

AN AUSTRALIAN MODEL: NONTRADED GOODS, REAL EXCHANGE RATES AND UNEMPLOYMENT

PAUL OSLINGTON*

University of NSW/Australian Defence Force Academy

A popular model for considering many international trade and macroeconomic questions is the 'Australian model' of Wilson, Swan and Salter. This paper develops a general equilibrium trade version of the 'Australian model' where unemployment comes from a specified factor market distortion, and considers the effects of immigration, transfers, changes in wage fixing arrangements, terms of trade shocks, tariffs and devaluations. Debates over policies for external and internal balance are revisited, with the advantage that the general equilibrium specification allows welfare consequences of various alternatives to be explicitly considered. In the model external balance is achieved through a flexible exchange rate and the most attractive policies for achieving internal balance are encouraging skilled immigration and skill augmenting technical change, training, and unskilled wage cuts (accompanied by redistribution to affected workers). Foreign borrowing, import tariffs and currency devaluation are problematic policies from a welfare point of view.

I. INTRODUCTION

A popular model for considering many international trade and macroeconomic questions is the 'Australian' model. It has been one of Australia's important contributions to economic theory and seminal works include Wilson (1931 ch4), Swan (1960; 1963) and Salter (1959). In recent years it has been further developed and used by Corden (1960; 1985; 1992), Dornbusch (1980), and Neary (1988) among others.¹ Central features are a traded/nontraded

* Correspondence to Paul Oslington, School of Economics and Management, UNSW/ADFA, Northcott Drive, Canberra 2602 Australia. Phone: 61-2-6268 8720. Email: p.oslington@adfa.edu.au. I thank Jeffrey Sheen, Alan Woodland, Heinz Arndt, Peter Neary and Neil Vousden for their comments at various stages of this research.

¹ The 'Australian' model name is due to Dornbusch (1980 ch. 6). Not all of these writers are Australians, although the Australian content is higher than it appears because some of the others worked on the model while visiting Australia or were influenced by Australian policy problems. Arndt (1976) discusses the background of the early contributions. It is also known as the 'Dependent Economy' model, for instance in Corden (1992), following the title on one of Swan's papers. An interesting aspect of these models is the blend of macroeconomic and microeconomic tools and issues. Unemployment, since Keynes at least, has been an issue for macroeconomists while trade and relative prices under full employment has been the domain of microeconomists. The Australian model brings both sets of tools to bear on both issues, epitomising the national impatience with theoretical fashions and concern for models which are relevant to its pressing policy problems.

goods distinction, fixed relative prices of traded goods, and a variable real exchange rate² which reflects the relative prices of traded and nontraded goods. Many of these features have been influenced by Australia's particular economic environment, especially the importance of trade (so that a trade model rather than a closed economy model must be used), inability to influence prices of traded goods (so that relative traded goods prices are taken as given) and unique industrial relations arrangements (including an effective minimum wage). Variants of the model have been used to consider a large number of policy questions including maintenance of internal and external balance, effects of foreign borrowing and effects of protection.

This paper synthesises and extends the Australian model literature by developing a modern general equilibrium version where unemployment comes from a factor market distortion. Fully investigating its comparative static properties brings out previously neglected aspects of the model and some significant new results are derived. Welfare, measured by the trade indirect utility function for the representative individual, is explicitly considered for the first time. Within this framework some perennial policy debates are revisited, including internal and external balance, foreign borrowing, tariff policy, labour market and immigration policy.

To briefly preview the structure of the model, there will be an imported good, an exported good, a nontradeable good, and two factors of production which can be interpreted as skilled and unskilled labour. This structure is a common one in the general equilibrium trade literature, for instance Jones (1974), Kemp (1969 ch6) and Woodland (1982 ch8). The novel element in relation to the general equilibrium trade literature is that one of the factors of production will be subject to a minimum wage and thus unemployment, along the lines of Brecher (1974), Neary (1988) or more recently Davis (1998). This wage floor may be justified in various ways; it may be a legislated minimum or award wage, an effective floor set by the social security system, or a proxy for some underlying efficiency wage, union bargaining or insider-outsider mechanism.³ Unlike the best known small open economy minimum wage model of Brecher (1974) we do not get a degenerate outcome of specialisation in the production of a single good, and dimensionality of the model together with the endogeneity of the nontraded good price means results are different to Brecher's model. In the general equilibrium trade literature this type of nontraded good model with a minimum wage has not been systematically investigated.⁴

In relation to the 'Australian' model literature the main difference between the model of this paper and the work of Swan (1960; 1963) and Salter (1959) is the mechanism generating unemployment. The earlier papers attributed unemployment to aggregate demand forces

² The term real exchange rate has been used for many different things in many bodies of literature, as discussed by Corden (1992). The use of the term in this paper for the relative price of the traded good in terms of the nontradeable good is consistent with most of the Australian model literature. In the notation of the paper the real exchange rate is p^2/p^3 and a fall is a real appreciation.

³ The underlying mechanism could be modelled, as in Kemp, Long and Shimomura (1991) for a union model, Brecher (1992) for an efficiency wage model, or Oslington (1998 ch. 7) for a general equilibrium insider-outsider model. The underlying mechanism is not the focus of the present paper, and is not specified in order to keep the model simple and to encompass a variety of underlying mechanisms.

⁴ Jones and Corden (1976) considered the effects of a devaluation in a nontraded good model where fiscal policy pegs the money wage. Under these conditions a devaluation raises the price of the nontraded good and improves the trade balance, provided the nontraded good is labour intensive. Brecher (1978) built a similar nontraded good model with a minimum wage to the present paper, but also introduced monetary balance of payments adjustment mechanisms focused his analysis focused on these rather than the real side of the model.

which, in Keynesian manner, were not fully specified in a general equilibrium model, although assumed to be under the influence of fiscal policy and various other things. In the present paper unemployment only comes from factor market distortion specified in the general equilibrium model.⁵ In this respect it is most similar to the early model of Wilson (1931 chIV pp. 66–77). However, as was pointed out by Viner (1937 pp. 327–332), Wilson did not fully consider linkages between nontraded and traded goods through factor markets.

The paper continues in Section II with a description of the model, and then Section III considers the comparative static effects of changes in endowments, income transfers, changes in the minimum wage, terms of trade shocks, a tariff and devaluation. New results in relation to the general equilibrium trade literature are noted. These results are drawn together in Section IV which revisits the issues of internal and external balance prominent in the earlier 'Australian' model literature and contrasts results with those of Wilson, Swan and Salter. Section V concludes.

II. NONTRADED GOODS MODEL WITH A MINIMUM WAGE

The starting point is a standard small open economy general equilibrium model with two traded goods, a third nontraded good, and two factors of production.⁶ In the paper p will represent world goods prices, w factor prices, y outputs, z consumption and v factor endowments. Technology exhibits constant returns to scale and is represented by a concave unit cost functions $c^j(w)$ for each of the j goods, with derivatives with respect to factor i denoted $c_i^j(w)$ equal to unit factor demands by Shephard's lemma.

It will be assumed that exported good 1 uses factor 1 relatively intensively compared to the nontraded good 3 (i.e. $c_1^1/c_2^1 > c_1^3/c_2^3$) and good 1 will be exported and good 2 imported. This factor intensity assumption is consistent with the large amount of empirical evidence that nontraded goods are unskilled labour intensive compared to traded goods.⁷

A simplifying assumption following Jones (1974), is that the imported good 2 is not produced domestically i.e. $y^2 = 0$, and the exported good 1 is not consumed domestically i.e. $z^1 = 0$. This means only goods 1 and 3 are produced domestically and goods 2 and 3 are consumed domestically.

The minimum wage denoted \bar{w}^2 applies in all industries, and binds for the factor 2 which is unskilled labour. Factor 1 will be identified for convenience as skilled labour, although it

⁵ This is not to imply that Keynes' principle of effective demand is incoherent or of limited practical importance, merely that effective demand questions are better examined in different types of models in which monetary effects and uncertainty are central.

⁶ A fuller description of the standard model may be found in Woodland (1982). Note the two traded goods can be thought of as a single composite tradeable good, since their prices are fixed in world markets. The relative numbers of goods and factors are crucial to the properties of the model. Here the number of traded goods is equal to the number of flexible price factors so that factor prices can be determined independently of endowments and demand. In the full employment version of the model (Jones 1974) this is not so, and factor prices depend on endowments and demand. The difference is due to the dimensionality consequences of imposing a minimum wage; it effectively reduces the number of factors by one, making the number of flexible price factors equal to the number of goods whose prices are set in world markets, and thus able to be determined by them. A more extensive discussion of dimensionality issues may be found in Ethier (1984).

⁷ The assumption that the nontraded good is labour intensive relative to the exported good is necessary for some of the results, and where it matters this will be noted and the consequences of the reverse assumption given. Empirical evidence for the assumption is provided by Kravis and Lipsey (1978) among others.

could equally be capital, or any other type of labour other than that affected by the minimum wage, or a combination of these.

Preferences will be represented by concave homothetic utility functions which are identical for all individuals, giving a relative demand function $z^2/z^3 = d(p^2/p^3)$. Any income transfers to the country will be denoted b .

Equilibrium conditions for the model are:

Zero profit conditions for each of the goods produced⁸

$$p^1 - c^1(w^1, \tilde{w}^2) = 0, y^1 > 0 \quad (1)$$

$$p^3 - c^3(w^1, \tilde{w}^2) = 0, y^3 > 0 \quad (2)$$

Full employment condition for the factor not subject to the floor

$$c_1^1(w^1, \tilde{w}^2)y^1 + c_1^3(w^1, \tilde{w}^2)y^3 - v^1 = 0, w^1 > 0 \quad (3)$$

Unemployment of the factor subject to the floor⁹

$$c_2^1(w^1, \tilde{w}^2)y^1 + c_2^3(w^1, \tilde{w}^2)y^3 - v^2 < 0, w^2 = \tilde{w}^2 \quad (4)$$

Relative Demand

$$z^2/z^3 = d(p^2/p^3) \quad (5)$$

Market clearing condition for the nontraded good

$$z^3 = y^3 \quad (6)$$

Balance of trade condition for traded goods

$$y^1 p^1 + b = z^2 p^2 \quad (7)$$

These conditions determine the endogenous variables $w^1 y^1 y^3 p^3 z^2 z^3$ given the exogenous variables $p^1 p^2 v^1 v^2 \tilde{w}^2 b$. Note that x will be used as an abbreviation for total employment of factor 2 i.e. $c_2^1(w^1, \tilde{w}^2)y^1 + c_2^3(w^1, \tilde{w}^2)y^3$. Unemployment of factor 2 (the endowment v^2 less employment x) will be denoted u . One of the traded goods prices is the numeraire and equal to 1.

The model captures the most important channels of effect discussed in the Australian model literature while remaining reasonably simple and easy to interpret. Factor prices and the price of the nontraded good are determined entirely by the zero profit conditions (1) and (2), which embody technology, world goods prices and the minimum wage. Once factor and nontraded goods prices are determined, outputs and consumption of goods are then determined jointly by the full employment condition (3), relative demand (5), the nontraded

⁸ Positive quantities of both the nontraded and exported goods must be produced if preferences are such that positive quantities of both the nontraded and exported goods are consumed. The outcome of specialisation in a single good when the minimum wage (noted by Brecher 1974) is avoided because the price of the nontraded good adjusts to maintain zero profits in both industries.

⁹ There must be unemployment in (4) according to the following argument. The minimum wage reduces the factor 2 intensity of both domestically produced goods 1 and 3. In order to maintain full employment of factor 2, the output and consumption of the factor 2 intensive good 3 would have to rise, which would mean the output of good 1 would fall. By the balance of trade condition equation (7) the fall in output of good 1 must mean consumption of good 2 would also have to fall. Now the minimum wage on factor 2 must increase the price of good 3 because it uses factor 2 relatively intensively, which by the relative demand condition (A5) will reduce the demand for good 3 and increase the demand for good 2. This reduction in demand for good 3 is inconsistent with the rise in demand and output of good 3, which is required to maintain full employment, and the inconsistency can only be resolved by unemployment of factor 2.

good market clearing condition (6), and the balance of trade condition (7). Given these output solutions, employment of the minimum wage factor can be determined from (4).

The equilibrium with unemployment is illustrated in figure 1, which will later be used to illustrate the effects of various changes.¹⁰ Unit cost frontiers, marked $c^1(w) = p^1$ and $c^3(w) = p^3$ in factor price space represent the zero profit conditions (1) and (2). The relative slopes of the unit cost frontiers indicate that good 1 uses factor 1 relatively intensively. Equilibrium factor prices w^1 and w^2 are the intersection of the traded good 1 unit cost frontier $c^1(w) = p^1$ and the minimum wage \tilde{w}^2 . The price of the nontraded good 3 and thus the position of the unit cost frontier $c^3(w) = p^3$ is such that this industry earns zero profits at equilibrium factor prices. Factor usage vectors for the two goods, marked $c_w^1(w)y^1$ and $c_w^3(w)y^3$ in factor quantity space with an origin at equilibrium factor prices represent conditions (3) and (4). They are normal to the respective unit cost frontiers and their lengths indicate outputs of the goods. Demand as well as production conditions are needed to determine outputs and thus total factor

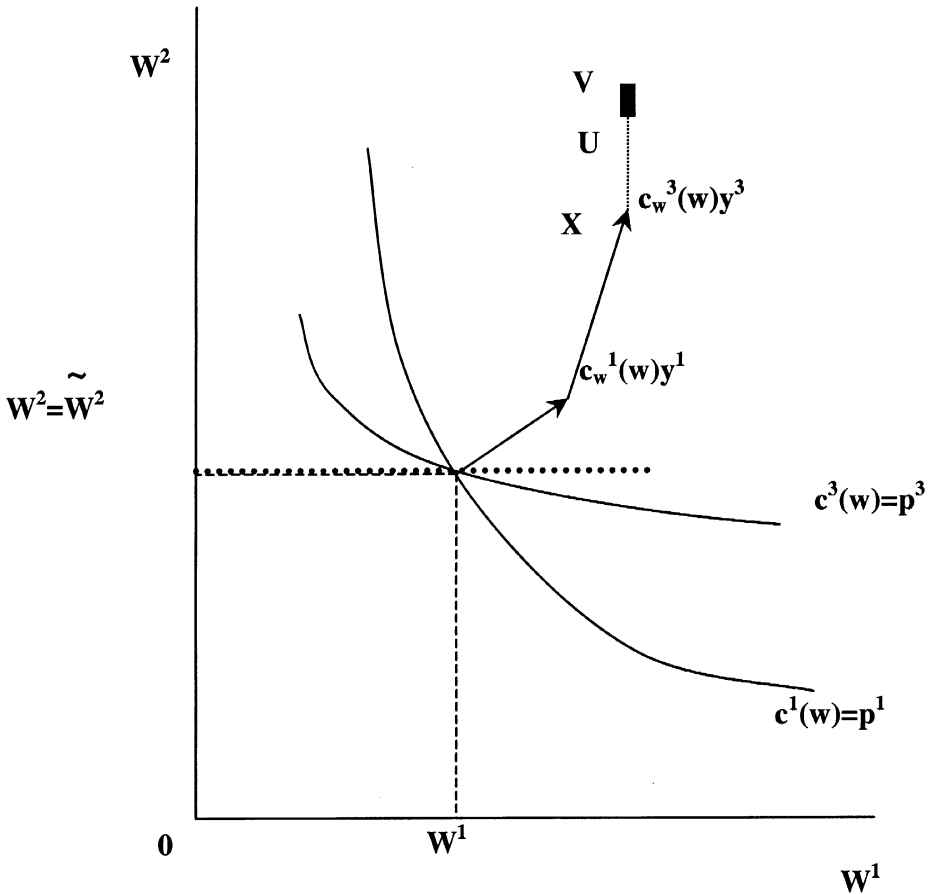


Figure 1. Nontraded good model with minimum wage

¹⁰ This diagram and its advantages are discussed in Woodland (1982 ch. 2).

usages, and an example for a particular specification of $d(\cdot)$ is shown. The sum of these factor usage vectors gives the total factor usage vector marked x . The endowment vector v can be shown in the same factor quantity space with an origin at equilibrium factor prices, and the distance between the total factor usage vector x and endowment vector v represents unemployment of factor 2, indicated by the thin vertical dotted line marked u .

An advantage of the general equilibrium approach adopted in this paper is that it allows explicit consideration of the welfare consequences of various shocks and policy instruments. Welfare will be measured by the value of the open economy indirect utility function¹¹ which is

$$H = V(p^2, p^3, GDP + b) \quad (8)$$

where $GDP = p^1 y^1 + p^3 y^3$ measured as the value of output

$$GDP = w^1 v^1 + \tilde{w}^2 x \text{ measured as the value of factor payments.}$$

This value of indirect utility depends on the prices of the goods consumed and the income of consumers, which is gross domestic product plus any income transfers. Like any other indirect utility function it will be decreasing in prices, and increasing in income.

The value of this indirect utility function can be interpreted as the welfare of a representative individual, provided each individual owns endowments in proportion to the whole economy's endowments of factors, and where factors are unemployed this unemployment is spread over owners of the factor in proportion to their endowment of the factor. Nowhere are endowments evenly distributed nor is unemployment, so this interpretation as the utility of the representative individual cannot be pushed too far.

III. COMPARATIVE STATICS

In this section the comparative static properties of the model will be systematically investigated, and where similar results have been previously derived in the general equilibrium trade literature this will be noted. The properties of the model will be drawn together in relation to the 'Australian' model literature in the next section.¹²

Change in factor endowments

An increase in factor endowments might come about through immigration of individuals endowed with unskilled labour or skilled labour or capital. It could also come through training which transforms unskilled workers into skilled. Alternatively the change in factor endowments might represent technical progress; neutral technical progress can be represented by a proportional increase in both endowments; factor biased technical progress can be represented by non-proportional increases.

The consequences of an increase in the endowment of factor 2 is easy to derive; the factor is already in excess supply there will be no effect other than to increase unemployment of factor 2.

Effects of an increase in the endowment of factor 1 are shown in figure 2. In the model factor prices and nontraded goods prices are determined entirely by the zero profit conditions, which depend only on the minimum wage and terms of trade, so changes in

¹¹ Details of the open economy indirect utility function are given in Woodland (1982 ch. 6).

¹² Full algebraic expressions for the comparative static responses and welfare changes are in an appendix available from the author.

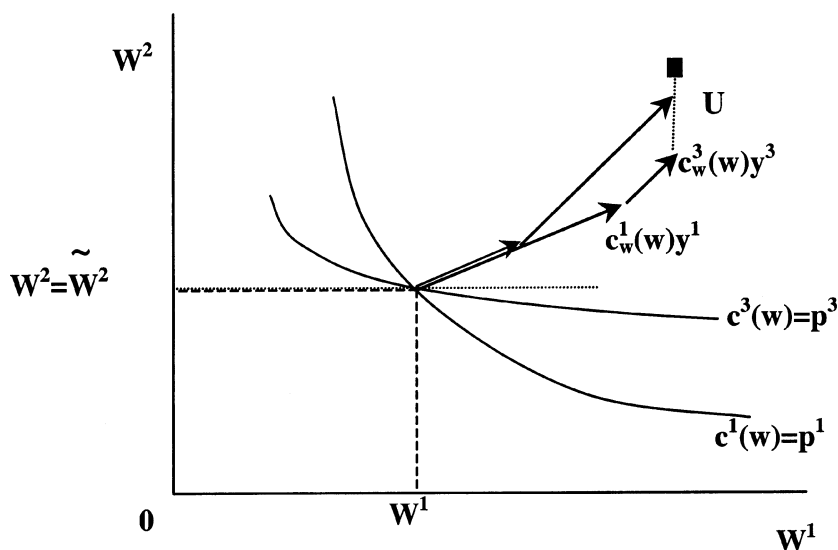


Figure 3. Income transfer

demand for the nontraded good 3 draws resources away from the export industry 1, reducing the output of good 1. Unemployment will fall because the expanding industry 3 uses the unemployed factor 2 relatively intensively, compared to the contracting industry 1. Welfare must increase since employment increases at unchanged factor prices, and goods prices do not change.¹⁵

Change in the minimum wage

In the model the minimum wage is capturing the effect of labour market rigidities and the social security system, so changes in these institutions can be analysed as changes in the minimum wage.

Consider a change which increases the effective minimum wage – an increase in benefit levels or the minimum award wage. As shown in figure 4, an increase in \tilde{w}^2 must reduce w^1 to maintain zero profits in industry 1. The effect on the price of the nontraded good p^3 is more complex. Zero profits in industry 3 must be maintained, but the effect of the increase in \tilde{w}^2 and the fall in w^1 push p^3 in opposite directions; however, the assumption that good 3 uses factor 2 relatively intensively implies that the \tilde{w}^2 effect predominates and p^3 rises. When analysing the effects on outputs, changes in demand brought about by the change in p^3 are crucial. Output of good 3 must fall because the rise in the relative price of good 3 reduces relative demand for good 3, pushing factor 1 out of industry 3 into industry 1. The

¹⁵ These results about the effect of an income transfer on employment and welfare depend on the assumption that the nontraded good is labour intensive, and with reversed factor intensities the result reverses. In this case resources are drawn out of industry 1 which uses factor 2 relatively intensively so employment will decline and welfare will decline. As has been noted above, the empirical evidence suggests that tradeables are skilled labour intensive, relative to nontradeables, so welfare losses from income transfers are not likely to be of practical importance.

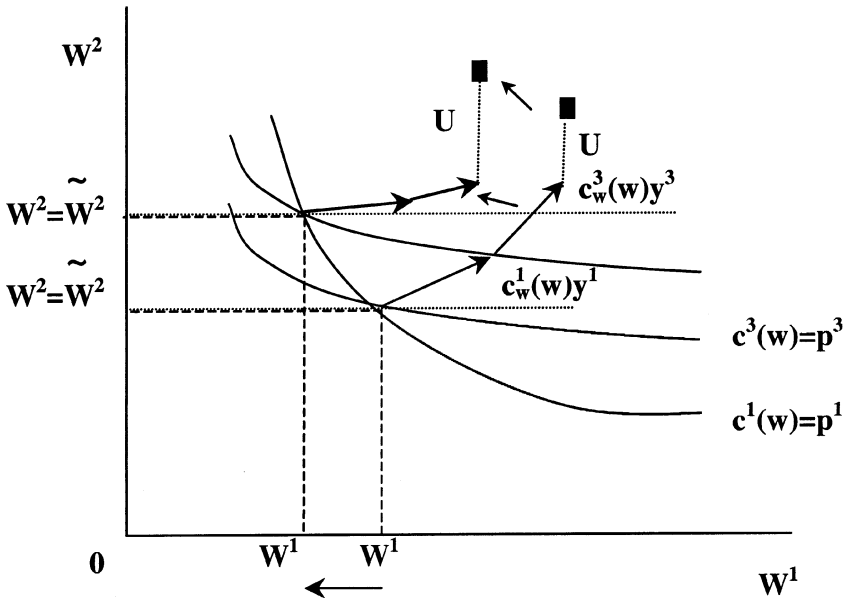


Figure 4. Increase in the minimum wage

effect on output of good 1 depends on the relative strengths of the movement of factor 1 into the industry and any changes in employment of factor 2. Employment of factor 2 will fall because the factor 2 intensive industry contracts and both industries use less factor 2 intensive techniques. Welfare falls in line with the fall in employment.

Change in the terms of trade

Consider an improvement of the terms of trade, represented by an increase in the price of the exported good p^1 . The imported good p^2 is the numeraire.

The effects of an increase in p^1 are represented in figure 5. Since the return to factor 2 is fixed by the binding minimum wage, the rise in p^1 must increase w^1 in order to maintain zero profits in industry 1. If the nontraded good 3 uses factor 2 relatively intensively, as has been assumed, this rise in w^1 must then increase the price of the nontraded good p^3 in order to maintain zero profits in industry 3, so that the terms of trade and the price of nontraded goods move together. The impacts on outputs and employment are uncertain, and for this reason not illustrated in figure 5. Welfare, however, must rise.¹⁶

The reason for this uncertainty about the direction of the output change is that prices of both goods produced, p^1 and p^3 , rise. The direction of movement of their ratio p^1/p^3 depends on the relative magnitudes of the rises, which cannot be determined without knowing more about the nature of the technology. With the direction of movement of the

¹⁶ A similar result in the general equilibrium trade literature is Hazari and Sgro (1987) who drew a diagram suggesting that a deterioration in the terms of trade raises employment and may raise or lower welfare. Their model differs from the present one in specifying the minimum wage in terms of the nontraded good and factor intensity assumptions.

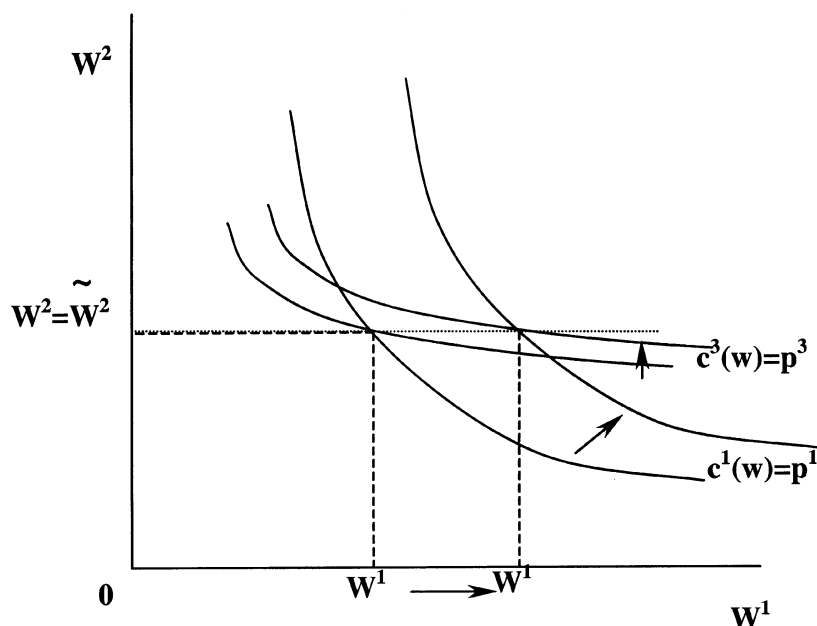


Figure 5. Improvement in the terms of trade

ratio of prices of goods produced p^1/p^3 uncertain, the direction of the relative supply effects is also uncertain. The demand effects depend on the ratio of prices of goods consumed, and the rise in p^3 means p^2/p^3 falls, so relative demand for the nontraded good 3 falls. This works in favour of a rise in the output of good 1 and a fall in the output of good 3, but there is no guarantee of these results. Even if the output of good 1 rose and the output of good 3 fell, the effect on employment would still be uncertain because the good whose output declines is the factor 2 intensive good 3, tending to reduce employment, while the rise in w^1 induces firms to use more factor 2 intensive techniques, tending to increase employment. The overall effect on employment of factor 2 would depend on the relative strengths of these output and factor intensity effects.

Imposition of a tariff

The imposition of a per-unit import tariff, denoted τ , may be modelled as an increase in the price of the imported good 2 of τ , together with an income transfer to equal to the redistributed tariff revenue of τz^2 . Since we are interested in a change in the price of good 2, good 1 will now be the numeraire.

The effects of the income transfer component of the tariff were determined in an earlier section: a transfer left factor prices and nontraded goods prices unchanged and increased employment. The other component – effect of the price change will now be considered. An increase in the price of the imported good p^2 will not change factor prices w^1 or nontraded goods prices p^3 since they are determined entirely by the zero profit condition for goods 1 and 3 which are produced. The whole effect is through demand; the higher price of imports p^2 gives a substitution effect towards the nontraded good, and an income effect which works

in the opposite direction reducing the demand for the nontraded good. Without further information about preferences the output changes are uncertain. Under the assumption that the nontraded good is labour intensive the price change will increase employment. Collating these results for the components of the tariff, employment will rise (on the assumption that the nontraded good is labour intensive), and the effects of the tariff on outputs and welfare are uncertain. Even if the tariff increases employment, welfare may not increase because the redistributed tariff revenue may not compensate consumers for the higher prices they pay for the imported good.

It is thus possible that a tariff cut may increase welfare of the representative individual while at the same time increasing unemployment. If, as suggested earlier in the paper, unemployment is lumpy (distributed unevenly across owners of a factor), then the impact of the rise in unemployment will fall most heavily on a few individuals, so that they lose even though most individuals gain. This effect operates even if ownership of factors is distributed evenly across individuals and so is not the same as the well known Stolper-Samuelson distributional effect, and is likely to be more severe than the Stolper-Samuelson effect because individuals jobs are at stake rather than just their wages. Tariff changes when there is unemployment can thus give rise to intense distributional conflicts.

Devaluation

In the model a devaluation is represented by a rise in both traded goods prices p^1 and p^2 (because more domestic currency is received for exports sold at an unchanged foreign currency price, and more domestic currency is required to pay an unchanged foreign currency price for imports). Earlier sections showed that an increase in p^1 increases p^3 , and that a change in p^2 has no effect on p^3 . The earlier results also indicated that a devaluation will reduce the price of the other factor w^1 , and have uncertain effects on outputs, employment and welfare.¹⁷ A devaluation, then, like a tariff will have some impact on employment and welfare but the directions of movement are uncertain.

IV. INTERNAL AND EXTERNAL BALANCE REVISITED

A major concern of policy makers throughout the postwar period has been the simultaneous achievement of external balance (i.e. balance of payments) and internal balance (i.e. full employment). These concerns partly motivated earlier 'Australian' model contributions of Swan (1960, 1963) and Salter (1959) where adjustment was through price and expenditure effects, which were able to be influenced by monetary, fiscal, exchange rate, tariff and other policies. The same issues can be addressed in the general equilibrium nontraded goods model with a minimum wage.

In the model, balanced trade (plus transfers) is imposed as an equilibrium condition, and there is no money or other assets, so external balance is maintained automatically through movements in outputs, demand and the real exchange rate. This specification better fits the current situation of flexible exchange rates than the fixed rate regimes which prevailed when many of the earlier 'Australian' model papers were written. Neutralisation of the external

¹⁷ Similar results for a devaluation in a model where fiscal policy fixed the money wage rate were derived by Jones and Corden (1976 pp. 154–157).

balance question by a flexible exchange rate means that choice among alternative instruments to achieve internal balance is left as the focus of the policy makers' attention.

Based on the comparative statics in the previous section the following contribute to the achievement of internal balance:

- Increases in endowments of factors not subject to a wage floor. This might be through encouraging immigration of individuals endowed with skilled labour or capital, through encouraging training, or by stimulating skill augmenting technical progress.
- Increased levels foreign borrowing. It must be remembered, though, that foreign borrowings must be repaid and that this will have the reverse effect on employment at a later stage.
- Relaxation of the wage floor, achieved perhaps by changes in industrial relations arrangements.
- Imposition of an import tariff or a currency devaluation may contribute to or may hinder the achievement of internal balance, depending on the relative strengths of various production and demand effects.

An advantage of the modelling approach in this paper was that it allowed explicit consideration of the welfare consequences of each of these routes to internal balance. From the earlier results:

- Increases in endowments of flexible price factors increase welfare.
- Foreign borrowings increase welfare, although repayment has the reverse effect.
- Lowering the wage floor is welfare improving.
- An import tariff or devaluation may increase or reduce welfare, although as noted earlier in the paper employment movements will not necessarily be in the same direction as the welfare effects, giving rise to distributional conflicts.

On this basis, the most attractive policies are those which increase endowments of flexible price factors and which lower the wage floor. This is consistent with the principles of second best welfare economics; the distortion is the wage floor so intervening in factor markets to correct it is going to be superior from a welfare point of view to intervening in goods markets via tariffs or currency devaluation. Considering the practicality of the optimal policies increasing endowments of skilled labour and capital may not be easy, nor is encouraging the right type of technical change. The most important determinants of these variables are probably outside the control of policy makers. With the wage floor option there are empirical question marks about the magnitude of the wage floor reduction that would be necessary to make much impact on unemployment. Gregory and Vella (1995) for instance, suggest that for Australia the magnitude of wage cuts would have to be very large and would hurt those already employed at the floor level of wages a great deal. More empirical work on these magnitudes is needed, but wage cuts combined with generous redistribution to affected workers seems an attractive and practical policy.

In the earlier 'Australian' model literature there is some attention to the level of wages in achieving internal balance, but this tended to be overshadowed by the discussion of the role of aggregate demand management policies. For example, Swan (1963 p. 393) in his discussion of the role of long run cost adjustments, after a lengthier discussion of appropriate levels of aggregate spending, deals with tariffs and other import restrictions, finding them problematic, and commenting that 'we are back with the necessity of real wage adjustments'. Even if the importance of arbitrated wage levels was acknowledged, policies to influence

wages were not always directed at internal balance. For example 'It should be noted, however, that the Court is never called upon to use wage policy as a means of influencing the aggregate volume of demand . . . ; on the other hand, within an appropriate set of rules the Court may properly consider the influence of wages on the share of demand directed towards domestic production. But even the latter is ruled out if the Treasury is supposed to be adjusting demand in the interests of internal balance' (Swan 1960 p. 64). This quotation clearly reflects the bad repute, in the heyday of Keynesian economics, of a general cut in wages as a cure for unemployment, but the 'on the other hand' comment suggests a similar mechanism to that considered in this section on the comparative static effects of a change in the minimum wage.

The unfavourable conclusions within the present model about tariffs as a policy for internal balance reinforce the considerable skepticism in the earlier 'Australian' model literature about a tariff compared to other policy instruments. Swan (1963) was prepared to allow import restrictions as a short run measure in response to some shocks, but found them problematic as a long run policy instrument. Salter (1959 p. 238) argued in relation to internal and external balance that the only respectable argument for import restrictions: [is] that they enable us to buy time. In Swan's other published version of his paper tariffs receive little attention and are not among the policy instruments that he suggested be allocated to policy objectives (Swan 1960 pp. 65–66).

A good way of summarising the differences is to compare the summary of rules for the conduct of policy in Swan (1960 pp. 65–66) with the results from the model of this paper. Swan suggests that Treasury demand management be used to maintain full employment i.e. internal balance, that the Arbitration Court set the level of real wages to maintain a balance of payments i.e. external balance, and that the Central Bank use the exchange rate to control the general price level. In the nontraded goods model with a minimum wage external balance is achieved automatically and determination of the general price level is outside the scope of the model. Internal balance can best be achieved through policies which influence the productive capacity of the economy through endowment or technological change, or by policies which lower wage floors. In each case though, there are strong reservations about the extent to which these crucial variables are under the control of policy makers and about the practical efficacy of wage cuts.

V. CONCLUSIONS

This paper has extended the general equilibrium trade literature by systematically investigating a non-traded goods model with unemployment coming from a minimum wage. Unlike the best known general equilibrium model with a minimum wage (that of Brecher 1974) the economy does not specialise completely in the production of a single good, so the model of the present paper is more reasonable representation of the Australian economy. Some new results for a nontraded goods model with a minimum wage have been derived, and others (for instance the impact of an improvement terms of trade on employment) shown to be ambiguous even in this very simple model. The paper has also contributed to the 'Australian' model literature by considering the welfare consequences of various shocks and policy interventions.

Results from the model may be relevant to continuing policy debates over internal and external balance, tariff policy, and labour market policy. For instance the inclusion of unemployment in the model has identified a source of distributional conflict when employ-

ment and welfare move in different directions as a result of tariff changes. It must be emphasised that the model is highly abstract and includes only some of the important channels of effects. Keynesian effective demand considerations, for instance, have not been considered at all. Policy implications should be treated as tentative, as should those from other similar modelling exercises.

APPENDIX

This appendix gives algebraic expressions for the comparative static results of the paper. Expressions will be derived for the impact of small changes in the exogenous variables in the neighbourhood of the equilibrium. These expressions will then be signed, making use of the properties of the functions which appear in the expressions. From the properties of cost functions $c_i^j < 0$, $c_{11}^j < 0$, $c_{22}^j < 0$, $c_{12}^j = c_{21}^j$. The assumption that the nontraded good is labour intensive $c_1^1/c_2^1 > c_1^3/c_2^3$ implies $[1 - c_1^3 c_2^1 / c_1^1 c_2^3] > 0$. Derivatives of the relative demand function $d(p^2/p^3)$ are pure substitution effects so $d_2 < 0$ and $d_3 < 0$. The initial value of b will be taken to be zero. Total employment of the rigid wage factor will be denoted x^2 .

Equilibrium conditions of the model are:

Zero profit conditions for each of the goods produced:

$$p^1 - c^1(w^1, \tilde{w}^2) = 0, y^1 > 0 \quad (\text{A1})$$

$$p^3 - c^3(w^1, \tilde{w}^2) = 0, y^3 > 0 \quad (\text{A2})$$

Full employment condition for the factor not subject to the floor:

$$c_1^1(w^1, \tilde{w}^2)y^1 + c_1^3(w^1, \tilde{w}^2)y^3 - v^1 = 0, w^1 > 0 \quad (\text{A3})$$

Unemployment of the factor subject to the floor:

$$c_2^1(w^1, \tilde{w}^2)y^1 + c_2^3(w^1, \tilde{w}^2)y^3 - v^2 < 0, w^2 = \tilde{w}^2 \quad (\text{A4})$$

Relative demand:

$$z^2/z^3 = d(p^2/p^3) \quad (\text{A5})$$

Market clearing condition for the nontraded good:

$$z^3 = y^3 \quad (\text{A6})$$

Balance of trade condition for traded goods:

$$y^1 p^1 + b = z^2 p^2 \quad (\text{A7})$$

From (A1) using the implicit function theorem

$$w^1/p^1 = 1/c_1^1 0.$$

$$w^1/\tilde{w}^2 = -c_2^1/c_1^1 0.$$

From (A2) $p^3 - c^3(w^1(p^1, \tilde{w}^2), \tilde{w}^2) = 0$ using the implicit function theorem

$$\partial p^3 / \partial p^1 = c_1^3 w^1 / p^1 = c_1^3 / c_1^1 < 0.$$

$$p^3 / \tilde{w}^2 = c_2^3 + c_1^3 w^1 / \tilde{w}^2 = c_2^3 [1 - c_1^3 c_2^1 / c_1^1 c_2^3] 0 \text{ (Sign 0 with reversed factor intensity)}$$

Substitute (A7) and (A6) into equation (A5) to give $(\alpha) y^1 = y^3 d(p^2, p^3(p^1, \tilde{w}^2)) p^2 / p^1 - b / p^1$.

Substitute (α) into equation (A3) and rearrange to give $(\beta) y^3 = [v^1 + c_1^1 (w^1(p^1, \tilde{w}^2), \tilde{w}^2) b / p^1] / [c_1^1 (w^1(p^1, \tilde{w}^2), \tilde{w}^2) d(p^2, p^3(p^1, \tilde{w}^2)) p^2 / p^1 + c_1^3 (w^1(p^1, \tilde{w}^2), \tilde{w}^2)]$

From (β) using the quotient rule and product rule

$$y^3 / v^1 = 1 / [c_1^1 d p^2 / p^1 + c_1^3] 0$$

$$y^3 / p^1 = -[v^1 p^2 / p^1] [c_1^1 d / p^1 - c_1^3 d_3 p^3 / p^1 / p^1 p^2 + d c_{11}^1 w^1 / p^1 + c_{11}^3 w^1 / p^1 p^1 / p^2]$$

$$/ [c_1^1 d p^2 / p^1 + c_1^3]^2$$

$$= -[v^1 p^2 / p^1] [-c_1^1 d / p^1 + c_1^3 d_3 / p^1 p^2 + d c_{11}^1 / c_1^1 + c_{11}^3 p^1 / c_1^1 p^2]$$

$$/ [c_1^1 d p^2 / p^1 + c_1^3]^2 = ?$$

$$y^3 / p^2 = -[v^1 c_1^1 / p^1] / [d + d_2 p^2] / [c_1^1 d p^2 / p^1 + c_1^3]^2 = ?$$

$$y^3 / \tilde{w}^2 = -v^1 [c_{11}^1 w^1 / \tilde{w}^2 d p^2 / p^1 + c_{12}^1 d p^2 / p^1 + c_1^1 p^3 / \tilde{w}^2 d_3 p^2 / p^1 + c_{11}^3 w^1 / \tilde{w}^2 + c_{12}^3]$$

$$/ [c_1^1 d p^2 / p^1 + c_1^3]^2 - v^1 [-c_{11}^1 c_2^1 d p^2 / p^1 c_1^1 + c_{12}^1 d p^2 / p^1 + c_1^1 c_2^3 d_3 [1 - c_1^3 c_2^1$$

$$/ c_1^1 c_2^3] p^2 / p^1 - c_{11}^3 c_2^1 / c_1^1 + c_{12}^3] / [c_1^1 d p^2 / p^1 + c_1^3]^2 0$$

(Sign ? with reversed factor intensity)

$$y^3 / b = [c_1^1 / p^1] / [c_1^1 d p^2 / p^1 + c_1^3] 0$$

From $(\alpha) y^1 = y^3(p^1, p^2, \tilde{w}^2, v^1, b) d(p^2, p^3(p^1, \tilde{w}^2)) p^2 / p^1 - b / p^1$

$$y^1 / v^1 = y^3 / v^1 d p^2 / p^1$$

$$= 1 / [c_1^1 + c_1^3 / [d p^2 / p^1]] 0$$

$$y^1 / p^1 = y^3 / p^1 d p^2 / p^1 + p^3 / p^1 y^3 d_3 p^2 / p^1 - y^3 d p^2 / p^1 p^1 = ?$$

$$y^1 / p^2 = y^3 / p^2 d p^2 / p^1 + y^3 d_2 p^2 / p^1 + y^3 d p^1 = ?$$

$$y^1 / \tilde{w}^2 = y^3 / \tilde{w}^2 d p^2 / p^1 + p^3 / \tilde{w}^2 y^3 d_3 p^2 / p^1 = ?$$

$$y^1 / b = y^3 / b d p^2 / p^1 - 1 / p^1 0$$

From equation (A4) $x^2 = c_2^1(w^1(p^1, \tilde{w}^2), \tilde{w}^2)y^1(p^1, p^2, \tilde{w}^2, v^1, b) + c_2^3(w^1(p^1, \tilde{w}^2), \tilde{w}^2)y^3(p^1, p^2, \tilde{w}^2, v^1, b)$

$$x^2/v^1 = c_2^1 y^1/v^1 + c_2^3 y^3/v^1 0$$

$$x^2/p^1 = c_{21}^1 w^1/p^1 y^1 + c_2^1 y^1/p^1 + c_{21}^3 w^1/p^1 y^3 + c_2^3 y^3/p^1 = ?$$

$$x^2/p^2 = c_2^1 y^1/p^2 + c_2^3 y^3/p^2$$

$$= y^3/p^2 + c_2^3[1 - c_1^3 c_2^1/c_1^1 c_2^3] = ?$$

$$x^2/\tilde{w}^2 = c_{21}^1 w^1/\tilde{w}^2 y^1 + c_{22}^1 y^1 + c_2^1 y^1/\tilde{w}^2 + c_{21}^3 w^1/\tilde{w}^2 + c_{22}^3 y^3 + c_2^3 y^3/\tilde{w}^2 0$$

$$x^2/b = c_2^1 y^1/b + c_2^3 y^3/b$$

$$= -c_2^1 y^3/b c_3^1/c_1^1 + c_2^3 y^3/b$$

$$= y^3/b c_2^3[1 - c_1^3 c_2^1/c_1^1 c_2^3] 0. \text{ (Sign 0 with reversed factor intensity)}$$

Defined as the value of output $GDP = p^1 y^1(p^1, p^2, \tilde{w}^2, v^1, b) + p^3(p^1, \tilde{w}^2) y^3(p^1, p^2, \tilde{w}^2, v^1, b)$

$$GDP/v^1 = p^1 y^1/v^1 + p^3 y^3/v^1 0.$$

$$GDP/p^1 = p^1 y^1/p^1 + y^1 + p^3 y^3/p^1 + p^3/p^1 y^3 0.$$

$$GDP/p^2 = p^1 y^1/p^2 + p^3 y^3/p^2 0$$

$$GDP/\tilde{w}^2 = p^1 y^1/\tilde{w}^2 + y^1 + p^3 y^3/\tilde{w}^2 + p^3/\tilde{w}^2 y^3 0$$

$$GDP/b = p^1 y^1/b + p^3 y^3/b 0.$$

Defined as factor payments $GDP = w^1(p^1, \tilde{w}^2)v^1 + \tilde{w}^2 x^2(p^1, p^2, \tilde{w}^2, v^1, b)$

$$GDP/v^1 = w^1 + \tilde{w}^2 x^2/v^1 0.$$

$$GDP/p^1 = w^1/p^1 v^1 + \tilde{w}^2 x^2/p^1 0.$$

$$GDP/p^2 = \tilde{w}^2 x^2/p^2 0$$

$$GDP/\tilde{w}^2 = w^1/\tilde{w}^2 v^1 + x^2 + \tilde{w}^2 x^2/\tilde{w}^2 0$$

$$GDP/b = \tilde{w}^2 x^2/b 0 \text{ (Sign 0 with reversed factor intensity)}$$

Open Economy Indirect Utility $H = V(p^2, p^3(p^1, \tilde{w}^2), M)$ where $M = \text{GDP}(p^1, p^2, \tilde{w}^2, v^1, b) + b$. From the properties of an indirect utility function $V/M0$ and V/p^30 and V/p^20 .

$$H/v^1 = V/M + \text{GDP}/v^10$$

$$H/p^1 = V/p^3 p^3/p^1 + V/\text{MGDP}/p^10.$$

$$H/p^2 = V/p^2 + V/\text{MGDP}/p^20$$

$$H/\tilde{w}^2 = V/p^3 p^3/\tilde{w}^2 + V/\text{MGDP}/\tilde{w}^20$$

$$H/b = V/\text{MGDP}/b + V/M0 \text{ (Sign ? with reversed factor intensity)}$$

A tariff of τ per unit may be represented as an increase in p^2 together with a redistribution of tariff revenue $z^2\tau$ to consumers. Combining these results from above gives:

$$\begin{aligned} x^2/\tau &= x^2/p^2 + z^2x^2/b \\ &= [c_2^3][1 - c_1^3c_2^1/c_1^1c_2^3] [y^3/p^2 + z^2y^3/b]0 \\ H/\tau &= V/p^2 + V/M^2x^2/\tau + V/Mz^2 = ? \end{aligned}$$

Effects of a devaluation are obtained by adding the effects of a change in p^1 and p^2

$$\begin{aligned} x^2/\text{devaluation} &= -x^2/p^1 - x^2/p^2 = ? \\ H/\text{devaluation} &= -H/p^1 - H/p^2 = ? \end{aligned}$$

Note: The signs of GDP/\tilde{w}^2 and H/\tilde{w} come from the following argument. Consider a very general model along the lines of Woodland (1982) or Neary (1985, 1988), for which a maximum GDP function can be derived. Our model is a special case of such a general model with a nontraded good and the rigid wage factor treated as a good with a negative output. Viewing our model this way the balance of trade condition can be written as $E(p^3, U) = \text{GDP}(p^3, \tilde{w}^2)$. Totally differentiating gives $E/U dU + E/p^3 dp^3 = \text{GDP}/\tilde{w}^2 d\tilde{w} + \text{GDP}/p^3 dp^3$. This reduces to $E/U dU = \text{GDP}/\tilde{w}^2 d\tilde{w}$ when we note that by the envelope theorem $E/p^3 = d$ and $\text{GDP}/p^3 = y^3$, and $d = y^3$ because the domestic market for the nontraded good must clear. Further by the envelope theorem (following Neary 1985) $\text{GDP}/\tilde{w}^2 = \tilde{w}^2 x^2/\tilde{w}^2 \leq 0$, so welfare measured by the open economy expenditure function must fall when the minimum wage increases.

An analogous argument establishes the signs of GDP/p^1 and H/p^1 .

I am indebted to the late Neil Vousden for this argument, which saves considerable algebra in establishing the result.

REFERENCES

- Arndt, H. 1976, 'Non-Traded Goods and the Balance of Payments: The Australian Contribution', *Economic Record*, vol. 52, pp. 104–107.
 Brecher, R.A. 1974, 'Minimum Wage Rates and the Pure Theory of International Trade', *Quarterly Journal of Economics*, vol. 88, pp. 98–116.
 Brecher, R.A. 1978, 'Money, Employment, and Trade-Balance Adjustment with Rigid Wages', *Oxford Economic Papers*, vol. 30, pp. 1–15.

- Brecher, R.A. 1992, 'An Efficiency Wage Model with Explicit Monitoring', *Journal of International Economics*, vol. 32, pp. 171–191.
- Corden, W.M. 1960, 'Geometric Representation of Policies to attain Internal and External Balance', *Review of Economic Studies*, vol. 28, pp. 1–22.
- Corden, W.M. 1985, *Inflation, Exchange Rates and the World Economy*. Oxford, Clarendon.
- Corden, W.M. 1992, *The Dependent Economy Model of the Balance of Payments in the New Palgrave Dictionary of Money and Finance*, London, Macmillan.
- Davis, D.R. 1998, 'Does European Unemployment Prop Up American Wages?', *American Economic Review*, vol. 88, pp. 478–494.
- Dornbusch, R. 1980, *Open Economy Macroeconomics*. New York, Basic Books.
- Ethier, W.J. 1984, 'Higher Dimensional Issues in Trade Theory', in *The Handbook of International Economics*, edited by R. Jones and P. Kenen. Amsterdam, North Holland.
- Gregory, R.G. and Vella, F. 1995, 'Real Wages, Employment and Wage Dispersion in US and Australian and US Labour Markets', in *Differences and Changes in Wage Structures*, edited by R.B. Freeman and L.F. Katz. Chicago, University of Chicago Press and NBER.
- Hazari, B. and Sgro, P.M. 1987, 'A Note on Minimum Wages, Nontraded Goods, Terms of Trade, Welfare and Unemployment'. *Note Economiche*, vol. 16(1), pp. 100–106.
- Jones, R.W. 1974, 'Trade with Non-Traded Goods: The Anatomy of Interconnected Markets', *Economica*, NS41: pp. 121–38.
- Jones, R.W. and Corden, W.M. 1976, 'Devaluation, Non-Flexible Prices and the Trade Balance for a Small Open Economy', *Canadian Journal of Economics*, vol. 9, pp. 150–161.
- Kemp, M.C. 1969, *The Pure Theory of International Trade and Investment*. New Jersey, Prentice Hall.
- Kemp, M.C., Long, N.V. and Shimomura, K. 1991, *Labour Unions and the Theory of International Trade*. Amsterdam, North Holland.
- Kravis, I. and Lipsey, R. 1978, 'Price Behaviour in the Light of Balance of Payments Theories', *Journal of International Economics*, vol. 8, pp. 193–246.
- Neary, J.P. 1985, 'International Factor Mobility, Minimum Wage Rates, and Factor Price Equalisation: A Synthesis', *Quarterly Journal of Economics*, vol. 100(3), pp. 551–570.
- Neary, J.P. 1988, 'Determinants of the Equilibrium Real Exchange Rate', *American Economic Review*, vol. 78(1), pp. 210–215.
- Oslington, P. 1998, *Unemployment in an Open Economy. PhD Thesis, Department of Economics, University of Sydney*.
- Oslington, P. 2000, 'Migration, Jobs and Welfare: A General Equilibrium Analysis', *Pacific Economic Review*.
- Salter, W.E.G. 1959, 'Internal and External Balance: The Role of Price and Expenditure Effects', *Economic Record*, vol. 35, pp. 226–38.
- Swan, T.W. 1960, originally 1953, 'Economic Control in a Dependent Economy', *Economic Record*, vol. 36, pp. 51–66.
- Swan, T.W. 1963, originally 1955, 'Longer Run Problems of the Balance of Payments' in *Longer Run Problems of the Balance of Payments* edited by H.W. Arndt and W.M. Corden. Melbourne, FW Cheshire.
- Viner, J. 1937, *Studies in the Theory of International Trade*. London, Allen and Unwin.
- Wilson, R. 1931, *Capital Imports and the Terms of Trade*. Melbourne, University Press.
- Woodland, A.D. 1982, *International Trade and Resource Allocation*. Amsterdam, North Holland.
- Yano, M. and Nugent, J.B. 1999, 'Aid, Nontraded Goods, and the Transfer Paradox in Small Countries', *American Economic Review*, vol. 89(3), pp. 431–49.