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FARM INCOMES AND THE REAL EXCHANGE RATE IN AUSTRALIA : EVIDENCE FROM THE ORANI MODEL

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CONTENTS

1.	INTRODUCTION	1
2.	MAJOR ASSUMPTIONS UNDERLYING THE ORANI SIMULATIONS	3
3.	RESULTS	7
	3.1 Economy-Wide Results	9
	3.2 The Agricultural Sector	11
4.	CONCLUSION	16
	REFERENCES	17
	TABLE 1 : Principal Economy-Wide and Agricultural Sector Results	8

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1. INTRODUCTION

The sensitivity of agricultural output and farm incomes to the ratio of the prices received for agricultural products to prices paid for farm inputs has long been recognized in the literature on agricultural economics. Since Australian agriculture is very export oriented and faces elastic foreign demand curves for its products, changes in the real exchange rate are a good measure of changes in this crucial price/cost ratio. The real exchange rate is defined as the ratio of the nominal exchange rate (i.e., the number of domestic dollars required to purchase 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).

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,[2] a

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1. This paper is based on a presentation given by Powell in April 1982 to a seminar organized by the Australian Institute of Agricultural Science on the topic "Economic Reality, Political Perceptions and the Future of Agriculture". A much more detailed and technical explanation of the results can be found in a separate paper by the same authors (Dixon, Parmenter and Powell, 1982).

2. ORANI is fully described in Dixon, Parmenter, Sutton and Vincent (1982).

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).

Readers will recognize each of these shocks as reflecting elements of recent debates about macroeconomic policy in Australia.[1] The sizes of the shocks (10.6 per cent for protection changes, 0.57 per cent for wage changes, etc.) were chosen such that under the conditions to be described in the next section, the ORANI model projects that each would result in a one per cent decrease in the real exchange rate.

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1. Even the manipulation of domestic oil prices was related to short-run macroeconomic objectives during the last Federal Election. For a detailed analysis see Higgs (1981).

2. MAJOR ASSUMPTIONS UNDERLYING THE ORANI SIMULATIONS

In order to understand the results to be presented in the next section, it is important for readers to be aware of the major assumptions which were made in generating those results. 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 ORANI 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.

In this paper, we have assumed that :

(i) 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 exogenously 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.

(ii) 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.

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4. CONCLUSION

The impact on agricultural sector incomes of general cost increases whose genesis lies elsewhere in the economy can be analysed most effectively by a comprehensive economy-wide model tracing the movements in all prices and quantities which enter into the income equation. We have used such a model of the Australian economy, ORANI, to estimate the short run effects on agricultural incomes of four shocks. All of these shocks have broadly similar consequences for agricultural incomes, the severity of the shocks being well indicated by the movements induced in the real exchange rate. The mechanisms by which these changes in the real exchange rate affect agricultural incomes and employment can be rationalized with some simple and intuitively appealing calculations.

and (iii) induced changes in the real exchange rate appear as changes in the domestic relative to the foreign inflation 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 effect 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 short-run assumptions. Our short run 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 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.

other hand, the assumption is an understatement of the rise in agriculture's intermediate costs. This is because the share of oil products in agricultural costs is about twice that for the economy as a whole and because agriculture also uses as inputs other commodities, such as chemical fertilizers, which are themselves relatively intensive users of oil products. The first of these factors alone accounts for an additional 0.26 per cent rise in the average unit price of intermediate inputs and thus, via (4), for an additional 0.76 per cent fall in factor incomes.

A final point about the results in table 1 is that the agricultural employment projections refer to changes in the demand, for aggregate 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.

exportable are fixed on world markets independently of domestic conditions[1] and that the prices of the remaining 30 per cent move in line with the CPI (yielding $p = 0.3$ for $cpi = 1$). Equation (4) then predicts $r = 2.04$ for the simulations in which real wages are constant ($w = 0$) and $r = 2.48$ for the case of the real-wage increase ($w = 0.57$). A more accurate procedure is to calculate values of p as weighted averages of the commodity price projections in each of the simulations.[2] The relevant averages are, in turn, 0.28, 0.39, 0.41 and 0.30. Using these values (4) predicts that the corresponding percentage changes in real factor incomes will be -2.1, -2.2, -1.7 and -2.0. For all, except the oil-price simulation, these are slight overestimates of the projections in table 1. The problem is that the assumption implicit in (2) that the prices of produced inputs move with the CPI slightly overstates the rise in the intermediate costs of agriculture for the non-oil shocks. For example, the prices of inputs purchased from within the agricultural sector itself, which represent a higher share of aggregate intermediate costs for agriculture than for the economy as a whole, have fallen relative to the CPI. For the oil-shock on the

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1. This is a simplification of the assumptions used in ORANI where export-demand elasticities are high but not infinite.

2. The individual farm-gate commodity price movements can be explained in detail taking account of factors such as the elasticities of the export demand curves and the shares in the at-port values of exports which are accounted for by trade and transport margins. For details see Dixon, Parmenter, Powell and Vincent (1982).

3. RESULTS

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 cluster around average reductions of 1.5 per cent in employment and two per cent in real income. Thus, they 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. It is not difficult to provide a quantitative explanation of the ORANI projections of the effects on the agricultural sector of the changes in the real exchange rate. First, however, we provide a qualitative explanation of the ORANI projections of the economy-wide effects of the four shocks. A quantitative analysis of these latter effects, which requires more work than is warranted here, can be found in Dixon, Parmenter and Powell (1982).

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.

Equation (3) just says that when capital and land are held fixed, the elasticity of substitution (σ) is equal to the ratio of the percentage change in employment to the percentage change in the factor price ratio ((q - cpi) - w).

Equations (1) - (3) are a simplified representation of the main mechanisms in ORANI responsible for the impact of changes in the real exchange rate on the agricultural sector. The role of the price-cost squeeze is evident in equations (2) and (3). Because they must compete on world markets, export oriented agricultural producers cannot readily pass on cost increases in the form of higher selling prices. Increases in the costs of purchased inputs (i.e., intermediate inputs and labour) thus reduce the implicit rental rates on land and capital, and result in reductions in agricultural activity and employment.

From the ORANI data base we can compute the values of the parameters of equations (1) - (3). They are $V_L = 0.61$, $V_F = 0.39$, $S_V = 0.61$ and $\sigma = 0.5$. Using these, and combining the equations we derive:

$$r = 2.92\,(p - cpi) - 0.78w \quad . \qquad (4)$$

Equation (4) is the explanation for the general rule, noted at the beginning of this section, that a one per cent increase in the real exchange rate leads to approximately two per cent decline in real factor incomes. To explain the percentage changes in the average price (p) of agricultural output we note that, in the ORANI data base about 70 per cent of the value of agricultural output is exportable, either directly or after only minor processing in domestic manufacturing. A rough estimate of p can be made by assuming that the prices of the 70 per cent of agricultural output which is

The real wage rate (w) is exogenous in our simulations (see section 2) and for each simulation the value for cpi is -1 (see table 1). The remaining variables on the right of equation (1) (i.e., ℓ and q) can be explained via some implications of producers' optimizing behaviour which is assumed in the theoretical structure of ORANI. Producers, including agricultural producers, are modelled as if they take as given the prices of their inputs and outputs and maximize profits subject to constant elasticity of substitution (CES) production functions. The percentage change in producers' demand for labour in the short run (i.e., with fixed capital and land) then depends on movements in the real wage rate relative to the real price of net output (i.e., the product price minus the cost per unit output of intermediate inputs). Equation (2) represents this relationship:

$$\ell = \frac{\sigma}{V_F}\left[\frac{1}{S_V}(p - cpi) - w\right] , \qquad (2)$$

where p is the percentage change in the price of output, σ is the elasticity of substitution between primary factors (i.e., a parameter which measures the response of the proportions in which producers demand different primary factors to changes in factor-price ratios) and S_V is the share of value added in total costs. Equation (2) incorporates the assumption that the average price of intermediate inputs moves in line with the domestic price level (i.e., with the CPI). The same behavioural assumptions imply:

$$q = \frac{1}{\sigma}\ell + w + cpi \quad . \qquad (3)$$

3.1 Economy-Wide 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 commodities. Thus, further, indirect, 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 successive rounds of price and wage increases which 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 simulations the capital stock in each industry is assumed fixed, supply curves in the model are upward sloping. Hence, 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 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

1. The effects of cost increases are projected to be less severe in the import competing than in the export sector since, according to the ORANI data base, imports and domestic output are far from perfect substitutes, whereas the elasticity of demand for exports is quite high.

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

3.2 The Agricultural Sector

In this subsection we provide a detailed explanation of the relationship between column (2) of table 1 and columns (3) and (4); that is, we explain the mechanisms in ORANI which determine the sensitivity of employment and factor income in the agricultural sector to changes in the real exchange rate. Real factor income is measured as the sum of real returns to labour, capital and land employed in agriculture. For short-run ORANI simulations, in which the quantities employed of capital and land are held fixed, the percentage change in real factor income (r) can be defined as :

$$r = V_L(\ell + w) + V_F(q - cpi) \quad , \qquad (1)$$

where ℓ is the percentage change in agricultural employment, w is the percentage change in the real wage rate, q is the common percentage change in the nominal implicit rental rates on agricultural capital and land,[1] and cpi is the percentage change in the CPI. V_L is the share of labour and V_F the share of capital and land in aggregate returns to land, labour and capital in the agricultural sector.

1. In short-run ORANI simulations, the percentage change in the rental rates on all fixed factors employed in an industry are equal.