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How Reliable are ORANI Conclusions?

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This paper seeks to systematically review the main criticisms of the ORANI model by developing a graphical version of a two-sector (exportables and nonexportables) miniature ORANI model. This model shows that ORANI results occur because while supply curves in both sectors have similar slopes, the slopes of the demand curves are polar opposites. Furthermore this model shows that results will tend to be more sensitive to variations in supply rather than demand parameters. Experiments using the ORANI model itself verified these findings. These results indicate that some form of sensitivity analysis with respect to assigned parameter values should form an integral part of any ORANI experiment.

I Introduction

In 1975 the Whitlam government decided to fund an ambitious modelling project. Mindful of the fact that the impact of any policy change can only be adequately assessed in a systems framework, it was decided to construct a suite of models to explore the impact of economic, technological and demographic changes upon the Australian economy. Professor A. A. Powell was nominated as Director of what became known as the IMPACT project, and an intensive research endeavour over the past decade has seen a large part of the original vision come to fruition.

Perhaps the best known product of the IMPACT project has been the ORANI model of the Australian economy. This represents a large-scale general equilibrium model designed to assess a wide variety of questions concerning commercial and industrial policy. To gain a good appreciation of the range of issues that have been addressed by the ORANI model, the interested reader is referred to the summary provided by Parmenter and Meagher (1985).

Not only is the ORANI model the best known of the IMPACT suite, it is also probably the most controversial. Since the first documentation in 1977 there have been a number of conflicts over the nature of the model, the assumptions underlying it, and its utility. Criticisms have come from a number of different sources. Initially the debate was largely academic, with strong dissenting judgements being delivered by those closely associated with the IMP model. But soon the argument extended to the bureaucracy. In particular, the Bureau of Industry Economics (BIE) has had several heated exchanges with the Industries Assistance Commission (IAC) over the use of the ORANI model in tariff enquiries, while individual officers such as Cronin (1984a and 1984b) have continued to argue against the utility of certain variants of the ORANI model.1

"Specifically what is referred to as 'short-run' ORANI, whose central feature is that capital stocks are fixed in each industry. This contrasts with 'long-run' ORANI which works with a fixed rate of return across industries. Many of the criticisms advanced regarding the former also apply to the latter, but we will not be directly concerned with long-run ORANI in this paper."
These controversies have been largely "in house". But the appointment of Professor P. B. Dixon – perhaps the major figure in the construction of ORANI as head of the Institute of Applied Economic and Social Research has moved the discussion much more into the public domain. Part of this shift arises from the belief that the ORANI model is no longer to be restricted to examining allocation issues such as arrears with, but also stabilization and distributional ones. Many of the critics find implausible that a single model can adequately serve all of these purposes, and it is a viewpoint with which one can sympathize. Of course it is doubtful if the builders of ORANI do maintain that the model can be successfully used to address problems that fall in all of the three areas above. Certainly the original design of the IMPACT project called for a suite of models rather than reliance on an exclusive one. It was envisaged it ORANI would need to be supplemented by MACRO – a macroeconomic model – if it was to effectively deal with stabilization issues.

Critiques of the ORANI model may be divided into three major categories. The first of these denies the neoclassical economics that provides the theoretical basis for ORANI. There are really two parts to this complaint. One rejects the use of optimization, utility etc. to derive demand and supply curves. This rejection could be applied to almost any macroeconomic model or analysis done by economists, and it is therefore directed more generally at economic theorizing than ORANI in itself. The second part is a critique of the system of demand and supply curves implied by a market-clearing assumption, the purpose of constructing these curves was to provide some restrictions upon the shapes of these curves.

The second part of this criticism relates to the requirement that markets clear. Cronin (1984a) argued that this was not very sensitive to demand conditions and cited a number of macroeconomic studies in support of his case. While that evidence is by no means clear cut, it is more important to ask whether it is incompatible with market-clearing. The answer must be in the negative. Lack of

sensitivity to demand shifts may not signify that markets do not clear; it may just indicate that supply is relatively elastic. Price changes induced by demand shifts vary in their ability to alter the structure of supply. Consequently, a wide range of responses is possible from ORANI depending upon the precise slopes and elasticities of the Phillips curve in the model.

The second of the three general types of criticism focuses upon the closure of ORANI. Most computable general equilibrium models have supply and demand curves not only for local industries but also for the labour market and the 'rest of the world'. Furthermore, demands are forced to sum to aggregate income, making the balance of trade zero. Because of these modifications, world prices and incomes are determined jointly with their domestic equivalents. By contrast, ORANI treats many foreign variables and real wages as fixed and, in its short-run mode, treats aggregate expenditure as exogenous, and so independent of aggregate incomes. Treating the foreign sector as given does not seem an unreasonable strategy. Although conceptually it is easier to determine all outputs and prices, it is almost inevitable that the 'rest of the world' is unlikely to be quantified with the same precision as the domestic sector, i.e., the slopes of the foreign demand and supply curves will be chosen somewhat more arbitrarily.

Treating aggregate expenditure as fixed may indeed be a serious deficiency. It is hard to envisage this action as a reasonable description of behaviour for any period over six months, whereas short-run ORANI moves towards that position only in a one to two-year period – see Cooper et al. (1985). To some extent this closure was just one of convenience, as the MACRO module was to endogenize aggregate expenditure (labour absorption). In some instances the assumption seems a reasonable simplification. For example, when the resource allocation effects of target price supports are being modelled, it is useful to abstract from the macroeconomic environment. But for other simulations in which the effects of supply and use of innovations become paramount, it is clearly unsatisfactory. Beginning with Dixon et al. (1984) and culminating in Horridge and Powell (1984), the IMPACT team has developed an approach to endogenous in long-run ORANI simulations, and this formulation could profitably be applied to the short-run model as well. In the next section we illustrate how this closure can influence conclusions and that the critics are actually objecting to this connection, but we know of no specific claim to that effect.
position. The derivation of the slopes, along with a mathematical statement of the BOTE equations, is given in Appendix I.

It is interesting to observe immediately that the supply elasticities are similar in both sectors, but the demand elasticities are virtually polar opposite. The position of each of these curves depends upon a number of different factors. For goods that are not exported, i.e. those in the non-traded and import-competing parts of the economy, the level of demand depends upon import good prices (in domestic currency) and the aggregate level of expenditure (absorption). Obviously, under the standard short-run ORANI closure in which absorption and foreign prices are exogenous, the position of the demand curve is fixed by policy and external events. Export demand levels also depend on exogenous foreign factors — the levels of income and competitors’ prices. Supply curves depend upon foreign prices through the cost of imported raw materials and also the level of nominal wages.

Figures 3 and 4 may be employed to obtain some of the characteristic ORANI responses to an aggregate demand shock and a rise in tariffs. Dashed lines in the figures indicate new equilibrium positions after the postulated disturbance.

Aggregate Demand Shock

A rise in domestic absorption shifts the non-export industry demand curve to the right, thereby raising prices and output in that industry. As exporters use some of the commodities produced by the non-export sector as inputs in the production process, these price rises increase their cost structure, shifting the export supply curve to the right. After this ‘first round’, holding nominal wages constant, the non-export sector has grown and the export sector has contracted. Probably this effect is not very large. For the BOTE model a rise of .45 per cent in absorption, with fixed nominal wages, increases output in the non-export sector by 0.39 per cent, while it reduces output in the export sector by 0.46 per cent.

The second round effects depend upon the labour market closure. If nominal wages rise in line with the aggregate price level, this will shift the supply curves of both industries further to the left (see Figures 5 and 6), further reducing output in the export sector and offsetting part of the positive impact of demand expansion on the non-export sector. The rise in nominal wages will actually be less than that for the price of the non-export commodity, as the aggregate price level includes contributions from export and import prices, both remaining constant. In fact, with a .45 per cent rise in aggregate demand and full indexation to the consumer price index, output in the non-export industry rises by 0.29 per cent, while it falls by 1.08 per cent in the export sector.

Obviously the final outcomes depend significantly upon the wage indexation rule in force, as that determines the magnitude of any shift in the supply curves. But, as is clear from the steep slope of the demand curve in the non-export sector, there will be very little offset to the positive effects of the demand expansion there; most of the impact is felt on prices and not quantities. By contrast, the infinite elasticity for export demand ensures a strong output contraction. This is a key ORANI

*The experiments considered in this paper are discussed in Dixon et al. (1992) who examined four different policy shocks each of which produced a 1 per cent decrease in the exchange rate when used in ORANI simulations.
characteristic and Figures 1 and 2 show it follows from the relative shapes of demand curves in the two sectors. Notice that a shock such as an oil price rise will also have a much smaller effect on the non-export sector than on exports. The same movement in supply curves translates into different output responses because of differing demand curve slopes: actual outcomes of the BOTE to a 26 per cent rise in local oil prices being 1.47 per cent for the non-export sector and 1.25 per cent for the export sector.

A Tariff Increase

The sequence is exactly the same as above, except that the demand expansion for non-export commodities stems from the assistance provided to one of their components, import-competing goods. There are however additional adverse supply-side effects, with tariffs directly increasing the cost of production in the export sector because of the assumption of imported inputs, and the CPI response is now much greater than in the previous experiment as both non-export and imported goods exhibit price movements. Overall the outcome is clouded. From the demand function for non-export commodities in BOTE, a 10.7 per cent increase in tariffs generates a 1.85 per cent rise in demand, which is offset by large movements in wages. Again, given the steepness of the demand curve in this sector, it is unlikely that some expansion would not be forthcoming, and indeed the non-export sector does increase its output by 8.6 per cent. Exports are reduced by 1.28 per cent.

A number of points may be made on the basis of this non-linear oligopoly model. First, while the shapes of the demand and supply curves are potentially very important for conclusions, their exact impact will depend upon the type of experiment being conducted. Thus, for a rise in foreign demand—a shift in the export demand curve—it is only the shape of the supply curve that is relevant; the fact that the export demand curve is taken to be infinitely elastic is irrelevant. Hence, it will never be possible to conclude that ORANI is sensitive to particular parameters; it will all depend upon the context. Furthermore, it would be a grave mistake to conclude that, because ORANI results might be sensitive to particular parameter values in one context, they will always exhibit such sensitivity. It is not possible to base a general acceptance or dismissal of the ORANI model upon how sensitive its conclusions are to specific situations.

Second, closures are also vital to results. Such a fact is apparent for the labour market in the form of second-round effects immediately following a shock to ORANI; in addition, it is also true regarding the endogeneity of absorption. If absorption is made to depend upon national income, then, in the event of an import demand, for example, would shift the demand curves of both the export and non-export industries, and shape of both supply curves then become critical. As an example of this phenomenon we added to BOTE a primitive absorption/income relation of the type employed in Horridge and Powell (1984). A 10.7 per cent rise in tariffs under this augmented specification gives a 0.52 per cent reduction in aggregate employment compared to the standard one of 0.21 per cent.

III Criticisms From the Demand Side

The Non-Export Industries

For the non-export industry the shape of the demand curve is determined by the own price elasticity. Under the ORANI specifications, and for import-competing industries, the latter is the product of the import share in total expenditure and a substitution parameter indicating how competitive imports and non-export goods are. Much of the controversy over demand curves in this sector relates to the magnitude of the substitution parameter.

Two themes may be identified here. First relates to the origin of the import substitution values employed in ORANI. Both the ORANI modellers and the Industries Assistance Commission (1983b) profess considerable confidence in them; Dixon et al. (1983a, p. 284) for example, say, regarding their estimation and reliability.

A detailed econometric study using newly mobilised data was conducted and the results are regarded as one of the strongest parts of the current ORANI parameter file. It is unlikely that a convincing case could be made for large variations in the standard ORANI values.

Doubts must exist about such a strong interpretation of the pioneering study of Alouoz et al. (1977). Cronin (1984a) for example has pointed to problems arising from aggregation when there is substantial variation in quality by country of origin. Both Walker (1981) and Ng (1983) have tried to assess whether ORANI estimates should be treated with caution, by asking if the specifications underlying the econometric work were adequate. Unless one is convinced of the adequacy of the specifications, the actual numbers derived from the exercise would seem to have little more validity than if arbitrarily assigned. Ng finds strong evidence of mis-specification of the relationship in a number of industries, particularly when he investigates the question of the constancy of the underlying substitution parameter over time. For example, he finds that both ASIC industries 2835 and 2111 (Asbestos and Cement Products, and Motor Vehicles, respectively) fail the cusums squared test for specification stability of Brown and Durbin (1975). Recursive estimation shows that the point estimate of the elasticity of substitution varies greatly over the sample period. When only the first half of the sample is used the elasticity is estimated as 0.37, whereas it is 1.15 over the whole period.

Revealed Preference provides another test of the reliability of the parameter values contained in ORANI. Despite a strong defence of these estimates in their report to the Bureau of Industry Economics - IAC (1983b) - the IAC during the Enquiry Into the Steel Industry raised the import substitution parameters for steel products from one to six (IAC, 1983a, p. 390). Their comments at that time were: 'The Commission has been unable to assemble time series... on which econometric estimates of these parameters could be based'. For the purpose of analysing the second part of Dixon et al.'s contention cited above, let us suppose that the econometric estimates have emerged from an acceptable methodology. Such estimates nevertheless have a degree of uncertainty about them induced by random elements in the data, and it is customary to recognise this uncertainty by considering the range of values covered by two standard deviations on either side of the point estimate. Denoting the standard error by $e$ and the standard deviation by $s$, the range would be $(b - 2e, b + 2s)$. The potential proportional change in the estimate is therefore $2/2e = 2/2e$. Clearly the uncertainty about the value coming from the data—summarized by $s$—determines how large a variance in the estimate is necessary to consider. Few econometric studies have $e$ values greater than six, so that a $3.3$ per cent change in the estimates would need to be contemplated in most circumstances. Potentially large changes in the

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more than 3.3%.
available in Pagan and Shannon (1985b) and there is a wide divergence in sensitivity in industry output, with some very high $S$ elasticities. However, for industries exhibiting this feature, the output change stemming from the imposition of a tariff is very low. Accordingly, in absolute terms the output solution under a new parameter setting is small, even though the proportional change is large. To avoid giving a false impression on sensitivity, Table 2 gives the median of the $S$ elasticities across industries.

To apply the results of Table 2 to any assessment of the ORANI model it needs to be borne in mind that the output from ORANI ($y$) is already expressed as a rate of change. Consequently, an $S$ elasticity represents the extent to which the growth rate in a variable will be modified as parameter values are revised. Bearing in this point in mind, it is apparent from Table 2 that output growth in the import-competing industries, following the imposition of a tariff, improves dramatically as the import substitution parameters increase. In fact, the implication of the $S$ elasticities in Table 2 is that a 33 per cent rise in all of these parameters roughly provides a 33 per cent stimuli to output growth in import-competing industry, and it would tend to lift aggregate employment growth by about 22 per cent over the ORANI prediction. On balance, however, it seems fair to conclude that, whilst plausible alternative import substitution terms can significantly ameliorate any conclusion that tariff increases reduce aggregate employment, it cannot, by itself, reverse such a judgement.  

Export Sector Demand

Possibly more heat has been generated over the size of export demand elasticities than over any other aspect of the ORANI model. Whilst Cronin (1979) has been the most vociferous critic, many other observers have expressed some doubts about the ORANI assumption of a very elastic demand curve for exports. For example, it has been pointed out that the demand elasticities used to calibrate short-run ORANI are actually those described by Freebairn (1978) as applicable to the long run. Dixon et al. devote most of their 1985 paper to an analysis of ORANI responses to export demand elasticities, concluding that it is only when demand elasticities become less than two that any major qualifications would need to be entered:

- if we are satisfied that export demand elasticities are, on average, greater than two, then the exact values we choose for them between two and infinity do not have critical implications for ORANI [p. 345].

Exactly why this should be so can be appreciated from Figures 7 and 8. Although the transition from an elasticity of infinity to one of two looks a major shift, it translates into a very limited alteration in demand curve shapes. Hence, any movements in the supply curve (as in the dashed line) are felt largely as output changes. Below unity though, the demand curve shifts rapidly to demand-pull inflation rather than output becoming the dominant response.

Dixon et al. make a strong case against inelastic demand curves, arguing that the acquisition of this characteristic would make it profitable for Australian producers to form cartels and exploit their monopoly power. Implicitly the ORANI modellers argue their case in terms of the predicted price increments following on a reduction in Australian exports, and it is indeed hard to believe that these would be major. By contrast, Cronin is more concerned with the revenue flow from a price cut in Australian exports. Because of the existence of various non-price barriers to trade, he doubts if these price reductions would stimulate much extra effective demand. Both of these arguments have merit, and reconciliation between them demands that an asymmetric response be recognized; the demand elasticity appropriate to a price rise being much greater than that for a price define. If one accedes to this proposition, it follows that the export elasticities to be used depend directly upon the scenario under examination. Unfortunately, at the moment ORANI users do not have a facility whereby such asymmetric behaviour could be encompassed.

It is worth looking at how important the export demand elasticity parameters are to ORANI solutions. When we examine Table 3 we see that the $S$ elasticity for aggregate employment to a 1 per cent change in these coefficients is 0.32. Once again, although there is a query about reliability, quite large variations in export demand elasticities—of the order of 300 per cent—would be needed to reverse employment results from the tariff experiment.

<table>
<thead>
<tr>
<th>Table 2</th>
<th>Sensitivity ($S$) Elasticities for the Import Substitution Parameters, ORANI(3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arg. Emp.</td>
<td>Output Export</td>
</tr>
<tr>
<td>$S$</td>
<td>0.67</td>
</tr>
</tbody>
</table>

(3) The $S$ elasticity shows the percentage change in solution values to a 1 per cent change in the parameter.

<table>
<thead>
<tr>
<th>Table 3</th>
<th>Sensitivity ($S$) Elasticities for the Export Demand Parameters, ORANI(4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Arg. Emp.</td>
<td>Output Export</td>
</tr>
<tr>
<td>$S$</td>
<td>0.32</td>
</tr>
</tbody>
</table>

(4) The $S$ elasticity shows the percentage change in solution values to a 1 per cent change in the parameter.

IV Sensitivity to the Supply Side

As seen in Figure 1 above, at around unity the elasticity of supply is approximately the same for both the export and non-export sectors in the BOTE model. Dissenting judgements have been made to both this equivalence and magnitude of supply elasticities. Cronin (1984a) has done this indirectly through an objection to the responsiveness of prices to demand in ORANI. He feels that, at least for the non-export sector, prices should not be greatly influenced by demand conditions, and he posits a very elastic supply curve. Lloyd (1983) believes that the agricultural supply elasticities are overstated.

Once again the issue is one of sensitivity; are the ORANI solutions very sensitive to plausible alternative values for these supply functions? Investigations by others—Harrison and Kimbell (1983)—have shown that supply elasticities are very important parameters in numerical general equilibrium models, and it would be surprising if these were not also true of ORANI. To gain some insight into this topic we have computed the $S$ elasticities separately for 1 per cent changes in the
Table 4  
Sensitivity Elasticities: Supply Side Parameters, ORANI

<table>
<thead>
<tr>
<th>Effect on Solution</th>
<th>Sector Supply Elasticity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Values</td>
<td>Non-Traded</td>
</tr>
<tr>
<td>Output, NT</td>
<td>0.21</td>
</tr>
<tr>
<td>Output, E</td>
<td>0.03</td>
</tr>
<tr>
<td>Avg. Emp.</td>
<td>0.16</td>
</tr>
</tbody>
</table>

(a) For the output variables, the S elasticities are the median values for all industries in the referenced classification.

supply elasticities in the non-traded (NT), export (E) and import-competing (IC) sectors (under the tariff experiment). Table 4 presents these results. Pagun and Shannon (1985h) provide industry-specific S elasticities.

Table 4 demonstrates that, of the three types of supply elasticity, it is the export category which is crucial to the ORANI outcomes. The aggregate employment S elasticity is extremely large, making modifications to any sharp conclusions probable if these elasticities are not known with any precision. It also is noticeable that the employment S elasticity to supply output coefficients is much larger than for the two parameters considered on the demand side, and this lends support to the hypothesis that it is on the supply side that the key parameters of ORANI are encountered.

V Conclusion

A number of points emerge from the above analysis. The likely variation in parameter values is such that ORANI results should always be subjected to some sensitivity analysis. Deciding on exactly what this should be is a different matter. Our solution was to advance the idea of sensitivity elasticities, which show the effect of a 1 per cent change in parameter values upon model solutions. With this tool we demonstrated that, at least when looking at tariff changes, it was the export supply elasticities which were probably the most important set of parameters in ORANI. In fact, the ORANI solutions were almost twice as sensitive to this parameter as to any from the demand side. Yet it is interesting that most of the doubts about ORANI concentrate upon the latter, particularly in respect of the 'trade parameters'. Our methodology is also capable of delivering other insights. First among them is the possibility of looking at combinations of changes in parameters. Using the S elasticities earlier, a 50 per cent increase in all import substitution parameters, combined with a 50 per cent decrease in export supply and demand elasticities gives a 100 per cent reduction in the aggregate employment reaction, i.e. a reversal of the sharp conclusion that a 25 per cent tariff increase reduces employment. To put this result in perspective, a 50 per cent change in parameter values is by no means implausible, being consistent with a regression t statistic of anything less than four. Thus, despite the fact that no single set of parameters could be plausibly varied to extract a reversal of outcomes, a combination of changes might.

Our analysis has shown how important various parameter values (and closures) can be to the conclusions drawn from a computable general equilibrium model such as ORANI. What should be our response to this? One solution is to provide an alternative set of parameter values to those currently adopted as standard in ORANI. We doubt that this can be accomplished in any satisfactory way, without far greater knowledge of industry structure than we (or most users) have. It seems unlikely that any user would have the confidence to override standard settings for more than a few industries. Thus it seems desirable that a facility exist whereby a choice can be made to either run ORANI with standard parameter values (the default option) or to easily modify the existing parameter file to exploit special knowledge. It clearly is imperative that any person seeking to override the normal parameter values should state quite clearly what changes were made, just as current runs have to describe the chosen environment. During 1986 a software package known as GEMPACK is being developed at the University of Melbourne to enable ORANI users to run a variety of experiments rather than just the standard ORANI experiments. A description of this software package is given in Pearson (1986).

But we also feel that it is important to know which parameters are critical to the answers from a given simulation. Users may then concentrate upon the reliability of those parameters, perhaps obtaining new evidence that would enable a more precise determination of their values. To this end, we believe it is useful to provide the sensitivity elasticities described in Section III of this paper. On-going research by Shannon aims at providing the software that would generate such information for the ORANI model.

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the proportion of the software that would generate such information for the ORANI model.

Review of ORANI

A Mathematical Statement of the BOTE Model

Statement of the Model

The BOTE model contains an export sector (e) and a nonexport sector (n). In each sector there is: a zero pure profit condition; a labour demand equation; an output function; and a factor input function. The model also includes the CPI function, and the demand function for importable goods. (Other equations are incorporated into the model when we attempt to close the model in alternative ways.)

Export sector

(zero pure profit) \( p^e = \lambda^e (\omega + \epsilon) + \lambda^e \cdot q^e + \lambda^e \cdot q^{e1} \)

(labour demand) \( \lambda^e = \rho^e \cdot \omega - \lambda^e \)

(output) \( q^e = q^e \cdot \rho^e \)

(factor input) \( \rho^e = \frac{1}{\lambda^e} (\rho^e + \omega) + \frac{1}{\lambda^e} (\rho^e + \omega) - 1 \)

Non-export sector

(zero pure profit) \( p^n = \lambda^n (\omega + \epsilon) + \lambda^n \cdot q^n + \lambda^n \cdot q^{n1} \)

(labour demand) \( \lambda^n = \rho^n \cdot \omega - \lambda^n \)

(output) \( q^n = q^n \cdot \rho^n \)

(factor input) \( \rho^n = \frac{1}{\lambda^n} (\rho^n + \omega) + \frac{1}{\lambda^n} (\rho^n + \omega) - 1 \)

In the nonexport sector there is also a (demand function) \( \lambda^n = \eta^n + (1 - \eta^n) \cdot \omega^{e1} - \eta^n \cdot mp^n \cdot q^{n1} + \eta^n \cdot mp^n \cdot q^{n1} \)

The CPI function for the model is

\[ \pi = \pi^e + \pi^e \cdot \omega + \pi^e \cdot \omega + \pi^e \cdot \omega^e + \pi^e \cdot \omega^e \]

Variables

\( \pi \) percentage change in the CPI

\( \omega \) percentage change in the real wage rate

\( p^e \) percentage change in the nominal wage rate

\( d^e \) percentage change in the nominal rental rate (per 1 per unit of capital in the exporting and nonexporting sectors

\( e^e \) percentage change in employment in the exporting and nonexporting sectors

\( e^e, d^e \) percentage change in volume of output in the exporting and nonexporting sectors

\( e^e, p^e \) percentage change in real primary factor income in the exporting and nonexporting sectors

\( a \) percentage change in aggregate absorption

\( p^n \) percentage change in the domestic price of oil

\( p^n \) percentage change in the domestic price of imported inputs and imported consumer goods

Derivation of Supply and Demand Equations:

The derivation of the graphical version of the BOTE is straightforward. Starting with the export sector we make the usual small-country assumption that export prices are exogenous or \( p^n = p^n \cdot p^n \) which gives us the horizontal demand curve in Figure 1. We then take our output or supply function given in (3) and substitute expressions for \( \rho^e \) and \( \omega^e \) obtained from (2) and (1) respectively. By substituting the appropriate parameter values we obtain the supply curve

\[ q^e = 1.23p^e - 0.775\omega - 1.23 \]

shown in Figure 1.

Similarly, procedures are used when deriving the nonexporting sector's curve shown in Figure 2. By substituting the parameter values into (10) we obtain the demand curve

\[ q^n = -1p^n + 0.96\omega + 0.045\pi^e + 0.057\pi^n + 0.035p^n \]

Using the same procedure as was used in the export sector we obtain the supply curve

\[ q^n = 1.12p^n - 8.9\omega - 0.09\pi^e - 3p^n - 0.93 \]

Incorporating an Absorption Income Relation

The simple absorption/income relation which was appended to BOTE was

\[ a = 0.65 (0.66 (0.66 (0.66 \cdot \omega + 1.12 + \pi^n) + 0.66 (0.66 \cdot \omega + 1.12 + \pi^n) + 0.66 (0.66 \cdot \omega + 1.12 + \pi^n) + 0.66 (0.66 \cdot \omega + 1.12 + \pi^n) + 0.66 (0.66 \cdot \omega + 1.12 + \pi^n)) \]

In this function absorption is equal to labour's income and capital's income (there is no provision for savings in BOTE).

The values \( 0.88 \) and 0.12 represent the share of total output which Doon et al. (1982, p. 29) attribute to the nonexport and export sectors. The new parameters are \( \omega, \) labour's share in domestic income = 0.7, and \( d^e, \) capital's share in domestic income = 0.3.

In the standard BOTE experiments the exogenous variables were

\( p^n, \omega, p^n, p^n, \rho^n, \omega, a \)

When the absorption/income relation is included it becomes an endogenous variable and the exogenous variables are

\( p^n, \omega, p^n, p^n, \rho^n, \omega, a \)

* A more detailed explanation is available on request.
Appendix 2

Construction of Sensitivity Elasticities

Dixon et al. (1985) have provided ORANI solutions when import substitution parameters are reduced by 10 per cent and when export demand elasticities are changed by 50 per cent. We compare the 5 elasticities to these changes assuming that the effect of a 5 per cent change is the same as 4 times a 1 per cent change. This is only true if the model response is linear, but experience with the BOTE model suggests that this assumption is reasonable provided extreme values are not being considered. An example of the last is when export demand elasticities go below two. In Pagan and Shannon (1985a) we present a method of obtaining exact values of these elasticities for any size change.

To obtain the supply elasticity impacts, the ORANI model elasticities file was modified for us by Russell Rimmer to enable to 10 per cent reduction in the standard parameter values. This information was used to compute the S elasticities.

Finally, it seemed sensible to divide the industries according to whether they were primarily oriented towards export, import-competing or non-traded categories. The classification we have used is essentially that in Higgs et al. (1984) and is given below with industry number.

Exports
1, 2, 3, 4, 5, 6, 7, 8, 9, 11, 14, 15, 25, 30, 49, 60, 70, 74, 93, 94, 95
Import-Competing
16, 19, 21, 24, 26, 29, 31, 34, 48, 50, 52, 58, 62, 65, 69, 71, 75, 77, 83, 96
Non-Traded
7, 10, 15, 17, 19, 20, 22, 23, 26, 27, 31, 39, 60, 61, 84, 92, 97, 112

References


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