Impact Project

Impact Centre
The University of Melbourne
153 Barry Street, Carlton
Vic. 3053 Australia
Phones: (03) 341 7417/8
Telex: AA 35185 UNIMEL
Telegrams: UNIMELB, Parkville

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FARM INCOMES IN AUSTRALIA AND THE REAL EXCHANGE RATE : ORANI SIMULATIONS WITH A BACK-OF-THE-ENVELOPE EXPLANATION

by

Peter B. Dixon and B.R. Parmenter
La Trobe University

and

Alan A. Powell
University of Melbourne

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1. Introduction

We define the real exchange rate for an economy to be the ratio of the nominal exchange rate (i.e., the number of domestic dollars which can be exchanged for a given basket of foreign dollars) to an index of the domestic price level relative to the world price level (for example, the domestic CPI divided by a weighted average of foreign CPI's). In an economy with an export-oriented agricultural sector facing high foreign demand elasticities for its products, changes in the real exchange rate have an important influence on agricultural activity. The reason is that a change in the real exchange rate generates a change in the ratio of the agricultural producer's unit selling price to his unit production costs.

Economic policy decisions of the domestic authorities, decisions for example about macroeconomic and trade policy, usually alter the real exchange rate. In this paper we use ORANI, a detailed multisectoral model, to project the effects of four such policy decisions on the real exchange rate in Australia and the consequent effects on agricultural income and employment. The four policy shocks are :

(i) a 10.6 per cent across-the-board increase in the nominal rates of protection for the import-competing sector,

(ii) a 0.57 per cent increase in real hourly wage rates,

(iii) a change in crude-oil pricing policy leading to a 26 per cent increase in the basic price of domestically refined oil products, and

(iv) a balanced 0.45 per cent increase in real aggregate domestic absorption (i.e., an increase in the domestic component of aggregate demand which leaves unchanged the shares of consumption, investment and government spending in the total).

There is in Australia an active debate concerning the roles in macroeconomic policy of changes in protection, wages and aggregate domestic absorption. In addition, owing to the relative self-sufficiency of Australia in oil supply, the government can control the domestic price of oil products independently of world prices. In recent years domestic oil prices have been raised towards world parity, although it has been argued that domestic prices should be restricted below world prices, essentially for short-run macroeconomic reasons.[1] Thus, all four sets of ORANI projections provided in this paper are concerned with issues relevant to Australian macroeconomic policy. The sizes (10.6 per cent for

1. Higgs (1981) provides a detailed analysis of the recent Australian debate on oil pricing policy.

do, in fact, follow from the theoretical structure and data base. Another role is in sensitivity analysis. By modifying and extending the BOTE calculations presented here, readers will be able to obtain a reasonably accurate idea of how some of the projections would respond to changes in underlying assumptions and data.

Given the success of our BOTE calculations in explaining the ORANI results, it might be tempting to conclude that we do not need large detailed models. It is worth emphasizing, however, that in our BOTE calculations, ORANI gave us some important help. Equation (34) of the BOTE model (i.e., the setting of the elasticity of substitution between capital and labour in sector n equal to 0.28) arose from covariance effects which could only have been apparent in the disaggregated model. More generally, it is difficult to imagine convincing BOTE calculations in the absence of a detailed model. For example, imagine that ORANI incorporates factors $A,B,C,\ldots,Z$ whereas the BOTE model includes factor A alone. If the BOTE model accurately describes a particular ORANI result, then we can conclude that for this result factors $B,C,\ldots,Z$ are not important. With the BOTE model alone, factors $B,C,\ldots,Z$ could not be dismissed.

5. Conclusion

Economic models are a long way from the stage where they can simply be trusted. If a model user claims that a 10.6 per cent increase in protection will cause a 1.8 per cent reduction in agricultural income, then in assessing his claim we must know about the underlying assumptions.

For most people, it is not praticable to work through a long technical document describing the specification and implementation of a large scale model merely to understand a particular set of simulations. In reporting results it is important, therefore, to identify the critical underlying assumptions and to describe their role in a digestible form. For non-technical audiences, it is not possible to go beyond qualitative descriptions of the type provided in sections 2 and 3. This leaves unexplained the quantitative aspects of the results. In this paper we have presented a series of back-of-the-envelope (BOTE) calculations which provide a quantitative description of mechanisms in the ORANI model. That our BOTE calculations are an adequate description of the particular ORANI simulations reported was evident in table 3.

Apart from being useful in result presentations, BOTE calculations have other virtues. For example, they are vital in checking for computational errors. With a model as large as ORANI, the model builders must provide detailed evidence that the computations are being performed correctly, i.e., that the results

protection, 0.57 per cent for wages, etc.) of the shocks were selected so that, under the conditions to be described in section 2, the ORANI model in each case projects a one per cent decrease in the real exchange rate. We will see that because the real exchange rate projections are identical, there is a strong similarity across the four shocks in their projected effects on the agricultural sector.

ORANI is a very detailed Johansen-style[1] model. It is fully described in Dixon, Parmenter, Sutton and Vincent (1982), hereafter DPSV. Rather than attempting to summarize DPSV, we have set out in section 4 of this paper a back-of-the-envelope (BOTE) version of ORANI. This BOTE model can be solved quite easily with a hand calculator. The BOTE model captures the main mechanisms responsible for the ORANI results which are reported in section 3. Each of our four shocks when applied to the BOTE model gives results surprisingly close to those obtained from ORANI.

The paper is organized as follows. Section 2 discusses the assumptions underlying the ORANI simulations. Section 3 describes the ORANI results in qualitative terms. Section 4 sets out the BOTE model and gives a more quantitative explanation of the ORANI results. Section 5 contains concluding remarks.

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1. This class of models is named in recognition of the pioneering contribution of Johansen (1960).

2. Major assumptions underlying the ORANI simulations

ORANI can be used to generate either short-run or long-run conditional projections. These are of the form : given a shock A, and assuming a macroeconomic environment B, then in the short run (long run) variable C will differ by x per cent (y per cent) from the value it would have had in the absence of the shock. The four shocks, A, to be considered in this paper were listed in the previous section. The variables, C, in which we will have most interest are those concerning agricultural incomes.

ORANI users are forced to introduce their own assumptions about three important areas of the macroeconomic environment, B. This is because there are three important aspects of the macroeconomic effects of shocks to the economy about which the model offers no guidance. They are :

(a) the extent to which induced changes in the overall buoyancy of the labour market will be realized as changes in real wages or as changes in employment;

(b) the extent to which induced changes in national income will be realized as changes in aggregate absorption (consumption plus investment plus government expenditure) or as changes in the balance of trade; and

(c) the extent to which induced changes in the real exchange rate will be realized as changes in the domestic inflation rate relative to the foreign rate or as changes in the nominal exchange rate.

Our final BOTE calculation is for aggregate employment. In the ORANI data base about 12 per cent of the workforce is occupied in the production of exportable commodities. Thus our BOTE calculation for aggregate employment is :

$$\ell = .12\ell^{e} + .88\ell^{n} . \qquad (41)$$

(41) gives the results shown in column (11) of table 4. These are all good approximations to the ORANI results, see column (1) of table 3.

Returning now to equations (12) and (14), we find that our BOTE model gives the values for employment and real factor income in the export sector as shown in columns (7) and (8) of table 4. As mentioned in section 3, in the ORANI data base about 70 per cent of agricultural activity is in the production of commodities which are either directly exportable or are exportable after processing in the manufacturing sector. Thirty per cent of agricultural production is non-exportable; such as tobacco, cotton and vegetables. This suggests that back-of-the-envelope calculations of percentage changes in agricultural employment and real factor income can be made according to:

$$\ell^a \doteq .70\ell^e + .30\ell^n \quad (39)$$

and

$$r^a = .70r^e + .30r^n \quad . \quad (40)$$

(39) and (40) give the results shown in columns (9) and (10) of table 4. These results have been transferred to table 3 where it is apparent that they are close to the ORANI results except in the third simulation. Our BOTE model underestimates the ORANI projections of the damage to the agricultural sector from increases in the domestic price of oil. The problem can be traced back to equation (1) where we assumed that the price per unit of non-primary factor inputs to the export sector moves with the CPI. The oil share in agricultural costs in the ORANI data base is about twice the share in the non-agricultural industries. In ORANI simulations of the effects of an increase in the price of oil, the increase in the non-primary factor costs per unit of output in agriculture is considerably greater than the increase in the CPI.

In this paper we have assumed that:

(A) induced labour-market effects appear as changes in the overall level of employment and not as changes in real wages. Thus, in all our simulations, real wages were set exogenously. In the simulation of a wage shock, the increase in real wages was set at 0.57 per cent. In the other simulations, zero change was assumed. An interpretation of our treatment of the labour market is that real hourly wage costs are 100 per cent indexed to the CPI and that excess labour is available at the going wage rate. This seems descriptive of the Australian labour market since 1974.

(B) induced changes in national income appear as changes in the balance of trade and not as changes in aggregate absorption which was set exogenously. In the simulation of an expansion in demand, the increase in real absorption was set at 0.45 per cent. In the other simulations, zero change was assumed. The exogenous treatment of aggregate absorption reflects the idea that the government has available to it instruments of domestic demand management which are not modelled in ORANI but whose separate exercise can stabilize the level of real absorption in the face of shocks affecting relative prices in the economy.

(C) induced changes in the real exchange rate appear as changes in the domestic inflation rate relative to the foreign rate and not as changes in the nominal exchange rate. In all simulations the change in the nominal exchange rate was fixed exogenously at zero. We also assume that the shocks under consideration have negligible effects on foreign rates of inflation. Thus in our ORANI simulations, adjustments in the real exchange rate are reflected by adjustments in the domestic CPI. There would have been no difference in the ORANI results for real variables if we had, instead, fixed the domestic CPI and allowed the nominal exchange rate to adjust.

Finally, with regard to timing, we have adopted the neo-classical short-run. This is a period sufficiently long for the changes in trading conditions brought about by the shocks under consideration to work their way through the economy and for producers and consumers to adjust their production and consumption behaviour accordingly. In the case of producers, this includes revisions of investment plans which in turn affect the demands faced by industries supplying capital goods. The period is sufficiently short, however, to ignore changes induced by the shocks in the quantities of plant and equipment available for use by the various industries. This short run period has been estimated to be about 1½ to 2 years, see Cooper and McLaren (1980). Thus, for example, we interpret the first

Table 4 : BOTE worksheet

Shock	ξ	p^n	x^n	ℓ^n	q^n	r^n	ℓ^e	r^e	ℓ^a	r^a	ℓ
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)
(i) 10.6% Increase in all Tariffs	1.01	1.01	0.033	0.045	1.17	0.07	-2.09	-2.92	-1.45	-2.02	-0.21
(ii) 0.57% Increase in Hourly Real Wage Costs	.86	0.98	-0.159	-0.215	0.66	0.21	-2.52	-2.94	-1.83	-1.99	-0.49
(iii) 26% Rise in Domestic Price of Crude Oil	.99	0.85	-0.135	-0.183	0.33	-0.31	-2.05	-2.86	-1.49	-2.09	-0.41
(iv) 0.45% Rise in Real Absorption	.85	0.97	0.292	0.394	2.26	0.66	-1.78	-2.48	1.13	-1.54	0.13

In addition to the CPI, our BOTE calculations can be used to produce results for the other variables considered in section 3 and for which ORANI results are shown in table 1. We start by noting from (19) that:

$$p^n = (1/W_n)\xi - (W_m/W_n)p_m^c - (W_o/W_n)p_o - (W_e/W_n)p^e. \quad (36)$$

That is:

$$p^n = 1.135\xi - 0.012t_m^c - 0.010p_o , \quad (37)$$

where we use (29) and (30) and the data in table 2. Equation (37), combined with the BOTE results for ξ in table 3, gives 1.01, 0.978, 0.853 and 0.969 for p^n under our four shocks.

These results, together with various other BOTE calculations are shown in table 4. Next we write (20) as:

$$x^n = 0.96a - 0.1(p^n - 0.120t_m^n - 0.055t_m^c) - 0.051\xi - 0.031w , \quad (38)$$

where, again, the coefficients have been evaluated according to table 2 and x^e, p_m^n and p_m^c have been eliminated by using (13) and (29) - (31). For our four shocks, (38) gives the values for x^n shown in column (3) of table 4. By substituting these values into equation (17) we obtain the values for ℓ^n shown in column (4). With σ^n set at 0.28, we can now calculate the four values for q^n. These are in column (5). Finally, for the non-export sector, we use (18) to compute the four values for r^n. These are in column (6).

ORANI result shown in table 1 as follows : if protection were increased by 10.6 per cent, then after about 2 years, aggregate employment would be 0.15 per cent less than it would have been in the absence of the increase in protection.

3. The ORANI projections

Table 1 contains projections of the effects of our four shocks on employment at the economy wide level and on employment and real income in the agricultural sector. It also shows (column 2) that we have normalized the shocks so that each leads to a one per cent reduction in the real exchange rate, i.e., to a one per cent increase in the domestic CPI under conditions in which the nominal exchange rate and foreign price levels are assumed fixed (see section 2). In each case, the one per cent reduction in the real exchange rate is associated with a reduction in agricultural employment and a larger reduction in real agricultural income. The results are clustered around average reductions of 1.5 per cent in employment and two per cent in real income. Thus, the results indicate that shocks to the economy occurring outside the agricultural sector may nevertheless have important effects on agricultural employment and income and that these effects are approximately proportional to the effects of the shocks on the real exchange rate.

In qualitative terms the results in table 1 are easily explained. We start with the CPI results. Shocks (i) - (iii) are exogenous increases in prices : the domestic prices of imported commodities, the prices of all categories of labour and the domestic price of oil. Rises in the prices of imports and oil increase the CPI directly. Each of the first three shocks raises domestic production costs and the selling prices of domestically produced

Table 3 : Comparison of ORANI and BOTE results*

Shock		Calculation Method	Economy-Wide Results		Agricultural Sector	
			Aggregate Employment (hours)	Real Exchange Rate (-CPI)†	Employment (hours)	Real Factor Income
			(1)	(2)	(3)	(4)
(i)	10.6% Increase in all Tariffs	BOTE ORANI	-0.21 -0.15	-1.01 -1.00	-1.45 -1.31	-2.0 -1.8
(ii)	0.57% Increase in Hourly Real Wage Costs	BOTE ORANI	-0.49 -0.46	-0.86 -1.00	-1.83 -1.85	-2.0 -1.9
(iii)	26% Rise in Domestic Price of Crude Oil	BOTE ORANI	-0.41 -0.50	-0.99 -1.00	-1.49 -1.93	-2.1 -2.7
(iv)	0.45% Rise in Real Absorption	BOTE ORANI	0.13 0.07	-0.85 -1.00	-1.13 -1.26	-1.5 -1.7

* The ORANI results are reproduced from table 1. Thus, the notes to that table are also relevant here.

† Under assumption (C) in section 2, the percentage change in the real exchange rate is the negative of the percentage change in the CPI.

labour shares in primary factor costs and vice versa. In constructing our BOTE description of the ORANI simulations, it is not clear how we should evaluate $S_k^n/(\sigma^n V_\ell^n)$. It seems plausible, however, to assume that the use of aggregate shares generates an inappropriately low value. Consequently, we feel justified in re-evaluating the coefficients in our CPI equation (32) with:

$$S_k^n/(\sigma^n V_\ell^n) = 0.893 \qquad (33)$$

rather than the original value of 0.500. (Notice that 0.893/0.500 equals 1/0.56. The value 0.893 was chosen with a view to raising our BOTE result for the CPI for $a = 0.45$ from the initial value of 0.56 to close to 1.) To achieve (33) we have repeated our various calculations with:

$$\sigma^n = 0.28 \qquad (34)$$

rather than 0.5. S_k^n and V_ℓ^n have been left at the values shown in table 2.

Under (34) we recompute ψ_1 in (24) as 0.918 instead of 0.952. ψ_2 in (26) becomes 3.04 instead of 3.29. Further alterations are required in (25) to the coefficients on p_m^c, a, p_m^n and x^e. Eventually, we replace (32) with:

$$\xi = 0.041t_m^c + 0.054t_m^n + 0.038p_o + 1.898a + 1.512w \quad . \qquad (35)$$

Equation (35) gives the results shown in the BOTE rows of column (2) in table 3. These are all close to the ORANI CPI results from table 1. For convenience of comparison we have reproduced the ORANI results from table 1 in table 3.

Table 1 : Principal economy-wide and agricultural sector results

Shock	Economy-Wide Results		Agricultural Sector	
	Aggregate Employment (hours)	Real Exchange Rate (-CPI)†	Employment (hours)	Real Factor Income
	(1)	(2)	(3)	(4)
(i) 10.6% Increase in all Tariffs	-0.15	-1.0	-1.31	-1.8
(ii) 0.57% Increase in Hourly Real Wage Costs	-0.46	-1.0	-1.85	-1.9
(iii) 26% Rise in Domestic Price of Crude Oil	-0.50	-1.0	-1.93	-2.7
(iv) 0.45% Rise in Real Absorption	+0.07	-1.0	-1.26	-1.7

* All results are percentage changes relative to the values which the variables would have had in the absence of the shock. The projected timing of these changes is about two years after the shock. Real factor income in column (4) is the total return in the agricultural sector to labour (hired and owner-operator), capital and land deflated by the CPI.

† Under assumption (iii) in section 2, the percentage change in the real exchange rate is the negative of the percentage change in the CPI.

Source : The simulations were conducted with ORANI 78 with the exogenous variables as listed in table 23.3 of DPSV and with standard 1974/5 input-output data.

commodities. Thus, further increases in the CPI are projected. Recall that in the ORANI simulations reported in this paper nominal wages are assumed indexed to the CPI. Nominal wage increases matching initial increases in the CPI produce yet further increases in production costs and the CPI. Successive rounds of price and wage increases ensure that the total projected effects of the shocks on the CPI are very much greater than the initial effects.

In the case of shock (iv) there are no exogenous price increases but the increase in domestic absorption is projected to increase output, especially in industries producing non-traded goods and services. Because in the current simulation the capital stock in each industry is assumed fixed, the model implies upward sloping supply curves. Thus, the exogenous increase in absorption induces price increases. These increase the CPI. As with shocks (i) - (iii), the initial increase in the CPI is magnified in ORANI by a price-wage spiral.

We turn now to the aggregate employment results in table 1 and note first that the increase in real wages and the increase in oil prices both lead to approximately the same decrease in aggregate employment (i.e., about 0.5 per cent). General increases in domestic costs, unaccompanied by compensating shifts in the demand curves for domestic products, are projected to reduce activity, especially in the exporting and import competing sectors where the scope for passing on cost increases into selling

How well does (32) describe the ORANI results for the CPI in table 1? If we set $t_m^c = t_m^n = 10.6$, with $p_o = 0$, $a = 0$ and $w = 0$, then according to (32), $\xi = .98$. If we set $w = 0.57$, with all the other variables on the RHS of (32) set at zero, then $\xi = 1.02$. If we set $p_o = 26$, then $\xi = 1.12$. Thus, (32) is a reasonably accurate description of the ORANI CPI results in simulations (i) - (iii). However, when we set $a = 0.45$, we obtain $\xi = 0.56$. For describing simulation (iv), it is apparent that (32) is inadequate.

On re-examining (25), we see that the value of the coefficient on a is approximately proportional to the value adopted for the ratio $S_k^n/(\sigma^n V_\ell^n)$. Because this ratio enters ψ_1 (see equation (24)), the coefficients on the other variables are also affected by the value of $S_k^n/(\sigma^n V_\ell^n)$. However, it is clear that changes in the value of $S_k^n/(\sigma^n V_\ell^n)$ will have a greater impact on the a coefficient than on the others. This suggests that the poor performance of (32) in describing the CPI result for ORANI simulation (iv) could be associated with a mis-evaluation of $S_k^n/(\sigma^n V_\ell^n)$.

The values for S_k^n and V_ℓ^n in table 2 are aggregate shares for the non-export sector taken from the ORANI data base. If we consider the S_k^n and V_ℓ^n shares for individual industries, we find a strong negative correlation. Industries with high shares of their costs accounted for by capital tend to have a low

When we use (13) to eliminate x^e, we obtain the reduced form :

$$\xi = 0.186p_m^c + 0.319p_m^n + 0.043p_o + 0.451p^e + 1.240a + 1.796w \quad . \qquad (28)$$

We assume that :

$$p^e = 0 \quad , \qquad (29)$$

$$p_m^c = 0.219t_m^c \qquad (30)$$

and

$$p_m^n = 0.160t_m^n \quad , \qquad (31)$$

where t_m^c and t_m^n are the percentage changes in the ad valorem tariff rates applying to consumer goods and intermediate inputs respectively. In equations (29) - (31) we assume that the nominal exchange rate is fixed. We also assume that foreign currency export and import prices are fixed. Thus we impose the small country assumption, i.e., foreign currency export and import prices are independent of export and import volumes. This assumption is made in ORANI on the import side. For exports it is only an approximation to the treatment in ORANI where high (but not infinite) values are adopted for export demand elasticities.[1] The coefficients on the RHS's of (30) and (31) are $T_m^c/(1 + T_m^c)$ and $T_m^n/(1 + T_m^n)$ where T_m^c and T_m^n are the average tariff rates applying to consumption goods and intermediate inputs. In the ORANI data base, $T_m^c = 0.28$ and $T_m^n = 0.19$. Substitution of (29) - (31) into (28) gives:

$$\xi = 0.041t_m^c + 0.051t_m^n + 0.043p_o + 1.240a + 1.796w \quad . \qquad (32)$$

1. See DPSV, p.196.

prices is constrained by international competition.[1] In cases in which tariff rates remain fixed, the change in the real exchange rate is a good indicator of the change in the international competitiveness of the import-competing as well as the export sector. When tariff rates are increased, as in the first simulation in table 1, the competitiveness of the domestic import-competing sector is influenced by the consequent increase in the domestic selling prices of imports as well as by the change in the real exchange rate. This explains why, in table 1, a one per cent deterioration in the real exchange rate induced by a general tariff increase is projected to cause a smaller reduction in aggregate employment than does the same deterioration brought about by wage or oil-price increases.

The final shock, an absorption increase, generates a small rise in aggregate employment in spite of the deterioration in the real exchange rate. The increase in domestic demand stimulates output and employment in the non-trading sector and in the import competing sector where the assumption of imperfect substitution between imports and domestic supplies prevents the demand increase from spilling entirely into imports. Note, however, that ORANI indicates that, because of the contractionary effects of the accompanying deterioration in the real exchange rate, demand expansion is not a very effective method of increasing domestic

1. The effects of cost increases are projected to be less severe in the import competing than in the export sector since the typical elasticity of substitution between imports and domestic commodities in the ORANI data base is only about 2 (DPSV, subsection 29.1) whereas foreign demand elasticities for exportables are, on average, about 16 (DPSV, subsection 29.6).

employment. According to ORANI, most of the demand expansion is accommodated by a deterioration in the balance of trade.

The results shown in table 1 for the agricultural sector reflect the fact that about 70 per cent of agricultural output is commodities which are exportable either directly or after only minor processing in the manufacturing sector. In all simulations export-related activity in the sector is projected to decline with the deterioration in the real exchange rate. In simulations (i) and (iv), the sector gains some compensation through expansions in its non-export-related activities (e.g., the production of tobacco, vegetables and cotton). These activities benefit from expansions in the import-competing sector (simulation (i)) and the non-trading sector (simulation (iv)). Thus, the deterioration in the real exchange rate is associated with less severe effects on agricultural income and employment in simulations (i) and (iv) than in simulations (ii) and (iii).

A final point about the results in table 1 is that the agricultural employment projections refer to changes in the demand for labour input, including both hired and owner-operators' labour. ORANI has nothing to say about how such changes will be apportioned between the two labour categories. In the short run it might be reasonable to assume that hired labour would bear the brunt of the changes. Using industries' shares of hired and owner-operators' labour derived from the ORANI data base, this assumption implies the following percentage changes in hired labour for our four simulations : -5.05, -7.09, -7.37 and -4.87.

that is,

$$q^n = (\eta_1/\sigma^n V_\ell^n)a - (\eta_2/\sigma^n V_\ell^n)p^n + (\eta_2 Q_m^n/\sigma^n V_\ell^n)p_m^n + (\eta_2 Q_m^c/\sigma^n V_\ell^n)p_m^c + \left\{(1-\eta_1)/\sigma^n V_\ell^n\right\}x^e + w + \xi \quad . \qquad (22)$$

We use (22) in (15) to eliminate q^n. This gives:

$$p^n = \psi_1\Big[(S_\ell^n+S_k^n)w + S_o^n p_o + S_e^n p^e + \left\{S_m^n+\left(S_k^n \eta_2 Q_m^n/(\sigma^n V_\ell^n)\right)\right\}p_m^n + \left(\eta_1 S_k^n/(\sigma^n V_\ell^n)\right)a + (S_\ell^n+S_k^n+S_i^n)\xi + \left(S_k^n \eta_2 Q_m^c/(\sigma^n V_\ell^n)\right)p_m^c + \left\{S_k^n(1-\eta_1)/(\sigma^n V_\ell^n)\right\}x^e\Big] \quad , \qquad (23)$$

where $$\psi_1 = 1\Big/\left[1 + \left(\eta_2 S_k^n/(\sigma^n V_\ell^n)\right)\right] \quad . \qquad (24)$$

Now we derive an expression for ξ by substituting into (19) :

$$\xi = \psi_2\Big(\left[W_m + \left(\psi_1 W_n S_k^n \eta_2 Q_m^c/(\sigma^n V_\ell^n)\right)\right]p_m^c + (W_o+\psi_1 W_n S_o^n)p_o + (W_e+\psi_1 W_n S_e^n)p^e + \left(\eta_1 \psi_1 W_n S_k^n/(\sigma^n V_\ell^n)\right)a + \psi_1 W_n(S_\ell^n+S_k^n)w + \psi_1 W_n\left\{S_m^n+S_k^n\left(\eta_2 Q_m^n/(\sigma^n V_\ell^n)\right)\right\}p_m^n + \psi_1 W_n\left(S_k^n(1-\eta_1)/(\sigma^n V_\ell^n)\right)x^e\Big) \quad , \qquad (25)$$

where $$\psi_2 = 1\Big/\left[1 - \psi_1 W_n(S_\ell^n + S_k^n + S_i^n)\right] \quad . \qquad (26)$$

On evaluating the coefficients in (25) using the data in table 2, we find that :

$$\xi = 0.199p_m^c + 0.341p_m^n + 0.046p_o + 0.413p^e + 1.326a + 1.965w + 0.055x^e \quad . \qquad (27)$$

Q^c_m is the share of imports absorbed by consumers and η_1 and η_2 are positive coefficients. η_1 is the share of the output from sector n used in domestic absorption and $(1-\eta_1)$ is the share used as an input to sector e. The first two terms on the RHS of (20) mean that in the absence of price changes, the percentage change in the demand for commodity n is a suitably weighted average of the percentage changes in aggregate absorption and the output of sector e. In view of the ORANI data base, a reasonable value to adopt for η_1 is 0.96. The final term on the RHS of (20) allows for import substitution. If the price of product n rises relative to that of imports, then this term generates decreases in the demand for product n as buyers of consumer goods and intermediate inputs switch towards imports. Given the substitution parameter values used in ORANI, a reasonable value for η_1 is 0.1. [1]

The endogenous variables in the system (15) - (20) are p^n, ξ, q^n, r^n, x^n and ℓ^n. We work towards a reduced form for ξ by first combining (16), (17) and (20) to obtain:

$$\sigma^n V^n_\ell(q^n-w-\xi) = \eta_1 a + (1-\eta_1)x^e - \eta_2(p^n-Q^n_m p^n_m-Q^c_m p^c_m) , \qquad (21)$$

1. In the demand equations for each good (e.g., footwear) the relevant substitution terms in ORANI take the form $\sigma SR(p_1-p_2)$ where p_1 and p_2 are the percentage changes in the basic prices of domestic and imported footwear, i.e., p_1 is the percentage change in the producer price of domestically produced footwear and p_2 is the percentage change in the landed-duty-paid price of imported footwear; R is the average ratio of the basic price of footwear to the various purchasers prices; S is the share of imported footwear in the total sales of footwear; and σ is the elasticity of substitution between imported and domestic footwear (i.e., the Armington elasticity). In the ORANI data base, average values for σ, S and R are 1.8, 0.07 and 0.8.

4. A back-of-the-envelope version of ORANI

In this section we attempt a more ambitious explanation of the results in table 1 than was given in section 3. Our aim is to explain the results quantitatively, not merely qualitatively. For example, rather than being satisfied with understanding why ORANI projects a decline in the real exchange rate under a 10.6 per cent increase in all rates of protection, we will now be concerned with why the projected decline is one per cent instead of say two per cent. Our approach will be to build a very small model, a back-of-the-envelope (BOTE) model, which includes the main mechanisms responsible for the results appearing in table 1.

A key to understanding ORANI results is the distinction in the model between export commodities and non-export commodities. For the former category, domestic selling prices are assumed to be determined almost entirely by exogenous developments in world markets. For the latter category, domestic selling prices are assumed to adjust to shifts in domestic demand and supply curves. In our BOTE model we include two sectors, one producing an exportable commodity and the other producing a non-exportable.

We describe activity in the exporting sector (sector e) by the equations :

$$p^e = S^e_\ell(w + \xi) + S^e_k q^e + S^e_i \xi , \qquad (1)$$

$$\ell^e = \sigma^e(q^e - w - \xi) , \qquad (2)$$

$$x^e = V^e_\ell \ell^e \quad (3)$$

and

$$r^e = V^e_\ell(\ell^e + w) + V^e_k(q^e - \xi) \quad (4)$$

The variables are :

p^e, the percentage change in the domestic price of the exportable product;

w, the percentage change in the real wage rate;

ξ, the percentage change in the consumer price index;

q^e, the percentage change in the nominal rental value (or profit) per unit of capital in the exporting sector;

ℓ^e, the percentage change in employment in the exporting sector;

x^e, the percentage change in the volume of output; and

r^e, the percentage change in real primary factor income in the sector.

The parameters are:

S^e_ℓ, S^e_k and S^e_i, the shares of the costs of production in the exporting sector represented by payments to labour, rentals on capital and purchases of other inputs;

V^e_ℓ and V^e_k, the shares of labour and capital in value added; and

σ^e, the elasticity of substitution between capital and labour.

S^e_ℓ, S^e_k and S^e_i sum to unity as do V^e_ℓ and V^e_k.

$V^e_\ell = S^e_\ell/(1 - S^e_i)$ and $V^e_k = S^e_k/(1 - S^e_i)$.

S^n_o, S^n_e and S^n_m are the shares of costs in sector n accounted for by inputs of oil, inputs of the exportable commodity and imports. p_o and p^n_m are the percentage changes in the domestic prices of oil and imported inputs. As before, p^e is the percentage change in the domestic price of the exportable. S^n_i is the share of miscellaneous costs, e.g., the costs of holding working capital. We assume that miscellaneous costs per unit of output move with the consumer price index. The cost shares S^n_ℓ, S^n_k, S^n_o, S^n_e, S^n_m and S^n_i sum to one. In (15) we have netted out sector n's intermediate usage of its own output.

Next, we define percentage changes in the CPI by:

$$\xi = W_n \, p^n + W_m \, p^c_m + W_o \, p_o + W_e \, p_e \, , \quad (19)$$

where W_n, W_m, W_o and W_e are the weights in the CPI of non-exportable commodities, imports, oil and exportables. p^c_m is the percentage change in the domestic price of imported consumer goods. It may differ from p^n_m.[1]

Finally, we introduce a demand function for non-exportables. (No explicit demand function is required for the exportables since we will be assuming that p^e is given exogenously by world-market conditions.) We assume that the demand for non-exportables is described by:

$$x^n = \eta_1 a + (1-\eta_1)x^e - \eta_2\left(p^n - (Q^n_m \, p^n_m + Q^c_m \, p^c_m)\right) \, , \quad (20)$$

where a is the percentage change in real domestic absorption (consumption plus investment plus government spending), Q^n_m is the share of total imports absorbed as inputs to production,

1. Note in table 2 that the average tariff rate on imported consumer goods exceeds that for imports used as intermediate inputs.

For the ORANI computations in this paper we used an updated data base incorporating the recently available 1974/5 input-output tables.

(b) This share may seem low. Cost shares in ORANI are derived from input-output tables for 1974/5. Major increases in the domestic price of oil did not occur in Australia until 1978. Also, it was appropriate to use cost shares for our non-export sector which are typical of consumer-good industries. These industries tend to be light users of oil.

(c) In our ORANI simulations, the capital/labour substitution elasticity was set at 0.5 for all industries. This was the value which we initially adopted for both sectors of our BOTE model. Subsequently we changed σ^n to 0.28, see the discussion of equations (33) and (34). In all the BOTE computations reported in tables 3 and 4 we used $\sigma^e = 0.5$ and $\sigma^n = 0.28$.

(d) These weights are the shares of the commodity categories in the aggregate value of consumption net of commodity taxes. In ORANI commodity taxes are assumed fully indexed to the CPI.

(e) These are weighted averages of commodity tariff rates using as weights commodity shares in the aggregate value of imports used as intermediate inputs and commodity shares in the aggregage value of imports directly consumed.

The pricing equation (1) is a zero pure profits condition. Notice that we have assumed that the price per unit of inputs other than labour and capital moves with the CPI. The labour-demand equation (2) is an implication of a short-run (fixed capital stock) profit maximizing problem for a price-taking producer; specifically, the problem of choosing X^e(output) and L^e(labour input) to maximize

$$P^e X^e - W\Xi L^e - \Xi A X^e , \qquad (5)$$

subject to:

$$X^e = CES(L^e, K^e) , \qquad (6)$$

where P^e, X^e, W, Ξ, L^e and K^e are the levels of product price, output, real wage rate, CPI, employment and capital stock; A is the number of units of intermediate input required per unit of output in the exporting sector and (6) indicates that output is a CES combination of labour and capital inputs. What (2) says is that the elasticity of substitution (σ^e) is the ratio of the percentage change in employment per unit of capital (which is the percentage change in the employment, ℓ^e, since we are holding capital constant) to the percentage change, $(q^e - w - \xi)$, in the factor price ratio. Equation (3) is also an implication of (5) - (6). Equation (4) defines the percentage change in real income (returns to labour and capital) in the exporting sector, assuming that the employment of capital is fixed.

The variables that can be thought of as endogenous to the exporting sector are q^e, ℓ^e, x^e and r^e. By rearranging (1) - (4) we express these variables as linear functions of p^e, w, and ξ as follows :

$$q^e = (1/S_k^e)p^e - \left[(S_\ell^e + S_i^e)/S_k^e\right]\xi - (S_\ell^e/S_k^e)w , \qquad (7)$$

$$\ell^e = \sigma^e(1/S_k^e)(p^e - \xi) - \sigma^e\left[(S_\ell^e + S_k^e)/S_k^e\right]w \ , \qquad (8)$$

$$x^e = \sigma^e(V_\ell^e/S_k^e)(p^e - \xi) - \sigma^e\, V_\ell^e\left[(S_\ell^e + S_k^e)/S_k^e\right]w \qquad (9)$$

and

$$r^e = \left[(\sigma^e\, V_\ell^e + V_k^e)/S_k^e\right](p^e - \xi) - \left[(\sigma^e\, V_\ell^e + V_k^e)(S_\ell^e/S_k^e) - V_\ell^e(1-\sigma^e)\right]w \ . \qquad (10)$$

Using the export-sector data in table 2, which are typical of those employed for the export-oriented industries in the ORANI model, we find that (7) - (10) imply that :

$$q^e = 4.17p^e - 3.17\xi - 1.54w \ , \qquad (11)$$

$$\ell^e = 2.08p^e - 2.08\xi - 1.27w \ , \qquad (12)$$

$$x^e = 1.27p^e - 1.27\xi - 0.78w \qquad (13)$$

and

$$r^e = 2.90p^e - 2.90\xi - 0.77w \ . \qquad (14)$$

For the sector producing the non-exported commodity (sector n), we adopt equations analogous to (1) - (4) :

$$p^n = S_\ell^n(w + \xi) + S_k^n\, q^n + S_o^n\, p_o + S_e^n\, p^e + S_m^n\, p_m^n + S_i^n\, \xi \ , \qquad (15)$$

$$\ell^n = \sigma^n(q^n - w - \xi) \ , \qquad (16)$$

$$x^n = V_\ell^n\, \ell^n \qquad (17)$$

and

$$r^n = V_\ell^n(\ell^n + w) + V_k^n(q^n - \xi) \ . \qquad (18)$$

Only (15) needs further explanation. Compared with (1), (15) provides a more detailed breakdown of other inputs.

Table 2 : Parameter values for the BOTE model[a]

1. Production Sectors

	Export Sector	Non-export Sector
Labour share in primary factor costs :	$V_\ell^e = .61$,	$V_\ell^n = .740$
Capital share in primary factor costs :	$V_k^e = .39$,	$V_k^n = .260$
Labour share in total costs :	$S_\ell^e = .37$,	$S_\ell^n = .526$
Capital share in total costs :	$S_k^e = .24$,	$S_k^n = .185$
Other input share in total costs :	$S_i^e = .39$,	
Oil share in total costs :		$S_o^n = .006$[b]
Share of the exportable in total costs :		$S_e^n = .078$
Imported input share in total costs :		$S_m^n = .086$
Miscellaneous input share in total costs :		$S_i^n = .119$
Capital/labour substitution elasticity :	$\sigma^e = .50$,	$\sigma^n = .50$(initially) $= .28$(finally)[c]
Demand function parameters (see equation 20)) :		$\eta_1 = .96$, $\eta_2 = .10$

2. Weights in the CPI[d]

Non-export good : $W_n = .881$

Imports : $W_m = .050$

Export good : $W_e = .060$

Oil : $W_o = .009$

3. Shares in aggregate imports

Industry usage : $Q_m^n = .75$

Consumption : $Q_m^c = .25$

4. Tariff rates[e]

Industry inputs : $T_m^n = 0.19$

Consumer goods : $T_m^c = 0.28$

(a) The parameter values were selected with reference to the ORANI data base. The original ORANI data base is described in detail in DPSV, ch.4.

continued ...