 1997). The followers of Robinson and Sraffa had, however, won a pyrrhic victory, for although they had found a logical inconsistency in the neoclassical growth theory, they were not able to develop an alternative analytic framework. Scientific reputations are made by the discovery of new theories, and not by the critique of old theories. Moving on, macroeconomists all but ignored the issue of measurement of capital in the production function. Capital accumulation drives economic growth in the Solow-Swan model, and the neoclassical production function is an integral part of modern macroeconomic models, which combine the Solow-Swan model with the Ramsey model of optimal saving. But some lingering unease remains, which Niehans (1990, p. 367) expresses succinctly:

> "The composite goods theorem is important primarily because it helps to give the macroeconomist a good conscience. For many purposes, for example, it would be perfectly legitimate to reduce labor of different skills to "common labor." In some cases, however, the theorem is important precisely because it gives the macroeconomist a bad conscience. The most important of these cases concerns capital goods of different longevity. The macroeconomist, in explaining the rate of interest, would often like to aggregate them to a composite capital good. However, any decline in the market rate of interest implies an increase in the price of long-lived capital goods relative to short-lived capital goods. As a consequence, the basic requirement of the composite goods theorem is not satisfied; different capital goods cannot be meaningfully aggregated in physical terms if the interest rate is variable."

The honours year gave Salter a solid foundation for graduate studies at the University of Cambridge, the epicentre of the capital controversy. The work on the Australian index of industrial production had taught him the importance of relative prices in economics. If he had not already become aware of the composite commodity theorem in Australia, he certainly had no difficulty to understand its significance for economic aggregation when he conducted graduate studies in Britain. Salter did not participate in the capital controversy because he eschewed academic debates. However, in his Ph.D. thesis, he developed a model of technical change that made it unnecessary to measure the aggregate capital stock! Indeed, Salter's vintage model of capital could have been used by the followers of Robinson and Sraffa as the starting point for a new macroeconomics that was untainted by the inconsistency of the neoclassical production function. It is one of the great mysteries of twentieth century macroeconomics, which cannot just be explained by

Salter's premature death, why British economists did not build on his model of economic growth. Salter's *Productivity and Technical Change* was considered a classic by his contemporaries, but it soon fell into oblivion. The macroeconomists who developed endogenous growth models in the 1990s were unaware of Salter's elegant analysis of technical change.

The hallmark of Salter's economic writings is the emphasis that he puts on the idea that economic decisions are taken at the margin. Relative prices are important because they reflect marginal rates of substitution. In *Productivity and Technical Change*, Salter applies the idea that economic decisions are taken at the margin in an imaginative way to the accumulation of capital and technical progress. There is no need to measure the capital stock because technical progress requires the installation of new capital goods. Old capital goods, which embody old technologies, are bygones and bygones do not influence economic decisions. Once a machine is installed, its owner earns an economic rent, which gradually falls over time as the machine becomes obsolete. The owner keeps the machine in operation as long as the rent stays positive. Since economic rents do not affect economic decisions, the existing capital stock is irrelevant for the analysis of technical progress. The investment decision is, however, crucial for the implementation of new technologies and Salter analysed it with great care. The difference between Salter's approach to economic growth and modern growth theory is profound. In modern macroeconomic models technical progress does not take place at the margin of the capital stock, but the efficiency of all machines – even that of "museum pieces" – improves. But like Salter, modern macroeconomists stress the price mechanism. In this regard, there is no difference between Salter's analysis and modern macroeconomic models with microeconomic foundations. The following quote, in which Salter demonstrates that technical progress induces substitution of capital for labour by reducing the relative price of capital, could well have been written by a contemporary macroeconomist.

> "The essence of technical progress is that it enables commodities to be produced with less labour and capital, and so reduces the prices of commodities in terms of labour. This is true of both consumption goods and capital goods; savings of labour in the consumption goods industry raises the price of labour in terms of consumption goods; and savings of labour in the capital goods industry raises the price of labour in terms of capital goods. Consequently, even though the wage rate and the interest rate may be

constant[8], the cheapening of capital goods which originates in technical progress reduces the capital costs of real investment and so induces substitution of capital equipment for labour. Thus, technical progress in the manufacture of capital goods produces a continuous pressure throughout industry for the substitution of capital equipment for labour. In effect, technical change raises the productivity of labour in two stages: the first is the direct effect of technical advances in each industry; and the second is the substitution of capital equipment for labour, following upon the cheapening of capital goods relative to wages." (Salter 1960, pp. 35-36)

It is not possible to give full justice to Salter's model of technical progress in the confined space of this article. The important point for the argument in this article is that there is a direct link from his honours thesis to his Ph.D. thesis, which was provided by the focus on relative prices and substitution. The application of the related idea that economic decisions are taken at the margin, which Salter extended to technical progress and the accumulation of capital, is an imaginative and original contribution to the theory of economic growth. Salter must have felt reassured of the correctness of his approach by the fact that the inclusion of the capital stock in a macroeconomic model that determines the interest rate violates the assumptions of the composite commodity theorem. The faculty at the University of Cambridge were certainly delighted that he saw no need to measure the capital stock in his theory of economic growth.

4. Open Economy Macroeconomics

Salter's second contribution to economic theory is his small open economy model with internationally traded and nontraded goods, which he developed in an article published in the *Economic Record* in 1959. The concept of internationally nontraded goods or home goods was not new, Rudiger Dornbusch (1980, Chapter 6) mentions several authors who had used it in open economy macroeconomics before Salter. Today, the model of Wilson (1931), Salter (1959a) and Swan (1960, 1963b) is known as the "Australian" or "dependent economy" model because it deals with a small open economy that is a price taker in world

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[8] Since technical progress raises the marginal product of labour and capital, both the wage rate and interest rate increase. A higher wage rate further depresses the price of capital relative to labour, and a higher interest rate does the same because the price of a capital good is determined by the present value of the future revenue flow. (Annotation by E.J. Weber)

commodity markets. Although Salter did not mention Wilson, he certainly knew him because Wilson, who served as Secretary to the Treasury from 1951 to 1966, was a major figure in economic policymaking in Australia. In his honours thesis, Salter used a monograph on productivity that Wilson had published in 1947. Wilson shared Salter's penchant for meticulous statistical research. In 1931, he published *Capital Imports and the Terms of Trade*, which drew on his research for two doctoral degrees at the University of Oxford and the University of Chicago. From his estimates of capital imports to Australia he distilled the hypothesis that capital imports raise the price of home goods relative to traded goods.

Salter's model of a small open economy considers two types of goods – internationally traded goods and home goods that are traded only locally. Home goods include personal services and goods whose properties either preclude transport by land, sea or air, or render it prohibitively expensive. Although the distinction between traded goods and home goods is not entirely black and white, each good is classified as either traded or nontraded. Salter's model is called the dependent economy model because it deals with a small open economy – Australia – that faces fixed terms of trade in international commodity markets. Since the price of export goods relative to import goods is fixed, it is legitimate to treat exportables and importables as a single aggregate of internationally traded goods. Thus, Salter's innovation was to apply the composite commodity theorem to exportables and importables in a model of a small open economy that also includes home goods. The aggregation of exportables and importables to a single internationally tradeable good simplified the analysis because the dimension of the model is reduced from three goods – exportables, importables and home goods – to only two goods – internationally tradeable goods and home goods. For this reason, the number of relative prices that has to be considered falls from two to only one. Dornbusch (1980, p. 97) and Maneschi (1997) both point to Salter's application of the composite commodity theorem.

In economic policy analysis the composite commodity problem is important because it makes it possible to treat a group of goods as a single good if their relative prices do not change in the particular problem at hand. Salter applied this principle, which can be found in Hicks (1946, Chapter II (4)), to economic policy in a dependent economy. He believed that domestic economic policy – he considered devaluation and deflation – does not affect the Australian terms of trade in world commodity markets. Therefore, the effect of

domestic economic policies on the balance of payments can be studied in an analytic framework that treats exportables and importables as a single aggregate of internationally traded goods. Salter (1959a) explained it as follows:

"Variations in the terms of trade - although frequent and often disastrous - are determined almost exclusively by conditions abroad; while the effects of Australian policies on the terms of trade are generally thought to be small.[1] Therefore there is a case for treating the terms of trade as given - a fact to which we in Australia must adjust our policies - and taking full advantage of the very considerable simplification this allows in the analysis of our international trading problems.[2]"

……..

"The procedure of treating exportables and importables as a single class of goods (traded goods) is quite legitimate so long as the terms of trade are unaffected by events inside Australia.[3]"

Notes: [1] See J.E. Meade: "The Price Mechanism and the Australian Balance of Payments", *Economic Record*, No. 63 (November 1956), p. 248. [2] The proposition that changes in the terms of trade play a minor role in restoring the balance of payments equilibrium has been argued *generally* by I.F. Pearce in a paper shortly to be published. [3] The formal assumption is a perfectly elastic world demand for exports, and a perfectly elastic world supply of imports.

With only two goods, the dependent economy model can be represented in a diagram with home goods on one axis and internationally traded goods on the other axis. The so-called Salter diagram, which is displayed in Figure 1, shows the production possibility frontier between home goods and traded goods. The slope of the production possibility frontier indicates the relative price between home goods and traded goods, which is the "real exchange rate".[9] The relative price of home goods and traded goods is the only

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[9] The law of one price implies:

$$P_T = \overline{P}_T^* e.$$

$P_T$ measures the domestic currency price of traded goods, $\overline{P}_T^*$ is the foreign currency price of traded goods, and $e$ is the exchange rate. A small country has no influence on $\overline{P}_T^*$. Dividing both sides by the price of home goods, $P_H$, yields the relative price of traded goods in terms of home goods:

$$\frac{P_T}{P_H} \updownarrow = \frac{\overline{P}_T^* e \updownarrow}{P_H}.$$

relative price that matters because it is assumed that domestic economic policy does not affect the terms of trade. For the argument in this paper, the important point is that Salter applied the composite commodity theorem to reduce the number of goods and relative prices that must be considered in economic policy analysis in a dependent economy.
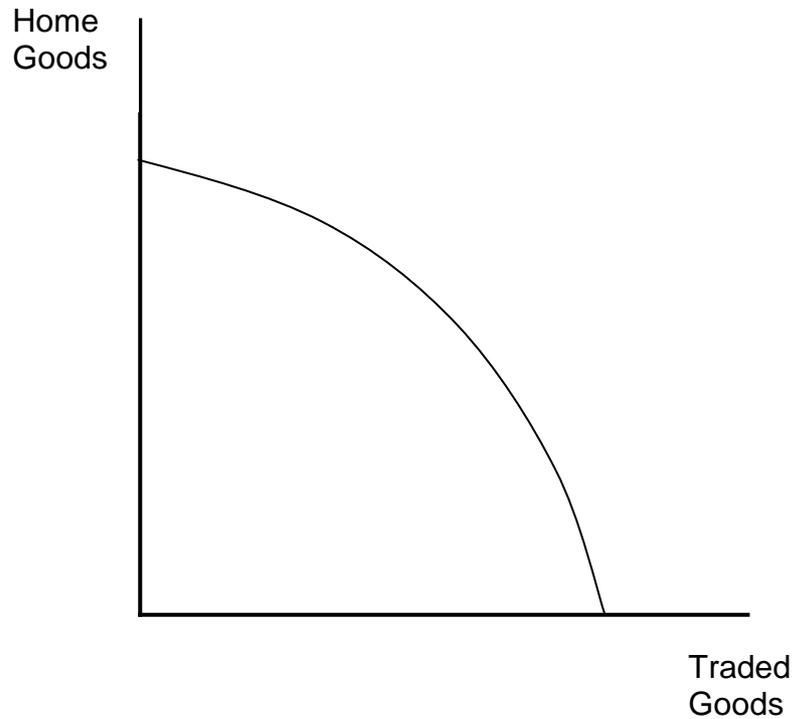
Home
Goods

Traded
Goods

Figure 1. The Salter Diagram

5. Economic Policy

Salter is best known for his two contributions to economic theory because his premature death robbed him of the opportunity to make a lasting contribution to economic policy in the public service. A notable exception is his testimony, together with Eric Russell, in the 1959 Basic Wage case, which he gave at the request of Robert James Lee (Bob) Hawke, the future Prime Minister of Australia. Bob Hawke was a contemporary of

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Domestic economic policy determines the price of home goods. A real economic shock that alters the relative price between traded goods and home goods – by shifting the production possibility frontier – leads to a proportional change in the exchange rate. The relative price between traded goods and home goods is called the real exchange rate because it is the fundamental force that drives the exchange rate in a dependent economy.

Salter in the Economics Department at the University of Western Australia. In this section, Australia's centralised wage setting system in the first half of the twentieth century is briefly reviewed, and then Salter's statement of evidence before the Commonwealth Conciliation and Arbitration Commission is discussed.

In 1906, Australia unwittingly stumbled into a centralised wage setting system when the Federal government, which had been established in 1901, passed the Excise Tariff Act. The Act, which introduced some excise duties for agricultural equipment, granted exceptions to Australian manufacturers of agricultural machinery if they paid "fair and reasonable" wages to their workers. In his famous Harvester judgement, 1907, Justice Henry Bournes Higgins, the President of the Federal Arbitration Court, defined as "fair and reasonable" a wage that covers "the normal needs of the average employee, regarded as a human being living in a civilized community."[10] In *A New Province for Law and Order*, which was published around 1919, Higgins assumed that the worker had to support a family of about five people.[11] In the Engineers' case, 1921, he reiterated that the basic wage "is the lowest which any male adult worker, not licensed as a slow worker, should receive, and is based, not on the value of his work, but on his requirements as a man in a civilized community which has resolved that, so far as laws can do it, competition shall no longer be allowed to crush him into sweat conditions."[12] Thus, the basic wage, which was also called 'living wage', was based on the needs of the worker and his family and not on his contribution to the output of the firm or the firm's ability to pay. The principle that the basic wage should only cover the needs of the "most humble" working class family, with no consideration being given to the increase in productivity, remained intact for half a century. In the Arbitration Act of 1949, the basic wage was still defined as "the wage, or part of a wage which is just and reasonable for an adult male, without regarding to any circumstances pertaining to the work upon which, or the industry in which he is employed, or the principles upon which it is computed."

Besides the basic wage the centralised wage setting system provided for a secondary wage – the so called margin – for skilled workers.[13] Although the Federal Arbitration Court

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[10] George Anderson (1929, p. 189)

[11] ibid.

[12] ibid. (p. 190)

[13] ibid. pp. 279ff.

attempted to keep the margins for different occupations constant over time, in practice margins reflected changing labour market conditions, providing some flexibility in the centralised wage system. The dual wage setting process with a basic wage and margins for skills survived until 1967, when the Commonwealth Conciliation and Arbitration Commission, which had succeeded the Federal Arbitration Court, introduced job specific wages. For sixty years, the basic wage had been one of the most important economic policy variables in Australia because it anchored the wage system. Cost of living adjustments, which were all but automatic as long as the needs principle was maintained, were implemented by raising the basic wage.

The basic wage had been adopted as a social measure to prevent sweat shop conditions, but the unintended consequence was that labour income fell behind in the post World War II prosperity. In 1953, the Federal Arbitration Court abandoned the needs principle in favour of the firm's ability to pay.[14] The consequence was that the quasi-automatic cost of living adjustments ceased because it was no longer the need of an unskilled worker that mattered but the firm's ability to pay. However, the move to the ability to pay criterion also opened the door for a rise in the basic wage when labour productivity increased. In the 1959 Basic Wage Case, the unions used Salter's estimates of the increase in labour productivity during the preceding five years to back up their wage claim. They were only partly successful because, after a minimal increase by 5s in the preceding year, the basic wage was raised from 13£/1s to 13£/16s, or by 5.75 percent, in 1959 (Keith Hancock 1960).

The statement of evidence that Salter (1959b) submitted to the Arbitration Commission is a repeat of his honours thesis, which he had written six years earlier. He estimated the output of various economic sectors and then derived estimates for labour productivity at the sectoral level and for the entire economy. In an appendix, the index number problem is restated, which arises from the use of fixed prices as weights. Yet, Salter dismissed the index number problem because he thought that the error was small in practice. In an experiment he found that from 1953/54 to 1957/58 the output per worker increased by 23 percent if 1953/54 weights are used (Laspeyres), and by 18 percent if 1956/57 weights are used, an error of five percentage points over four years. The following

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[14] David Plowman (1986) discusses institutional changes in Australian wage determination from 1953 to 1983.

quote confirms that he considered it legitimate to use quantity indexes for economic policy formulation.

> "(The) purely logical difficulties of measurement, however, should not be exaggerated. In recent years a good deal of experimentation has been undertaken to ascertain how far different weighting systems affect volume measures. The general conclusion is that, over short periods at least, the difference between alternative measures is not large, and certainly not sufficient to render futile measurement in volume terms." (Salter 1959b, p. 44)

Not surprisingly, Salter sided with the unions that the basic wage should reflect the increase in productivity. This followed directly from the theory of technical progress that he had developed in his Ph.D. thesis. As documented in the second quote in Section 3, Salter believed that technical progress induced substitution of capital for labour by reducing the price of capital relative to labour. The old system of wage fixation paid no attention to increases in labour productivity, although the Federal Arbitration Court sometimes grudgingly accepted a small increase in the real wage. The artificial cheapening of labour interfered with the process of substitution of capital for labour, which reinforces the direct effect of technical progress on the productivity of labour. Low wages reduced the incentive to install new machines that took advantage of new technologies. Salter (1959b, p. 2) supports the unions' position on productivity and wages because artificially low wages hold back economic development:

> "The relationship between productivity and real wages is double-sided: increased productivity provides the goods and services necessary for increased real wages, while higher real wages provide incentives to increase productivity through more efficient production. Stagnation of real wages eventually has unfavourable effects on productivity: incentives to install new and improved methods of production are weakened; high-cost inefficient enterprises are allowed to survive; and progress in mechanising production processes is restricted."

6. Nature or Nurture?

From his honours research on an Australian index of industrial production, Salter gained first hand experience that, strictly, economic aggregation is only possible if relative prices are stable. He acquired a firm understanding of the composite commodity theorem,

preparing him for his two famous contributions to economic theory. He knew when it was legitimate to appeal to the composite commodity theorem, and when the composite commodity theorem did not apply; thus he knew when relative price changes could be dismissed and when they mattered in economic policy analysis. In his Ph.D. thesis, he developed a theory of technical advance in which there is no need to measure the economy wide capital stock. He agreed with Joan Robinson that it is impossible to measure the aggregate capital stock because the assumptions of the composite commodity theorem do not hold in a general equilibrium framework. Interest rate changes, which are endogenous in a macroeconomic model, produce relative price changes between capital items with different durations. But unlike his contemporaries, Salter was not bothered by the elusive nature of capital because he saw no need to measure the capital stock in the first place. In his vintage model of capital technical progress occurs at the margin of the capital stock when new investment goods that incorporate modern technology are installed. In the dependent economy model Salter, however, accepted the aggregation of exportables and importables because in a small open economy the terms of trade are unaffected by domestic economic policy. For this reason, it is sensible to analyse economic policy in a framework with only two goods – home goods and internationally traded goods. Thus, Salter recognised that the capital stock is an invalid aggregate in a macroeconomic model but internationally traded goods are a valid aggregate in the dependent economy model. His success as an economic theorist lies in the fact that he understood when to apply the composite commodity theorem as an analytic tool, and when to avoid it.

What explains Salter's stellar career – his talent as an economist (nature), the economics education that he received at the University of Western Australia (nurture), or just plain luck? Certainly, he was a gifted economist with a strong analytic talent who was, at the same time, keenly interested in economic policy. But analytic talent and a fervent disposition towards economic policy cannot fully explain his extraordinary performance: he completed the Ph.D. within two years with a thesis that could have revolutionised the theory of economic growth if his contemporaries had been able to take up the baton. Salter's success reflects well on the economics education that he received at the University of Western Australia. He was trained in the classical theory of value, which stresses the price mechanism. Indeed, it appears that the economics curriculum at the University of Western Australia was somewhat old fashioned, being based on the writings of Alfred Marshall, David Ricardo and other classical economists at a time when Keynesian

economics was the frontier of macroeconomics. The curriculum had survived from the time of Edward Owen Giblin Shann, who – as discussed in Graeme Donald Snooks (1993) and Gregory C. G. Moore (2008) – was an advocate of laissez-faire economics. After the departure of Shann in 1935, Merab Harris kept the Economics Department afloat as a temporary lecturer (!) until Mauldon arrived in 1941. Neither Harris nor Mauldon are likely to have changed the economics curriculum that they had inherited from Shann. Harris was an economic historian who also taught history of economic thought. McLure (2008) found that she emphasized the classical theory of value in her 1953 lecture on political economy. Mauldon, who took up the professorship at the University of Western Australia at the age of fifty, was an applied economist who had studied economics before the Great Depression in the 1930s. The exposure to classical economics, which Salter received in the Department of Economics at the University of Western Australia, was decisive for his success. Without the solid analytic foundations of the classical theory of value, he would not have been able to make his path-breaking contributions to growth theory and open economy macroeconomics, which both stressed the role of the price mechanism in the economy.

Salter was lucky that he found a supervisor for his honours research who shared his enthusiasm for applied statistical research. Mauldon is best known for his writings on the Australian coal industry. As pointed out by Ray Petridis (2007), Mauldon was influential as an economics teacher because he remained receptive to new developments in economics throughout his life. He was a precursor to the Cambridge tradition of applied economics, which started in 1945 when Richard Stone became the first head of the Department of Applied Economics at the University of Cambridge. Salter was educated in an empirical tradition that stressed that "to measure is not to understand", as he put it in the introduction to *Productivity and Technical Change*. Harcourt and Kitson (1993) found that Stone's microeconomics had Marshallian foundations. Similarly, Mauldon's empirical research grounded on Marshallian economic theory. Mauldon involved staff members and students in his applied research. In 1944/45/46, he completed three annual reports on the West Australian economy with estimates of state income, employment and some business indicators. Besides Salter's honours thesis and his report on state income, the Library of the University of Western Australia holds a report by Alex M. Kerr and John Nevile (1957), which "continues the income research [on Western Australia] which has been the main preoccupation of the Faculty of Economics for some years now." (p. ii) Salter was lucky

that he had the opportunity to take part in applied economic research with firm price theoretic foundations at the beginning of his career as an economist.

The timing of Salter's undergraduate studies was also fortunate. National income accounting was an active research area in economics in the 1940s and 50s, which culminated in the establishment of the United Nations System of National Accounts. The Department of Applied Economics at the University of Cambridge was the leading academic institution in this field. Richard Stone, who headed the Department of Applied Economics from 1945 to 1955, received the Nobel Prize in Economics in 1984 "for having made fundamental contributions to the development of systems of national accounts and hence greatly improved the basis for empirical economic analysis". In 1948, Stone co-authored *The Measurement of Production Movements* with Charles Frederick Carter and Brian Reddaway, Salter's Ph.D. supervisor. In 1955, Reddaway succeeded Stone as head of the Department of Applied Economics. Starting with Mauldon's mentorship, Salter had the good fortune to move in a research environment that was highly conducive to his own aspirations.

It is futile to speculate how Salter's career would have developed if he had not died at a young age, but his brand of classical economic analysis and applied statistical research would certainly have enriched the economic policy debate in the 1960s and 70s, when Australia still adhered to an economic model that stressed wage and price controls and a host of stifling economic regulations. The common thread in Salter's writings is the play of relative prices that guides the production and distribution of goods and services. The statement of evidence that Salter gave to the Arbitration Commission in 1959 at the invitation of Bob Hawke provides a glimpse of what could have been, but it fell to Hawke, who was exposed to the same economic ideas as Salter at the University of Western Australia, to reform the Australian economy in the spirit of Salter and Shann in the 1980s.

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