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Sectoral and Macroeconomic Effects of Movements in Real Exchange Rates: The Case of Australia

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Summary

The sustained real exchange rate movements experienced by most industrial countries in the past four years have had important effects on resource allocation and macroeconomic variables. The present paper attempts to quantify the macroeconomic and sectoral effects that might be expected following a depreciation in the real value of the Australian dollar against the U.S. dollar and to assess the effects of policies by which the Australian authorities may seek to influence the real exchange rate. These effects are analyzed using an input-output model of the Australian economy.

The results of the first simulation experiment, in which the real exchange rate is assumed to be an exogenous variable, show that the largest expansion in output and employment is experienced within the traded goods sector relative to the nontraded sector, and, within the traded sector, by agricultural industries. Aggregate output and employment are also higher than they would otherwise have been in the absence of the real exchange rate depreciation. In the second simulation experiment, the real exchange rate is assumed to be an endogenous variable, responding to various structural shocks or policy changes. The results suggest that the authorities can simultaneously achieve a targeted real depreciation and full employment by policies that succeed in reducing real wage costs and increasing real domestic absorption. However, achievement of these goals also results in a considerable increase in the surplus on merchandise trade.

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I. Introduction

Since 1980, most industrial countries have experienced considerable real depreciations of their exchange rates against the U.S. dollar. The significance of these real exchange rate movements is that they may cause certain sectors of the economy to contract while stimulating others. Sustained real depreciations are likely to result in a shift of resources from the nontraded to traded sectors, expanding output and employment in the traded sector. In small, open economies such as Australia, growth in the traded goods sector is usually considered to be a desirable policy goal. Thus, the authorities may undertake specific policies designed to reinforce market-induced real depreciations, or they may attempt to prevent appreciations that would otherwise occur.

The purpose of this paper is to quantify the macroeconomic and sectoral effects that might be expected following a depreciation in the real value of the Australian dollar, and to assess the effects of policies by which the authorities may seek to influence the real exchange rate, thereby "protecting" certain sectors and industries. In order to establish the direction and order of magnitude of the sectoral and macroeconomic effects resulting from movements in the real exchange rate, the Orani input-output model of the Australian economy is used. The main advantage of analyzing the effects of real exchange rate movements using the Orani model is that this model makes possible a detailed multisectoral analysis within a well-specified general equilibrium framework which emphasizes the sectoral linkages in the economy. Hence, both the industry-specific and macroeconomic effects of any given exogenous shift in an economic variable can be described. 1/ Such an investigation is particularly interesting in the case of Australia. Unlike many of the smaller industrial countries, the traded goods sector in Australia is composed mainly of agricultural and mining industries while the nontraded sector is mainly manufacturing industry. The linkages between the two sectors through traded and nontraded intermediate inputs and primary factors provide a rich field for multisectoral analysis.

For the purposes of assessing quantitatively the macroeconomic and industry effects of the recent real depreciation of the Australian dollar against the U.S. dollar, it is convenient to treat the real exchange rate as an exogenous variable. More realistically, in order to determine how the level of the real exchange rate is affected by various policies or structural shocks, the real exchange rate can itself be assumed to be an endogenous variable in the Orani model. From this perspective, an important feature of the Orani model is that it enables the user to swap variables between endogenous and exogenous categories.

1/ The Orani model does not specify the monetary sector, and unless interfaced with a macroeconomic model (see Cooper and McLaren (1983)), is not designed to analyze monetary shocks.

The paper is divided into four main sections. In Section II, some evidence is presented on recent movements in the effective and bilateral real exchange rates of the Australian dollar. Section III discusses the sorts of "exchange rate protection" policies that might be used in an attempt to manage the real exchange rate in order to expand or maintain output in particular sectors of the economy. Section IV uses the Orani input-output model of the Australian economy for the purpose of carrying out two simulation experiments. The first simulation exercise attempts to assess quantitatively the macroeconomic and sectoral effects of an (assumed exogenous) 10 percent real depreciation of the Australian dollar against the U.S. dollar. This experiment provides some quantitative estimates of the effects of the recent real depreciation of the Australian dollar on the domestic economy. In the second experiment, the real exchange is assumed to be an endogenous variable which responds to various structural shocks. A simple two-target, two-instrument policy simulation is carried out in which it is assumed that the authorities target an unchanged real exchange rate (or a real depreciation of a given size) and a 5 percent increase in aggregate employment. The final section draws together the main conclusions of the research and its policy implications.

II. Recent Movements in Australia's Real Exchange Rate

The real exchange rate has generally been identified with the international terms of trade or the relative price of traded to nontraded goods. In two-country, two-good models where all goods are assumed to be traded, the equilibrium real exchange rate is usually defined as the terms of trade. However, for many small, open economies, the international terms of trade may be given. In this case, the relative price that is of interest from the standpoint of economic policy is that between traded goods and domestic nontradables.

For the purpose of describing past movements in Australia's real exchange rate, the first definition will be used. The real exchange rate, r, is measured by adjusting the nominal exchange rate index by an index of domestic prices relative to those abroad as given in (1):

$$r = ep/p^* \qquad (1)$$

where

e = index of spot exchange rate (number of units of foreign currency per unit of domestic currency)

p = index of domestic prices

p^* = index of foreign prices

Conceptually, movements in the real exchange rate index are assumed to be the outcome of two separable components, an inflation differential between the domestic and foreign country and a component reflecting changes in the nominal exchange rate.

In percentage changes, (1) becomes:

$$\hat{r} = \hat{e} + (\hat{p}-\hat{p}^*) \qquad (2)$$

where $\hat{r}$ reflects movements in the real exchange rate and $(\hat{p}-\hat{p}^*)$ reflects the inflation differential.

The question of the particular price index that is to be used to measure movements in the real exchange rate has attracted some attention (see for example, International Monetary Fund (1984a,b), Maciejewski (1983), Artus (1978)). Some researchers have argued that an index based on unit labor costs in the manufacturing sector (usually adjusted for cyclical changes in labor productivity) is superior to other price indexes because it measures a major component of the domestic costs of producing tradable goods, rather than actual prices. However, in the case of Australia this index has the disadvantage that it excludes the agricultural and mineral sectors, which form an important component of the tradable goods sector. Alternative price indexes which have been used include export and import prices, wholesale prices and the consumer price index (CPI). The following description of past movements in the real bilateral rate between Australia and the United States, and in Australia's real effective exchange rate, is based upon the CPI. 1/ This index offers greater comparability across countries. Further, movements in the real exchange rate in the Orani model are measured by shifts in the CPI in Australia, given the nominal exchange rate and the CPI in other countries.

Chart 1 shows quarterly data on the real effective value of the Australian dollar (solid line) as well as its real bilateral value against the U.S. dollar (dotted line) over the period 1973/84. As of the first quarter of 1985, the Australian dollar had depreciated in real terms against the U.S. dollar by about 27 percent relative to its average value for the decade 1974/83. The magnitude of the Australian dollar's depreciation has been somewhat smaller in real terms than those experienced by the major industrial countries against the U.S. dollar. Over the same period, for example, the deutsche mark and the pound sterling depreciated in real terms (measured by CPI indexes) against the U.S. dollar by about 40 percent and 30 percent, respectively, with the Japanese yen depreciating in real terms by about 20 percent.

In contrast to its recent real depreciation, a large real appreciation of the Australian dollar occurred in the early 1970s, especially from

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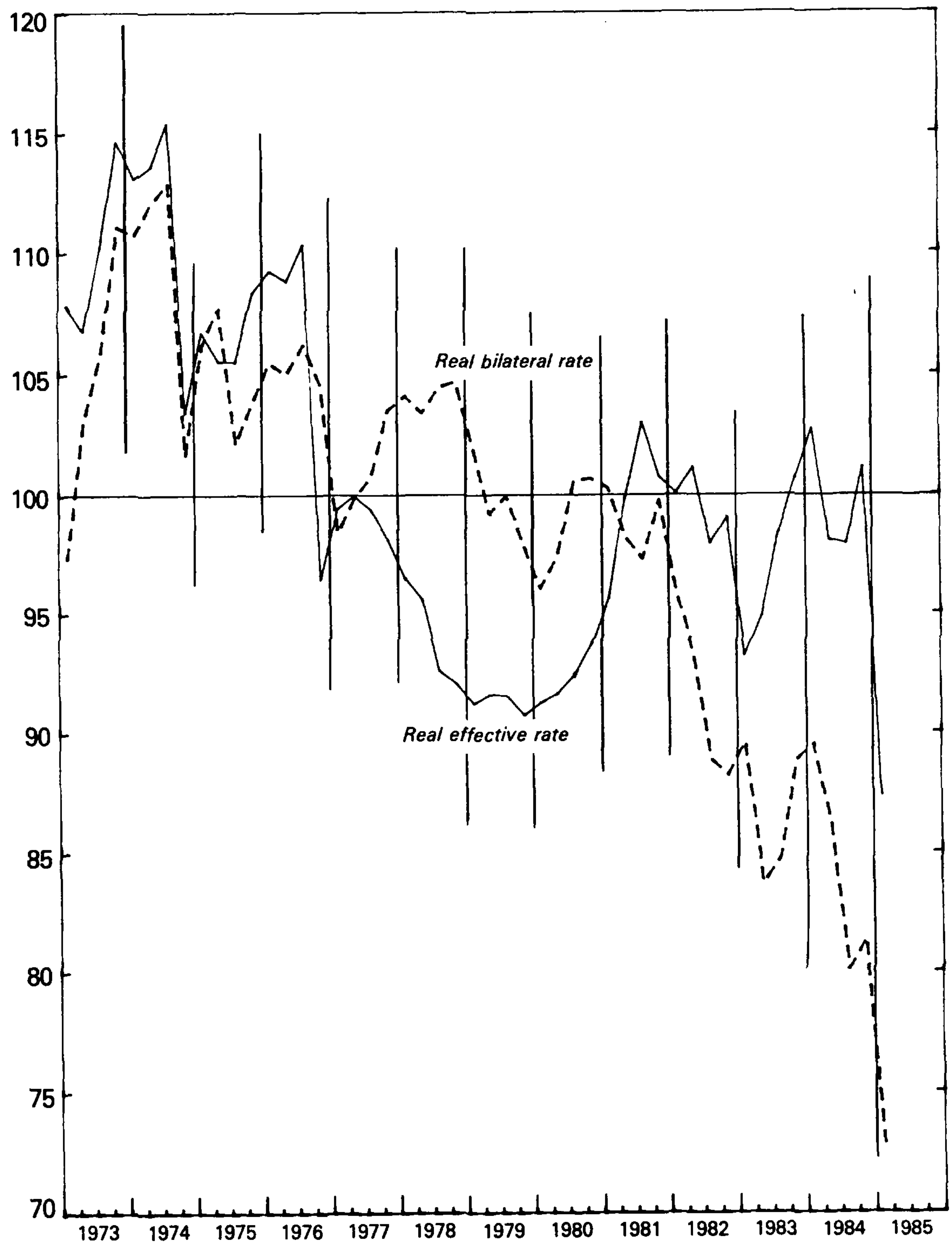
1/ In the case of the effective exchange rate, the weights are based upon bilateral trade patterns between Australia and its main trading partners.

CHART 1

AUSTRALIA

MOVEMENTS IN THE REAL EFFECTIVE EXCHANGE RATE AND REAL BILATERAL EXCHANGE RATE AGAINST THE U.S. DOLLAR-1973-1985

(Indices, average value for 1974-83 = 100)[1]



Source: Staff estimates.

1 Based on CPI indices. A rise/fall suggests a loss/gain in international competitiveness

1973(2) to 1974(2). Relative to the average level over the period 1974/83 the maximum real appreciation that occurred was about 12 percent in 1974(2) with a subsequent smaller real appreciation of around 5 percent occurring in 1978(4). These earlier appreciations were primarily the outcome of the two mineral booms in Australia, and bear some similarity to the rise in the real value of sterling associated with North Sea oil--although the magnitude of the real appreciation of sterling was considerably greater, being about 32 percent (see Bond and Knobl (1982)). 1/

As shown in Chart 1, movements in the real effective value of the Australian dollar have displayed a similar pattern to that of its bilateral rate with the dollar. However, during the appreciation phase the magnitude of the real effective appreciation was much greater than the corresponding appreciation against the U.S. dollar, as the Australian dollar strengthened against the currencies of its other major trading partners. Conversely, during the recent episode of depreciation, the decline in the real effective exchange rate was considerably smaller than the real bilateral depreciation of the Australian dollar against the U.S. dollar (since the Australian dollar was relatively stronger against the currencies of its other major trading partners).

In Table 1, quarterly movements in the real exchange rate (US$ per $A) are decomposed into changes in nominal spot rates and in the inflation differential. In general, movements in the real exchange rate tend to be closely associated with movements in the nominal exchange rate and weakly associated with contemporaneous movements in the inflation differential. 2/ For example, from the end of the fourth quarter of 1972 to the end of the first quarter of 1973, the spot rate of the Australian dollar appreciated by 13 percent. During the same period, the rate of price change in Australia exceeded that of the United States by only 0.8 of one percentage point, giving a real appreciation of the Australian dollar of 13.8 percent. In both the second quarter of 1983 and third quarter of 1984, the spot rate depreciated by about 7 percent. With the inflation differential lying between 0.2 and 0.9 percentage points, there was a real depreciation of the Australian dollar of about 7 percent.

Table 1 also shows that the variability in both nominal and real exchange rates (measured by the standard deviation of quarterly percentage changes) is about three times that of the inflation differential. 3/ Much

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1/ The tight monetary policy pursued in the United Kingdom also contributed to sterling's real appreciation. Using a time series macroeconomic model of the United Kingdom, Bond and Knobl (1982) suggest that a little over one half of the real appreciation of sterling (1977/81) can be explained by North Sea oil.

2/ The correlation coefficient between quarterly changes in real and nominal exchange rates is 0.94, while that between quarterly changes in the real exchange rate and the inflation differential is 0.06.

3/ The covariance between changes in the nominal exchange rate and the inflation differential is very small.

Table I. Quarterly Percentage Changes in Bilateral Real and Nominal Spot Rates (U.S. dollar per Australian dollar) and Inflation Differentials Between Australia and the United States

Quarter	Real bilateral spot rate 1/	Nominal bilateral rate 1/	Inflation differential (Australia-United States) 2/
1973.1	13.8	13.0	0.8
1973.2	5.9	4.8	1.1
1973.3	2.7	1.2	1.5
1973.4	4.9	3.7	1.2
1974.1	-0.3	0.0	-0.3
1974.2	1.2	0.0	1.2
1974.3	0.8	-1.2	2.0
1974.4	-9.9	-10.7	0.9
1975.1	4.5	2.7	1.8
1975.2	1.4	-0.5	1.9
1975.3	-5.2	-3.9	-1.4
1975.4	1.7	-2.1	4.0
1976.1	1.5	-0.4	2.0
1976.2	-0.5	-1.7	1.3
1976.3	1.2	0.6	0.6
1976.4	-1.6	-0.1	4.9
1977.1	-5.9	-6.3	0.5
1977.2	1.4	1.2	0.2
1977.3	0.9	0.4	0.5
1977.4	2.7	1.4	1.3
1978.1	0.6	1.0	-0.4
1978.2	-0.7	-0.2	-0.5
1978.3	1.0	1.4	-0.4
1978.4	0.2	-0.02	0.2
1979.1	-2.6	-1.8	-0.8
1979.2	-2.7	-2.0	-0.7
1979.3	0.7	1.7	-1.0
1979.4	-2.1	-2.1	0.07
1980.1	-1.8	-0.2	-1.7
1980.2	1.4	2.1	-0.8
1980.3	3.3	3.3	0.03
1980.4	0.1	0.7	-0.6
1981.1	-0.4	-0.1	-0.3
1981.2	-2.1	-2.0	-0.04
1981.3	-0.9	-0.1	-0.8
1981.4	2.5	-0.1	2.7
1982.1	-3.9	-4.8	0.9
1982.2	-2.7	-3.6	0.9
1982.3	-4.7	-6.2	1.6
1982.4	-0.7	-3.3	2.7
1983.1	1.6	-0.7	2.3
1983.2	-6.6	-7.4	0.9
1983.3	1.2	0.7	0.4
1983.4	4.9	3.4	1.5
1984.1	0.7	2.2	-1.5
1984.2	-3.7	-2.9	-0.9
1984.3	-7.1	-7.3	0.2
1984.4	1.5	0.9	0.7
1985.1	-10.5	-11.2	0.7
Standard deviation of quarterly changes	3.1	4.0	1.3

1/ Negative sign represents an exchange rate depreciation of the Australian dollar against the U.S. dollar.
2/ At quarterly rates.

of the recent discussion in the literature (see, for example, International Monetary Fund (1984a), Cushman (1983), and Gotur (1985)) has been concerned with the effects of volatility in both real and nominal exchange rates on the volume of world trade. To the extent that economic agents are risk-averse and that observed exchange rate variability is a measure of risk, the greater uncertainty associated with real exchange rate variability tends to act as a disincentive to trade. In addition to increasing costs through uncertainty, exchange rate movements may also result in shifts of resources between sectors in response to changing price incentives. Furthermore, if real exchange rates are subject to substantial medium-term swings, then these shifts in resource allocation may be reversed in the future, leading to costly "double adjustment" problems. Although the present analysis is concerned with the adverse sectoral effects of shifts in the level of the real exchange rate, it is recognized that it is frequently difficult in practice to distinguish between the effects of variability in real exchange rates and shifts in their levels.

III. Exchange Rate Protection Policies

Real exchange rate movements may be the outcome of market forces, economic policies, or some combination of the two. In the case of market-induced movements, both temporary and permanent changes in the real exchange rate may occur under a generalized floating exchange rate regime. Temporary real exchange rate movements may arise from unanticipated real shocks that are subsequently reversed. They may also occur in response to monetary shocks accompanied by domestic price or wage stickiness that results in short-run deviations from purchasing power parity. In contrast, permanent real exchange rate movements arise from permanent real shocks, such as shifts in productivity in the traded and nontraded sectors and structural changes in trading patterns among countries.

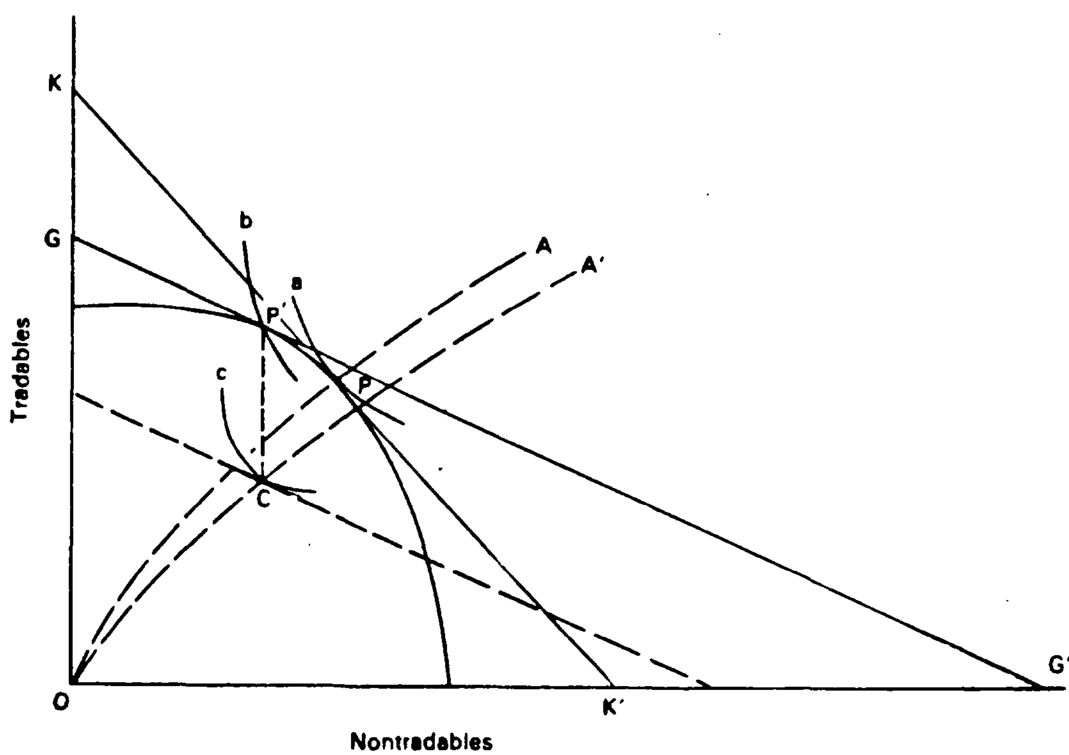
In the case of policy-induced shifts in the real exchange rate, various policies including expenditure policies, incomes policies and exchange market intervention may be required, since the authorities need to control both the nominal exchange rate and domestic prices (or nominal wages). Corden (1981a) defines an exchange rate protection policy in the following way:

> "There is exchange rate protection when a country protects its tradable goods sector (export and import-competing industries) relative to its nontradable sector by devaluing its exchange rate, allowing the exchange rate to depreciate more than it would otherwise, or preventing an appreciation that would otherwise take place."

Corden's analysis is based upon the small country assumption in which the real exchange rate is defined as the price of nontraded to traded goods, P_N/P_T. In Figure 1, it is assumed that the current account is initially in balance at P (the general equilibrium position) with the real exchange rate given by the slope of KK'. It is assumed that the authorities wish to increase the output of the traded goods sector to P'. Assuming given nominal prices of nontradables, this objective can be achieved, at least in the short run, by devaluing the domestic currency and thereby altering the real exchange rate to the slope GG'. However, the resulting fall in the relative price of nontradables shifts the pattern of domestic absorption away from tradables, moving the expenditure curve OA to OA', resulting in an excess demand for nontradables at P'. In order to prevent the price of nontradables from rising, domestic absorption needs to be reduced. The new short-run equilibrium position is at C (in terms of domestic absorption) with a current account surplus P'C, measured in terms of tradable goods, equal to the reduction in domestic absorption.

FIGURE 1

EXCHANGE RATE PROTECTION POLICY



Several issues arise with respect to exchange rate protection policies. The first concerns the instruments that the authorities can use to alter the relative price of traded to nontraded goods. In the short run, management of the nominal exchange rate is sufficient, provided the prices of nontradables are sticky. 1/ However, if the prices of nontradables are flexible or institutional constraints such as wage indexation prevent flexibility in the real wage, additional policies are needed, such as restrictive expenditure measures or incomes policies. In the longer run, the current account surplus induces an inflow of foreign resources, increasing the domestic money stock and domestic prices. In order to prevent a movement in the real exchange rate back to its initial equilibrium position, the authorities may need to implement a sterilization policy whereby domestic assets are exchanged for foreign assets.

A second issue concerns the welfare implications of exchange rate protection policies. The undervaluation of the real exchange rate and the maintenance of a disequilibrium current account surplus impose a static welfare cost as compared with the initial situation of current account equilibrium. In Figure 1, the exchange rate protection policy results in a fall in the community indifference curve from a to c. The welfare cost to the community arises from the reduction in domestic expenditure necessary to maintain the disequilibrium real exchange rate and the current account surplus. 2/

If, as assumed above, the goal of an exchange rate protection policy is to increase or maintain output in the traded sector, the above approach is not a first-best solution. A first-best policy would be to subsidize the production of tradables, financing the subsidy by a lump-sum tax on the production of nontradables. The resulting social cost would be a downward shift in the community indifference curve to b, which lies somewhat above that resulting from exchange rate protection.

An alternative policy response to any structural changes within the tradables sector which may result from shifts in the real exchange rate is to increase the level of tariff protection. 3/ Tariff protection policy differs from the above policy since it is concerned with shifts within the tradables sector, between importables and exportables instead of

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1/ It is assumed that the prices of traded goods are flexible.

2/ *However, it is important to note that the fall in domestic absorption* reduces current welfare whereas the increase in foreign reserves, by increasing wealth, raises future welfare and thereby generates future social benefits. The final level of community welfare may lie between a and c.

3/ For recent empirical evidence relating appreciations of the real exchange rate, a rise in import penetration and the imposition of nontariff barriers, see Clifton (1985).

between tradables and nontradables. Based upon welfare criteria, the choice between a policy of direct protection (tariffs and export subsidies) to the lagging industries and exchange rate protection is not clear cut. Tariff protection imposes a consumption distortion cost by shifting the pattern of consumption away from lagging toward booming industries. Although an exchange rate protection policy avoids this cost, it imposes an additional cost which is the reduction in domestic absorption (payments surplus) discussed above. 1/

Other considerations, however, are likely to affect the choice between the three policies. One advantage of a general policy of exchange rate protection is that, in contrast to subsidies to particular industries, it is less likely to cause other countries to retaliate by implementing protectionist trade policies of their own. A relatively stronger case could also be made for an exchange rate protection policy over tariff protection since it offers greater flexibility to policymakers. Tariff protection tends to be asymmetric in the sense that it is usually easier to impose or increase the general levels of tariffs than to lift them.

IV. Empirical Results

In this section, the Orani input-output model of the Australian economy is used to simulate the macroeconomic and sectoral effects of some important shocks to the economy. The exchange rate change is assumed to be exogenous in subsection 1 of Section IV but it is endogenous in subsection 2. The simulation experiments reported in this section are based upon the specification of the Orani '78 model, a detailed discussion of which is given in Dixon, Parmenter, and Powell (1982) and upon 1974/75 input-output data. The percentage-change projections are to be interpreted as percentage differences between the values that the endogenous variables would have taken in the solution year with and without the shock.

Orani is a general equilibrium model in which the behavior of economic agents is modelled according to orthodox neoclassical macroeconomic theory in which relative prices play an active role in determining economic outcomes. A brief overview of the theoretical structure is given in the appendix. 2/ The model is nonlinear in levels of its variables but can be

1/ In practice, protection of lagging industries within the tradables sector (rather than protection of the entire tradables sector as assumed above) may also be the motive behind an exchange rate protection policy. Within a three-good model with the tradables sector composed of a booming and lagging sector, exchange rate protection can be shown to impose an additional cost by protecting the booming sector relative to nontradables (see Corden (1981a)).

2/ A complete specification of the model is given in Dixon, Sutton, and Vincent (1982), pp. 130-140.

solved, following Johansen (1960), in a linear form in the percentage changes of the variables. The first group of equations describes household and other final demands (foreign and government) for commodities. Consumers are assumed to maximize their utility subject to an aggregate budget constraint; they can satisfy their demand for any good by buying either imported or domestic goods, with goods in the same category from the two sources assumed to be imperfect substitutes.

The specification of input technology in Orani can be summarized as follows. The input-activity functions assume constant returns to scale and are of a three-level form. At the top level, the Leontief assumption is adopted which assumes fixed input-output coefficients, i.e., no substitution between different materials or between materials and primary factors (occupation-specific labor, industry-specific capital, and region-specific land). At the next level, Orani assumes constant elasticity of substitution (CES) and CRESH functions describing substitution in production between imported and domestic goods of the same type and among primary factors. 1/ At the last level, labor inputs are disaggregated to allow for imperfect substitutability between nine different labor occupations. Producers are assumed to be efficient in the sense that at any given level of activity the producers in a particular industry select the combination of inputs which minimizes their costs and the combination of outputs which maximizes their revenue. The remaining equations of the model are price equations setting pure profits from the three activities (production, exporting, and importing) to zero, market-clearing equations for primary factors and commodities, and miscellaneous definitional equations including the balance of trade, the consumer price index, and the wage indexation. 2/

At the outset, it is important to state clearly the assumptions and limitations inherent in the use of the Orani model to analyze the simulated effects of a 10 percent bilateral real depreciation of the Australian dollar against the U.S. dollar. First, most countries, including Australia, have shown sharp swings in their nominal and real spot exchange rates (Chart 1). The Orani model is not designed to handle very short-run changes nor the uncertainties and resulting revisions in exchange rate expectations associated with high volatility in nominal and real exchange rates. In analytical time, the "short run" in Orani is based upon the assumption that there are fixed industry-specific capital stocks and

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1/ The advantage of CRESH functions is that they allow for variable elasticities of substitution between primary factors and between different skill categories of labor.

2/ Although labor demand is equated to the supply of each given skill category of labor, Orani is not necessarily a full-employment model. For example, full employment can be imposed by setting a given labor supply exogenously at a full employment level. Alternatively, wages can be set exogenously and the labor supply allowed to be endogenous.

fixed region-specific land, but producers and consumers can adjust their behavior to any change in relative prices. The short run is a period sufficiently long for the changes in activity induced by the shocks to work their way through the economy via the key linkages and the usual multiplier effects. In the case of producers, this also allows for some revisions in investment decisions, which also affect the demands faced by industries supplying capital goods. However, the period is sufficiently short that induced changes in the quantity of plant and equipment available for use by the various industries may be ignored. 1/

1. Exogenous real exchange rate

In the simulation experiment of this subsection the real exchange rate is treated as an exogenous variable. In the Orani model, this can be achieved either by assuming an exogenous shift in the bilateral (A/US) spot rate, given domestic prices (measured by the CPI) or equivalently by assuming an exogenous shift in the CPI, given the nominal spot rate. The simulation experiment described here is undertaken on the assumption that the Australian dollar depreciates by 10 percent against the U.S. dollar with the bilateral exchange rates of all other currencies against the Australian dollar held constant. Real wages in each sector are assumed to be endogenous. 2/ It is also assumed that the markets for each of the model's nine types of labor are slack at the going wage rate (i.e., there is less-than-full employment) and that export subsidies, tariff rates, industry-specific capital stocks, aggregate real domestic absorption (aggregate consumption, investment and government spending), and foreign prices are exogenous.

Before discussing the results of the simulation, it is useful to describe briefly the main characteristics of some key industries of the productive structure of the Australian economy. Table 2 classifies the key industries by four main characteristics: share of industrial output in total gross output, degree of export orientation and import competitiveness, cost structure and sales pattern. As shown in Table 2, the traded goods sector in Australia is made up primarily of the agricultural and mining industries. Within the traded goods sector, industries have been grouped into three main categories: exporting, export-related and import-competing. 3/ Industries classified as exporting industries are those in which exports form a significant proportion of aggregate industrial output. The industries falling into this category include the wheat/sheep zone, food products and mining industries in which exports make up between 40-75 percent of total output. Export-related industries are defined as

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1/ The Orani short run has been estimated to be about 1 1/2 to 2 years (see Cooper and McLaren (1983)).

2/ Real wage costs are defined as the costs of employing a unit of labor deflated by the CPI.

3/ Except for the trade category, classification is based upon the input-output tables (1974-75).

Table 2. Structural Characteristics of Some Key Industries in the Australian Productive Sector

Industry	Gross Domestic Output by Industry as Percent of Total Gross Domestic Production by all Industries	Wage Costs as Percent of Gross Domestic Production by all Industries	Exports as Percent of Gross Domestic Production by all Industries	Trade Classification 1/	Final Private Consumption as Percent of Gross Domestic Output by all Industries
Cereal Grains	1.3	6.1	74.9	E	1.1
Sheep	0.9	12.6	51.8	E	1.1
Basic iron and steel	1.5	24.7	18.2	E	0.1
Food products n.e.c. 2/	1.4	10.9	40.8	E	23.7
Other basic metals	2.2	13.4	44.3	E	0.6
Coal	1.2	19.8	47.6	E	0.8
Other metallic minerals	0.9	26.5	34.3	E	—
Fishing	0.1	25.5	47.4	E	27.7
Meat cattle	0.3	11.6	0.7	ER	1.6
Other farming exports	0.8	12.3	4.9	ER	28.2
Agricultural machinery	0.2	40.6	12.4	IC ER	0.1
Furniture	0.5	31.1	0.5	IC	66.7
Sheet metal products	0.6	29.4	0.9	IC	2.3
Building n.e.c. 2/	7.1	34.7	—	NT	—
Ready-mixed concrete	0.2	10.3	—	NT	—
Retail trade	3.1	40.9	0.03	NT	90.8

Source: Australian National Accounts Input-Output Tables 1974-75, Australian Bureau of Statistics, Canberra, 1980.

1/ IC = import-competing, NT = non-traded, ER = export-related, E = exporting.
2/ n.e.c. = not elsewhere classified.

those industries producing commodities which are not exported directly but which are sold largely to export industries. The remaining agricultural industries fall within this group. The import-competing industries are defined as those industries which sell in markets where the level of import penetration is significant and in which exports and imports are close substitutes. Agricultural machinery, furniture, and metal products fall within this group. Non trading industries are classified as all the remaining industries which are not directly linked to international trade. The main industries falling into this group are construction-related and retail trade in which exports are a negligible component of output.

The cost structures of the traded and nontraded sectors also differ considerably. Exporting and export-related industries in general, and agricultural industries in particular, tend to have a lower proportion of wage costs as a percent of gross industrial output compared to the non-traded sector and import-competing industries. Table 2 also shows that there is considerable variation across industries with respect to sales. However, the most striking feature is the extremely high proportion of private household consumption as a percent of gross industrial output in the retail trade and furniture industries.

The chief mechanism generating the macroeconomic and sectoral effects in the Orani model in response to an exogenous change in the real exchange rate is the cost-price gap which is opened up in the export sector. Industries specializing in the production of exports are assumed to face a highly elastic foreign demand curve and hence have little leeway to pass on cost increases or decreases. 1/ The fall in domestic prices relative to foreign prices that is the consequence of the assumed exchange rate change enables an expansion in the quantity of exports and a rise in their value (in foreign or domestic currency, since it is being assumed that the elasticities condition is met). At the same time, the rise in the relative price of imports reduces demand for them and induces a fall in their value. Assuming short-run diminishing returns to labor, there is a fall in the real wage and a rise in aggregate output and employment.

The simulated macroeconomic effects of the exogenous 10 percent exchange rate change are given in Table 3. Interpreting these results we can say, for example, that after about 2 years a sustained 10 percent real depreciation of the Australian dollar would cause real GNP and aggregate employment to be about 3.8 and 5.3 percent higher, respectively, than they would have been in the absence of the real depreciation. The model's standard neoclassical short-run assumption of fixed industry-specific capital stocks and diminishing returns to labor results in a projected

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1/ The average export demand elasticity assumed for export or export-related industries is about 16.0. The export demand elasticities vary from 1.3 (wool), 12.5 (wheat) to 20.0 (coal, basic iron and steel, other basic metals, food productions, other metallic minerals).

Table 3. Orani Model: Simulated Macroeconomic Effects of a 10 Percent Real Devaluation of the Australian Dollar Against the U.S. Dollar

Variable	Simulated Change 1/	Percent of Employment
	(Percentage change)	
Aggregate employment (hours)	5.3	
Employment by occupation (labor hours): 2/		
Professional white collar	2.9	4.0
Other skilled white collar	3.6	13.0
Semi- and underskilled white collar	3.7	27.0
Skilled blue collar (metal and electrical)	6.8	10.0
Skilled blue collar (building)	2.4	4.0
Skilled blue collar (other)	7.1	3.0
Semi- and unskilled blue collar	5.8	30.0
Rural workers	17.1	6.0
Armed services	0	2.0
Balance of trade (in billions of 1974-75 Australian dollars)	1.9	
GNP	3.9	
Real wage	-5.9	

Source: All simulations were conducted using Orani 1978 and 1974/75 Input-output data.

1/ All simulations are percentage changes except for the balance of trade which is in billions of 1974/75 Australian dollars.

2/ All the occupational employment results are projections of percentage changes in the demand for labor hours. In referring to them as changes in employment, it is assumed that all labor demands are satisfied. Because Orani works in labor hours at the occupational level, additional assumptions concerning changes in hours per worker are required for Orani employment projections to be converted into projections of changes in numbers employed. The aggregate employment index is computed using person weights which are given in the last column of Table 3. It should be interpreted as the percentage change in the aggregate employment of persons assuming that average hours worked per person remains constant.

increase in aggregate employment greater than that of output and hence an implied fall in average labor productivity. The merchandise trade surplus is also higher by $A1.92 billion (in 1974/75 prices) than it would otherwise have been which is equivalent to a gain of about 22 percent of export revenue. Table 3 also shows the projected increase in employment by occupation. Rural workers benefit most, since this occupation is primarily export-related. In contrast, the smallest rise in employment is experienced by skilled blue-collar workers because of the resulting contraction in the construction industries.

The simulation results for output and employment in specific industries are given in Table 4. The expansion of GNP represents an average output response across all industries. The actual response of particular industries depends upon several important industry characteristics, including the degree of export orientation (and import competitiveness), sales patterns and cost structure discussed earlier.

As might be expected, the most striking feature of Table 4 is the large positive output and employment response to the real exchange rate depreciation experienced by the traded goods sector relative to the non traded sector. For example, agricultural industries experience the greatest expansion within the traded goods sector. Within the agricultural sector, differences in industry output effects are due mainly to labor intensity. In Australia, farming in high rainfall regions and other export-oriented farming industries are more labor intensive than agriculture on average and hence any change in wages tends to have a greater effect upon costs. Within the export-related group of industries, those export industries which rely more on traded inputs (such as agricultural machinery) face relatively higher costs as a result of a real exchange rate depreciation, and hence are stimulated less by it (relative to other export industries). Although not part of the industry group which experiences the greatest expansion, import-competing industries such as agricultural machinery also experience an increase in industry output above the average economy-wide increase in GNP.

Those industries that experience output contraction or very small output rises are those which are nontraded with relatively inelastic demand curves and which sell almost all their output to household consumption such as retail trade, furniture and building. Construction industries also experience adverse effects mainly owing to the fact that the output of construction industries is absorbed into capital formation in the owner-occupied dwellings, for which investment is assumed to be held constant. Further, capital formation in the export sector is less construction-intensive than overall investment. Finally, the output of those industries with the highest capital intensity, such as iron and steel, is less affected in the short run than industries such as coal with

Table 4. Orani Model: Simulated Effects of an Exogenous 10 Percent Real Depreciation on Industry Outputs and Employment (Percentage Difference from Control Simulation)

Industry	Industry Output (gross)	Industry Employment (persons)
Northern beef 1/	32.9	48.0
High rainfall zone 1/	24.7	33.0
Other farming exports	15.1	24.0
Pastoral 1/	16.9	25.0
Wheat/sheep zone 1/	10.5	20.0
Basic iron and steel	23.0	30.0
Food products n.e.c.	20.0	32.0
Other basic metals	18.9	29.0
Coal	11.3	23.0
Agricultural machinery	21.7	22.0
Other metallic minerals	10.8	23.0
Fishing	4.8	7.0
Building n.e.c.	-0.4	-0.5
Ready mixed concrete	-0.2	-0.4
Retail trade	0.0	0.0
Furniture	0.8	0.9
Sheet metal	1.8	2.1

Source: As in Table 3.

1/ The Pastoral zone, the wheat/sheep zone and high rainfall zones are modelled as multiproduct industries in the Orani model, producing in total nine separate commodities. These three zonal industries are geographically defined, aggregating enterprises faced with similar climactic and technological conditions. Northern beef is also geographically defined.

a lower capital intensity, for the obvious reason that capital-intensive industries cannot expand output as easily by employing additional labor. 1/

2. Endogenous real exchange rate

In the simulation experiment that was described above the shift in the real exchange rate was imposed on the model as an exogenous shock. However, it is more realistic to relax this assumption and allow the real exchange rate to be an endogenous variable that responds to both economic policy developments and other types of real and financial shocks. In the experiments, we assume the following set of permanent structural shocks or policy changes: an across-the-board reduction in nominal rates of protection in the import-competing sector, a reduction in real hourly wage rates and an increase in real aggregate domestic absorption. Since the Orani model does not specify the monetary sector, the effects of unanticipated monetary disturbances on the real exchange rate cannot be analyzed. With full wage indexation, a depreciation of the nominal exchange rate increases the CPI and nominal wages proportionately, leaving the real exchange rate (and all real variables) unchanged. An endogenous real exchange rate change can be simulated by an exogenous change in the nominal exchange rate assuming partial wage indexation, which is equivalent to a given exogenous shift in the real wage rate.

The choice of these shocks reflects important elements of recent debates about macroeconomic policy in Australia and, in particular, the effectiveness of alternative approaches to reducing Australia's major short-run problem--high unemployment. 2/ One of the main policy recommendations derived from earlier work on the Orani model was that the key to Australian macroeconomic recovery lay in downward flexibility of real wage costs. 3/ In the absence of reductions in real costs, an expansionary

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1/ A study by Deardoff and Stern (1982) has examined the macroeconomic and sectoral effects of the 6.9 percent real effective appreciation of the U.S. dollar which occurred over the period 1980:2/1981:2 using the Michigan disaggregated input-output model of world production and trade. After two years, the sectoral industry employment effects within the U.S. economy are the reverse of those given for Australia with an average percentage gain in industry employment for the nontradable sector of 0.1 percent and an average percentage fall within the traded sector of 2.2 percent. Aggregate U.S. employment is shown to fall by 0.5 percent. The real effective appreciation of the U.S. dollar (measured by CPI indexes) has been about 47 percent from its low level in 1980 to the fourth quarter of 1984. Thus, it would appear that the sectoral effects have been considerable.

2/ The shocks are similar to those described in the earlier Orani literature (Dixon and Powell (1979) and, more recently in Dixon, Parmenter, and Powell (1982)).

3/ See Dixon and Powell (1979).

demand management policy tends to exercise little stimulative effect on aggregate output and employment in Orani simulations, but adds to inflationary pressure. Similarly, protectionism also increases the domestic price level while redistributing unemployment among industries.

Table 5 shows the simulated effects of the above structural shocks upon the real exchange rate, aggregate employment, and the balance of trade. All the experiments were carried out assuming an exogenous real wage and real domestic absorption (the other assumptions are similar to those used in the first experiment). It is clear from Table 5 that the three structural shifts exercise rather different effects on their respective targets. A detailed discussion of the reasons, which arise from the different initial price effect and differing magnitudes of the wage-price spiral and the link with the production sector in the case of real absorption, is given in Dixon, Parmenter, and Powell (1982).

Because of the wage-price spiral, in all cases the structural shocks magnify the initial effect on the real exchange rate (the CPI, given the nominal exchange rate). Falls in the domestic prices of imported commodities and the prices of all categories of labor reduce the CPI directly. These shocks also lower domestic production costs and the selling prices of domestically produced commodities and hence result in further indirect falls in the CPI. Because nominal wages are indexed to the CPI, the wage-price spiral results in a magnified projected fall in the CPI. The increase in domestic absorption is projected to raise output, especially in the nontraded sector in which cost increases can be passed on in the form of price increases. Since it is assumed that capital is industry-specific and is held fixed in the short run, the upward-sloping industry supply curves result in an initial rise in the CPI (a real appreciation) which is amplified in a wage-price spiral. It is also worth noting that a fairly large tariff change is required to induce real exchange rate movements, for example, a 25 percent reduction in all tariffs induces only a 2.25 percent real depreciation. 1/

While a more expansionary demand management policy increases output and employment, these benefits are achieved at the cost of an increase in inflation and a deterioration in the trade balance. Although the real wage is assumed fixed in the absorption experiment, some limited opportunities exist for improvement in price/cost ratios because of assumed imperfect substitutability between domestic and foreign goods. The increase is aggregate demand raises the price of domestic goods relative to foreign goods. Since the increase in aggregate demand benefits those

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1/ Ad valorem tariff rates on protected industries in Australia lie within the range 5-54 percent. For example, a 25 percent reduction in the tariff rate on a commodity with an initial base-period value for its ad valorem tariff rate of 42 percent increases its tariff by about 0.11 (7 percent) from 0.42 to 0.53.

Table 5. Simulated Effects of Various Policies on the Real Exchange Rate, Aggregate Employment, and the Balance of Trade in Australia 1/

Target	One percent tariff reductions (I)	One percent increase in all real absorption (II)	One percent reduction in real wage (III)	Policy package which achieves unchanged real exchange rate and 5% rise in aggregate employment 2/ (IV)	Policy package which achieves unchanged trade balance and 5% rise in aggregate employment 3/ (V)	Policy package which achieves 5% real depreciation and 5% rise in aggregate employment 4/ (VI)
Real exchange rate 5/	-0.1	2.2	-1.7	0.0	-0.2	-5.0
Aggregate employment (hours)	0.0	0.2	0.9	5.0	5.0	5.0
Balance of trade		-0.4	0.3	-0.1	0.0	0.9

Source: As in Tables 3 and 4.

1/ All policy projections are percentage changes except the balance of trade which is in billions of 1974/75 Australian dollars. Projections are based on 1974/75 Input-output tables.
2/ This would require a 3.8 percent increase in real domestic absorption plus a 4.9 percent cut in real wages.
3/ This would require a 3.7 percent increase in real domestic absorption plus a 4.9 percent cut in real wages.
4/ This would require a 1.8 percent increase in real domestic absorption plus a 5 percent cut in real wages.
5/ Negative sign represents a depreciation in the real value of the Australian dollars.

industries where cost rises can be easily passed into higher prices, it harms export industries facing intense import competition. Cuts in real wages have opposite sectoral effects and are most beneficial to export industries.

Suppose the policy target is an unchanged real exchange rate and, consistent with previous Orani model experiments, the authorities attempt to achieve a 5 percent rise in aggregate employment. The required combination of a 3.8 percent increase in real absorption and a 4.9 percent cut in real wages is given in column (IV). 1/ The negative effect of the rise in domestic absorption on the trade balance slightly outweighs the positive effect of the real wage reduction, resulting in a deterioration in the balance of trade of about $A0.1 billion (1974/75 Australian dollars) which is equivalent to a loss of about 1 percent of export revenue. Alternatively, if the external target is a zero change in the balance of trade with the above employment target, the required policy mix is now a 3.7 percent increase in real absorption combined with a 4.9 percent cut in the real wage as given in column (V). The net "cost" of the two policies is a small real depreciation of about 0.2 percent which as shown earlier tends to benefit certain industries within the traded sector while adversely affecting nontradables.

In terms of the earlier analysis, the authorities may wish to achieve a given real depreciation of the exchange rate, assuming the same employment target. Column VI gives the required combination of an increase in real absorption and reduction in real wages that would achieve a 5 percent real depreciation of the exchange rate and a 5 percent increase in aggregate employment. 2/ To achieve a 5 percent real depreciation and a

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1/ Column IV is derived from columns II and III by computing:

Column IV = 3.8 x Column II + 4.9 x Column III.

The coefficients 3.8 and 4.9 were derived from the two-instrument, two-target problem:

$0.2x_1 + 0.9x_2 = 5$ (5 percent rise in employment)
$2.2x_1 - 1.7x_2 = 0$ (zero change in real exchange rate)

where x_1 = percentage change in real absorption and x_2 = percentage change in real wage. Columns V and VI were derived in a similar manner where:

$0.2x_1 + 0.9x_2 = 5$ (5 percent rise in employment)
$-0.4x_1 + 0.3x_2 = 0$ (zero change in trade balance)
and $0.2x_1 + 0.9x_2 = 5$ (5 percent rise in employment)
$2.2x_1 - 1.7x_2 = 5$ (-5 percent real exchange rate depreciation)

2/ The Orani model does not offer any guidance as to how this package could be achieved. However, Corden and Dixon (1980) show how this package could be achieved by a wage-tax bargain whereby trade unions agree to fixed post-tax real wages. The government would reduce the costs of employing labor (pre-tax wages) by reducing income taxes which, in turn would increase aggregate demand. Such an incomes policy was followed in 1982/84 by the Labor Government in Australia.

5 percent increase in aggregate employment requires a smaller rise in domestic absorption and a larger cut in real wage costs. Since the effect of the reduction in real wages in inducing a trade surplus outweighs the effect of the increase in domestic absorption in inducing a trade deficit, the cost of the exchange rate protection policy is an improvement in the balance of trade which is equivalent to a gain of about 10 percent of export revenue.

In the theoretical model of Section III, only two sectors, a traded and a nontraded sector, and one relative price were distinguished. Orani is a multisectoral model which allows for many relative prices, including that between importables and exportables, tradables and nontradables, domestic and imported intermediate inputs, and between primary factors. In the theoretical model, it was also assumed that aggregate full employment was continually maintained, with sector output expansion in the traded sector being offset by a contraction in output in the nontraded sector. In contrast, in both simulation experiments, the assumption of slack labor markets permitted aggregate output and employment effects in addition to sectoral changes.

The second simulation experiment also demonstrates the important point that the underlying cause of the real exchange rate depreciation influences the sectoral and macroeconomic effects of the real exchange rate change. For example, in the Orani model, a 0.5 percent increase in real domestic absorption and a 0.6 percent reduction in real wage costs will both induce a 1 percent real exchange rate depreciation, but the reduction in real wages induces a greater projected rise in output in the traded goods sector. The first simulation experiment in which the real exchange rate is assumed exogenous and the real wage endogenous (with real domestic absorption exogenous) is equivalent in its sectoral and macroeconomic effects to one in which the 10 percent real exchange rate depreciation is achieved via a 6 percent cut in real wages. The reduction in real wages could in turn be achieved via a nominal exchange rate depreciation with partial wage indexation or a cut in nominal wages with a fixed nominal exchange rate. Traditionally, governments have preferred to attempt to manage the nominal exchange rate (with an accompanying incomes policy) as a means of achieving a reduction in real wages and a real exchange rate depreciation.

It is important to reiterate that the results of both the simulation experiments described above are based upon the set of specific assumptions underlying the Orani model. In particular, three key assumptions relate to an elastic labor supply at any given real wage, upward-sloping industry supply curves, and highly elastic demand curves of export industries.

Alternative assumptions relating to demand and supply elasticity parameters will affect quantitatively the projections and dimensions of the policy packages. For example, if it is assumed that capital services and labor are infinitely elastic in the short run, non-agricultural industries will have horizontal short-run supply curves. An increase in aggregate absorption will induce a larger output increase, and smaller rise in the CPI index (smaller real depreciation), and a smaller deterioration in the trade balance. If smaller export elasticities of demand are assumed, the fall in real wages (and real depreciation) will be less effective in improving the trade balance and the resulting output and employment effects will be weaker. 1/

IV. Conclusions

The main objective of this paper has been to study the macroeconomic and sectoral effects of changes in real exchange rates, given the structural characteristics of the Australian economy. The discussion also focused attention on "exchange rate protection" policies which attempt to control the real exchange rate in order to increase output and employment in the tradable goods sector.

By simulating an exogenous 10 percent real devaluation of the Australian dollar against the U.S. dollar within the Orani input-output model of the Australian economy, the likely order of magnitude of the sectoral and macroeconomic effects of the recent real depreciation of the Australian dollar against the U.S. dollar can be assessed. In the paper, these sectoral effects and macroeconomic effects are shown to be quite large, resulting in a rise of aggregate employment of about 5 percent and an increase in real output of 4 percent. The industries which experienced the greatest expansion in output from the 10 percent real depreciation were the agricultural industries within the traded sector with an average increase in output of about 20 percent and increase in employment of about 30 percent. In contrast, the industries which experienced contractionary output effects were construction and services within the nontraded sector which suffered an average fall in industrial output of about 0.2 percent and in employment of about 0.3 percent. Since the Australian dollar has undergone a real bilateral depreciation of about 27 percent against the U.S. dollar over the past four years, the above results suggest that the industry and macroeconomic effects have been considerable and, as predicted, have operated in the direction of stimulating production and employment in the traded goods sector.

In the second simulation experiment, the real exchange rate was assumed to be an endogenous variable that responded to various structural

1/ A sensitivity analysis of Orani projections in the short run has shown that, in order to reverse the sign of the trade balance effects, export elasticities would need to be unrealistically very low, below unity. See Dixon, Parmenter, and Rimmer (1982).

shocks or policy changes. A simple two-target two-instrument policy simulation was carried out in which it was assumed that the authorities attempt to achieve an external balance target, an unchanged real exchange rate (or 5 percent real depreciation) and an internal balance target (a 5 percent increase in aggregate employment) by altering real wage costs and domestic absorption. The resulting macroeconomic cost of targeting the real exchange rate instead of zero trade balance ranged from a small trade deficit (targeting an unchanged real exchange rate) to a large trade surplus (targeting a 5 percent real depreciation). Assuming that the motive behind a policy of targeting the real exchange rate is to expand or maintain output in the traded sector, a policy of targeting the real exchange rate appears to be a rather blunt-edged instrument, since it affects both lagging and expanding industries within the traded goods sector. As noted earlier, on strict welfare criteria a first-best solution would be to subsidize those particular industries. However, additional criteria, including fear of retaliation from other countries and the greater flexibility afforded by management of the exchange rate, may make an exchange rate protection policy an attractive option to policymakers.

Theoretical Structure of the Orani Model 1/

Commodity and Factor Demands		
Domestic commodities for domestic use	$D = f_D(Z, C, P_1, P_2, Q_D)$	I.1
Imported commodities	$M = f_M(Z, C, P_1, P_2, Q_M)$	I.2
Export demand	$E = f_E(P_1^*, Q_E)$	I.3
Demands for primary factors	$L = f_L(Z, P_3, Q_L)$	I.4
Commodity Supplies	$Y = f_Y(Z, P_1, Q_Y)$	I.5
Pricing		
Production	$V(P_1, Q_V) = W(P_1, P_2, P_3, Q_W)$	I.6
Exports	$eP_1 = P_1^* S$	I.7
Imports	$eP_2 = P_2^* T$	I.8
Market Clearing		
Commodities	$D + E = Y$	I.9
Primary factors	$L = L^*$	I.10
Miscellaneous Equations		
Balance of trade	$B = P_1^* E - P_2^* M$	I.11
Consumer price index	$P = f_P(P_1, P_2)$	I.12
Wage indexation	$P_3 = f_{P3}(P, Q_{P3})$	I.13

1/ For a more detailed description see Parmenter and Meagher (1984), Dixon, Sutton and Vincent (1982).

Glossary of Variables

D	Vector of demands for domestically produced commodities
Z	Vector of activity levels for each industry
C	Vector of aggregate real absorption
P_1	Vector of local prices of domestic commodities
P_2	Vector of local prices of imported commodities
M	Vector of demands for imported commodities
E	Vector of exports
P_1^*	Vector of foreign currency prices for exports
P_2^*	Vector of foreign currency prices for imports
L	Vector of demands for primary factors
P_3	Vector of prices for primary factors
Y	Vector of commodity output levels
e	Exchange rate (US$/$A)
T	Vector of one plus ad valorem rates of protection
S	Vector of one plus ad valorem rates of export subsidy
L^*	Vector of factor employment levels
B	Balance of trade (US$)
P	Consumer price index
Q	Vector of shift variables

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