THE EFFECT OF EXCHANGE RATE CHANGES ON THE VALUE OF AUSTRALIA'S MAJOR AGRICULTURAL EXPORTS

W. Martin and I. Shaw
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SUMMARY

Estimates of the response of Australia’s major agricultural exports to devaluation taking into account the dynamic structure of production and demand, are reported in this paper. Although the EMABA model used in the analysis allows additional resources to be drawn into the sector, the aggregate supply elasticity is found to be relatively low. Expansion of export value is also constrained by relatively low export demand elasticities for some major products.

Following an hypothetical real devaluation by 10 percent, with all other factors remaining constant, it is estimated that the value of Australia’s major agricultural exports would increase by 9.6 percent in the first year. In subsequent years, the response would increase as volume adjustments occurred, leading to an increase of 12.6 percent after five years. Actual outcomes in particular time periods are likely to be influenced by a range of other changes such as the recent marked downturn in grain prices which are not included in the analysis.
THE EFFECT OF EXCHANGE RATE CHANGES ON THE VALUE OF AUSTRALIA'S MAJOR AGRICULTURAL EXPORTS

W. Martin and I. Shaw*

Agricultural products account for approximately 35 percent of total Australian exports. Depressed prices in many agricultural markets have contributed to the current account difficulties facing Australia and hence to the decline in the value of the Australian dollar. Thus, the agricultural sector has, on one hand, lost from the fall in commodity prices and, on the other, gained from the consequent devaluation.

A devaluation, if it leads to a sustained change in relative prices (Dornbusch 1975), can be expected to result in increases in the production of traded goods and a switching of domestic expenditure away from traded goods towards nontraded goods. The extent and timing of such shifts in production and expenditure have important implications for policy and for the behaviour of the foreign exchange market. Measurement of the likely response of the traded goods sector is complicated by the time lags involved in the response of flows of goods and services to exchange rate changes (Krueger 1983, p.39).

In this paper the effects of exchange rate changes on the value of Australia's major agricultural exports are assessed. Because of the strong interdependence between the major agricultural export industries in production, and the diverse nature of

* The authors wish to thank Joe Dewbre for helpful discussions and assistance in interpretation of the results, as well as colleagues at ANU and BAE for comments on earlier versions of this paper. Marti Pascall cheerfully did an excellent job at typing the manuscript a number of times.
the export markets for particular commodities, the analysis is undertaken using a large scale econometric model which incorporates the interactions between the major agricultural export industries (Dewbre, Shaw, Corra and Harris 1985). For several reasons, the empirical analysis deals only with the broadacre industries. Firstly, these industries supply approximately three quarters of total agricultural exports. Second, of the remaining agricultural industries, a number (e.g. dairy, sugar and rice) are likely to respond relatively little to exchange rate changes because of institutional and technical constraints on adjustment. Thirdly, the difficulties in obtaining a satisfactory aggregate representation of the remaining, diverse, rural export industries are likely to be substantial.1

In the next section, the main characteristics of Australia's major agricultural export industries are reviewed as a basis for the subsequent analysis of exchange rate responsiveness. Then, in the third section, the channels by which exchange rate changes affect the level and price of agricultural exports are considered and the resulting issues in modelling exchange rate effects are discussed. The broad structure of the model and the approach used for the empirical analysis are set out in the fourth section. The results of the analysis are presented in the fifth section. Concluding comments are presented in the final section.

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1 It should be emphasised that the ceteris paribus estimates of the effects of exchange rate changes obtained from an analysis of this type are considerably different from a forecast taking into account all developments in a particular time period.
Structure of Australia's Major Agricultural Export Industries

The key features of an industry which are relevant in determining the impact of exchange rate changes are likely to be: (i) the extent to which price changes resulting from exchange rate changes are transmitted to producers and consumers; (ii) the responsiveness of domestic demand and supply to price changes, and (iii) the responsiveness of export demand to price changes. These broad features are now briefly surveyed for the major broadacre industries: wool, wheat and beef.

A common feature of the industries under consideration is their relatively direct exposure to international commodity market prices, which generally appear to be considerably more flexible than consumer prices (Røttemborg 1982; Chalfant, Love, Rausser and Stamoulis 1986). Thus delays in the transmission of price changes resulting from exchange rate changes are likely to be less important in agriculture than in manufacturing where they have received considerable attention (Johns 1986).

Wool prices are formed largely in Australian auction markets which respond rapidly to all available information on the international outlook for supply and demand. Wool production appears to respond significantly to price, with lags primarily reflecting biological constraints in the industry (Dewbre et al 1985, p.24). Wool is strongly interdependent in production with the other broadacre industries, competing strongly with cattle and cropping activities for land and other resources. Since a very high proportion of Australian wool is exported, there is very little response through changes in domestic consumption, although stock demand by the Australian Wool Corporation is highly price responsive. On the demand side, Australia is a large supplier on world wool markets and hence can clearly influence the price of wool. Because of the size of Australia's exports, and the substantial differences between Australian wool and wool
from many other suppliers, such as New Zealand, the elasticity of demand for Australian wool appears to be relatively low in the short term (Haszler, Martin and Vlastuin 1985). The elasticity of export demand seems likely to be considerably higher in the longer term, once adjustment in overseas production is allowed for (Freebairn 1978, p.78).

For wheat, world prices are now transmitted relatively directly to Australian producers and consumers, even though export wheat marketing is the responsibility of a single statutory authority - the Australian Wheat Board (Ryan 1984). The price paid to growers is underwritten on the basis of a moving average of market prices, and such conditional price support will undoubtedly have an effect on producers' price expectations. However, government payments have been very infrequent (Ryan 1984) and hence would not be expected to have a major effect on producers' price expectations in most years. Further, assistance would be phased out relatively quickly in the event of a sustained downturn in prices. When the market price is low relative to the Guaranteed Minimum Price (GMP), however, the GMP will become more important in growers' decisions (Martin and Urban 1984) and may reduce the short-term importance of exchange rate induced changes in output price for supply response.

The prices of wheat used domestically for stock feed and for human consumption are now also closely linked to export prices. Domestic consumption of wheat for food and feed averages only around 15 percent of production, and so the major long term impact of price changes on export supplies is likely to be through production adjustment. Production of wheat is influenced by returns from wheat production and from the range of crop and livestock activities with which it competes for resources.

Australia is frequently regarded as close to being a price taker in international markets for wheat (Watson 1984). While there are many barriers to trade in wheat, which
would generally tend to reduce the elasticity of export demand (Cronin 1979), Australia is a relatively small supplier on world markets, and price policy variables in the USA and the European Community play a major role in determining world grain prices (Chambers and Just 1981). Australian prices for wheat and coarse grains appear to be closely related to US prices for comparable grains (Perkins, Sniekers and Geldard 1984; Foster and Geldard 1985). Despite this, there may be some differences in prices actually achieved in some markets, particularly those involved in the current trade "war" between the US and EC in which levels of export subsidies vary between markets. Thus, the export demand curve may have a slight downward slope, as suggested by Freebairn (1983), although the elasticity of export demand is likely to be sufficiently large to make little difference in analyses of devaluation responses.

The beef industry is relatively directly exposed to international prices, with relatively little domestic intervention affecting output price. Production and consumption are strongly influenced by own price and the prices of a number of substitutes, including some (e.g. pork and chicken meat) which are essentially non-traded, as well as the extensively traded broadacre commodities. An important feature of these industries is the capital-good nature of livestock, which can result in negative short term supply response. Export supply is more likely to behave "normally" than production as domestic consumption accounts for approximately half of Australian beef production and reacts relatively quickly to price changes.

It seems unlikely that Australia can satisfactorily be viewed as a price taker for beef, even though Australian production is less than 3% of world production. World trade in beef is strongly segmented by differences in product quality and by quarantine and trade barriers. In recent years, almost all of Australia's exports have been directed to the foot and mouth disease free markets of the Pacific Basin in which quantitative controls on
imports are particularly prevalent (Martin and Porter 1985). This trading region is dominated by the United States in which quantitative restrictions have been a binding constraint in fewer than half the years since their introduction in 1965.

Given the brief sketch of the major agricultural industries provided above, it is possible to consider qualitatively the likely effects of a devaluation. For all export industries, one effect of a devaluation of the domestic currency will be to shift the demand curve for output upwards, and hence to increase the domestic currency price. Quantities exported are likely to increase rapidly for wool and wheat, for which stockholding is relatively important, while short term supply response is likely to be small or even negative for the meat industries. Gains in revenue from wool are likely to be substantially reduced because of the low short-run elasticity of demand for Australian exports, while wheat revenues should be much less adversely affected since the elasticity of export demand for wheat is likely to be much higher. Increasing prices in at least some agricultural industries will intensify inter-industry competition and counteract the stimulus to output from rising own-product prices. The final result is likely to be a moderate expansion in the size of the sector, with relatively large increases in industries such as wheat which appear to face a high elasticity of export demand.

Modelling the Effects of Exchange Rate Changes

The analysis reported in this paper is for a ceteris paribus change in the exchange rate which is assumed to be exogenous to the rural sector. In a recent paper, Dixon and Johnson (1986) have emphasised the fact that the exchange rate is endogenous to the economy and questioned its use in explaining trade performance. In fact, however, the exchange rate is endogenous to the complete macroeconomic system involving both goods and assets markets (Murphy 1986), and not just the goods market
considered by Dixon and Johnson. Thus some real exchange rate changes might be viewed as largely exogenous to the goods market.

Even where the current account is the most important determinant of exchange rate changes, the exchange rate can only be viewed as exogenous to any particular sector, since it is the behaviour of the current account in total which influences the value of the exchange rate. Where changes in the demand for or supply of a particular commodity have also occurred as well as an exchange rate change in some particular time period, then the influence of these exogenous changes on trade performance can be considered separately. In this paper, the focus is on the effects of exchange rate changes.

In exchange rate models of the Mundell-Fleming type (Krugman 1983), the goods market equation is of the general form:

\[ Y = C(Y, r) + I(r) + G + \text{BOT}(E^* / P, Y) \] (1)

where

\[ Y \] = domestic output expressed in units of domestic currency

\[ I \] = investment demand

\[ C \] = consumption by residents

\[ r \] = the domestic rate of interest

\[ G \] = government expenditure

\[ \text{BOT} \] = the balance of trade expressed in units of the domestic good

\[ E \] = the exchange rate in units of domestic currency per unit of foreign currency

\[ P \] = the price of the domestic good

and \[ P^* \] = the price of the foreign good.
Changes in the relative price term (EP*/P) in equation (1) result in expenditure switching between domestic and foreign traded goods, and between traded and nontraded goods. In a disaggregated model, P and P* are vectors of prices and the present analysis deals only with only the effects of changes in E on the prices of agricultural export commodities within the P and P* vectors. Any impacts of exchange rate changes through Y are not considered, since such impacts would require a model of the entire economy and would in any event depend on the magnitude of the expenditure switching effects under study. Further, direct income effects are likely to be relatively minor for agricultural products since only a small proportion of the major agricultural commodities is consumed domestically.

Equation (1) makes clear the identity between the trade balance and the gap between income and absorption. From (1) \[ Y - A = BOT \] \[ (2) \]
where A = C + I + G = absorption. Equation (2) highlights the fact that changes in both absorption and expenditure switching may be necessary to reach equilibrium. As Dornbusch (1975) has demonstrated, a reduction in A relative to Y will need to be brought about for a devaluation to have a sustained effect on relative prices. Assuming that a change in relative prices is achieved, then the extent and timing of expenditure switching will depend upon the ability of producers and consumers to switch production and consumption in response to the change in relative prices.

Since the breakdown of the fixed exchange rate system in the early 1970s, considerable attention has been given to analysing the effects of exchange rate changes on the agricultural sector. Many of the initial attempts treated the exchange rate as having an effect only on the output price of the industry under consideration. Chambers and Just (1979) pointed out that this approach could be extremely misleading because it
ignores the effects of exchange rate changes on other traded goods. To overcome this problem, they suggested (1979, p.255) that concepts of separability be used to aggregate commodities into groups, and that indexes for "all other" traded commodities, and all nontraded commodities, as well as of the price of the good in question, should appear in the behavioural equations. They noted that this approach suffers from the difficulty that the baskets of goods used in computing the generally available price indexes are generally not delineated between traded and nontraded goods.

As a more pragmatic alternative to the derivation of traded/nontraded price indexes, Chambers and Just (1979) suggested the use of the exchange rate as a price index for all other traded goods, and this suggestion has been implemented in a number of studies (e.g. Chambers and Just 1981). A difficulty with this approach is that it involves introducing a nominal variable, the exchange rate, into models which are otherwise specified in real terms. If the country under consideration is running a higher rate of inflation than its trading partners, its nominal exchange rate would be expected to depreciate over time even if the domestic ratio of traded to nontraded goods prices remained constant. However, a model incorporating a nominal exchange rate variable would treat such a neutral depreciation as causing real price changes.

As Dornbusch (1975) has emphasised, any analysis of trade volume effects using an elasticities approach must take as exogenous some price level within the economy. In his theoretical analysis, Dornbusch chose to treat the price of nontraded goods as held constant by fiscal or monetary policy operating in the background. In an empirical analysis, the price of nontraded goods is difficult to observe and so difficult to utilise as an exogenous variable. Further, it seems likely that the general price level, rather than the price of nontraded goods, would be a target for fiscal and monetary policy, and hence would logically be viewed as exogenous to a sectoral model. Use of a general
price deflator such as the Consumer Price Index as an exogenous variable is consistent with the approach usually adopted in the formulation of real exchange rate indexes (O'Mara, Carland and Campbell 1990).

The analysis reported in this paper was undertaken treating the CPI and other, enterprise-specific, cost indexes appearing in the model as exogenous. This approach would be appropriate only if these indexes responded to the same degree to changes in the exchange rate, i.e. if the "intensity" of traded and nontraded goods in the indexes did not differ. This proposition was examined (see Appendix A) and the hypothesis of no difference in traded goods intensity was not rejected.

Even though the CPI can reasonably be viewed as exogenous to the sector, it is unlikely to remain constant over time. As long as the behavioural equations of the model are homogeneous of degree zero in prices and income, and all nontraded goods appearing in the model are incorporated in the CPI or other exogenous indexes, then the real effect of a devaluation can be estimated by adjusting changes in the nominal exchange rate by the differential between domestic and foreign rates of inflation. This is illustrated for a simple model in Appendix B.

If it is believed that a devaluation will affect the CPI either directly or through its effects on wages and other factor returns, then ex ante evaluation of the effect of a nominal devaluation will require estimation of its effects on the CPI. The real devaluation will then be equal to the nominal devaluation less the induced increase in the CPI. Direct approaches to estimating the effects of exchange rate changes on the CPI have been used by Department of the Treasury (1985), Dixon and McDonald (1985) and Katseli-Papaefstratiou (1979). An alternative might be to begin from the exogenous disturbance which causes an exchange rate change, and compare the magnitude of the
change in the nominal exchange rate and the CPI (Lim and Parmenter 1985).

The Model and the Experiment

The analysis reported in the study was based on a simulation experiment conducted with a modified version of the EMABA (Econometric Model of Australian Broadacre Agriculture) model developed at the Bureau of Agricultural Economics. A general overview of the model is given in Dewbre et al. (1985), while full details of the equations of the model are presented in Harris, Corra, Shaw and Dewbre (1985). Since the technical documentation of the model was completed (Harris et al. 1985), a major effort has been made in modelling world trade in wool. In addition, there has been further development of the model's representation of export demand for beef and lamb. The details of all changes made to the model since its documentation are available from the authors.

The model incorporates dynamic annual, industry-level determination of market supply, demand and price in the sheep, cattle and crops sectors of Australian agriculture. For wool and meat, the model includes a representation of foreign demand which explicitly incorporates product heterogeneity, barriers to trade and the dynamics of supply response by competing suppliers.

The supply module contains equations representing Australian production of six crop and five livestock commodities. These decisions are modelled on relative per hectare and per head net returns to crop and livestock commodity production, respectively. Since all output prices are deflated by appropriate cost indexes, the supply module exhibits homogeneity of degree zero in input and output prices. Areas planted to the endogenous crop supplies in the model (wheat, barley, oats, sorghum, winter
oilseeds and summer oilseeds) are modelled as the result of a hierarchical sequence of
land area allocation decisions. The total land area of agricultural land is initially
allocated between cropping and pasture. The cropping area is then allocated between
summer and winter cropping groups and finally amongst the individual crops.

In the standard version of EMABA (Dewbre et al. 1985), the total area of cultivated
land does not respond to the profitability of the agricultural sector. For this analysis, in
which aggregate supply response behaviour is of particular importance, the decision to
improve land for crops or improved pasture was explicitly modelled as a function of the
profitability of both crops and livestock enterprises. The estimated elasticity response of
cultivated land with respect to profitability in the broadacre industries as a whole was
estimated to be 0.32, allowing total output to expand in response to an increase in price
by more than in the standard version of the model.

The supply of livestock commodities (wool, wheat, beef, lamb and mutton)
depends predominantly on decisions about livestock slaughters, which influence the
dynamics of livestock inventories. The single most important decision affecting the two
outputs of the cattle system, beef and veal production and milk production, is the
slaughter of cows and heifers since breeding animals have alternative roles as a source
of current output and as an input to future production. The outputs of the sheep supply
system - wool, lamb and mutton production - are predominantly influenced by decisions
about adult sheep slaughter.

The medium term supply elasticities of the model for Australia are presented in
Table 1. These elasticities reflect the substantial possibilities for substitution between
enterprises, with positive own price elasticities, generally associated with somewhat
smaller negative cross price elasticities. As a result, the response of any individual
output is greater to an increase in its own price alone than to simultaneous increases in all output prices. Supply responses in the model are explicitly time dimensioned, with the nature of the response being affected by the inherent dynamics of adjustment in livestock enterprises and by lags in the adjustment of producer expectations. These dynamic elasticities are generally considerably smaller than those presented in Table 1, in the first two years and somewhat larger in the longer-term. The own price elasticity for beef in particular increases to 1.1 after ten years when inventory adjustment is largely complete. The own price elasticity for wool also increases to around 0.6 while other elasticities do not change greatly.

**TABLE 1: ESTIMATED SUPPLY RESPONSE AFTER 5 YEARS TO A 1% CHANGE IN THE PRODUCER PRICE OF**

<table>
<thead>
<tr>
<th></th>
<th>BEEF &amp; VEAL</th>
<th>LAMB</th>
<th>WOOL</th>
<th>WHEAT</th>
<th>BARLEY</th>
<th>OATS</th>
<th>SORGHUM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beef &amp; Veal</td>
<td>.45</td>
<td>-0.07</td>
<td>-0.21</td>
<td>-0.01</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Lamb</td>
<td>0</td>
<td>0.55</td>
<td>-0.29</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wool</td>
<td>-0.15</td>
<td>0.01</td>
<td>0.43</td>
<td>-0.17</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Wheat</td>
<td>-0.03</td>
<td>-0.01</td>
<td>-0.02</td>
<td>0.57</td>
<td>-0.08</td>
<td>-0.02</td>
<td>-0.04</td>
</tr>
<tr>
<td>Barley</td>
<td>-0.03</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.12</td>
<td>0.77</td>
<td>-0.02</td>
<td>-0.04</td>
</tr>
<tr>
<td>Oats</td>
<td>-0.03</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-0.24</td>
<td>-0.05</td>
<td>0.76</td>
<td>-0.04</td>
</tr>
<tr>
<td>Sorghum</td>
<td>-0.03</td>
<td>-0.01</td>
<td>-0.02</td>
<td>-2.0</td>
<td>-0.40</td>
<td>-0.08</td>
<td>1.80</td>
</tr>
</tbody>
</table>

Note: The cross price elasticities for the above livestock categories on wheat are also applicable to every particular crop category i.e. barley, oats, etc.

The supply elasticities of the model refer to the analytical short run in which some factors (particularly total land area and farm operator labour) are assumed constant. Most purchased factor inputs (such as hired labour, fertiliser, machinery and chemicals) are variable in the model (Dewbre et al. 1985, p.8). Thus, unlike some models of
Australia's multi-output agricultural sector (e.g. Powell and Gruen 1968), the model does allow for some overall expansion of the sector as increased prices of the traded commodities in the model draw resources other than land and operator labour into the sector.

The aggregate supply elasticity of the model for equal changes in the prices of all the commodities covered is 0.22 after five years, and reaches 0.3 after full adjustment. These estimates are comparable with the short-run estimates (after two years) reported by Pandey, Piggott and MacAulay (1982), and lower than their estimates of the long-run elasticity (0.6 to 1.0) at the end of their sample period (1975-76). The estimates obtained in this study also appear to be considerably lower than the constructed supply response estimates of 0.6 to 0.9 in the short run and 3.2 to 5.1 in the long run incorporated in ORANI (D. Vincent, IAC, personal communication).

The own and cross price elasticities from EMABA reported in Table 1 appear to be consistent with other estimates reported in the literature (Dewbre et al 1985, p.24). The system approach incorporated in EMABA utilises some of the restrictions from economic theory (e.g. homogeneity of degree zero in the behavioural functions) and explicitly takes account of the physical constraints on adjustment imposed by factors such as livestock inventory dynamics. These adjustment path constraints are of particular importance in an explicitly dynamic analysis such as the present one. Apart from the assumption that land and operator labour are fixed, there is no explicit restriction on aggregate supply response in the model. Thus, there is no obvious reason to expect the aggregate supply response estimate from the model to be biased downward. In fact, it seems difficult to reconcile the sets of own and cross price elasticities obtained from disaggregated studies (e.g. Wicks and Dillon 1978; Hall and Menz 1985) with aggregate supply elasticities as high as those obtained by Pandey, Piggott and MacAulay (1983), or the
long run estimates used in ORANI.

Unfortunately, attempts to obtain disaggregated estimates of the input side of the production technology (Vincent, Dixon and Powell 1980, p.229) appear to have experienced considerable difficulty. Given the absence of satisfactory evidence on the extent and timing of input substitution, there seems no clear reason to reject the directly estimated supply response elasticities of the type estimated in EMABA, especially since these are the only integrated set which explicitly represents the dynamic pattern of response. As emphasised by Colman (1983, p.226), however, an understanding of aggregate supply response is of profound importance and further work in this area would appear to be highly desirable.

In addition to the production response patterns depicted in Table 1, export supply is substantially affected by supply from stocks in the case of wool, wheat and barley. Supplies from Australian Wool Corporation stocks are specified as a function of market prices and the minimum reserve prices as well as of lagged stock levels (Dewbre et al. 1985, p.30). Stocks of grain were not included in the original model but, for the purposes of this analysis, were added using the price elasticity estimates reported by Spriggs (1979). Changes in domestic consumption of wheat, barley and sorghum were also added to the model, using the most recent available set of elasticity estimates for domestic consumption (Ryan 1981a,b,c; 1982a,b).

The demand side of the model includes equations representing domestic demand in Australia for six meats and for wool stockholding by the Australian Wool Corporation, and a system of trade equations which determine export demands for Australian beef, wool, lamb and mutton. Demand for grains is based on a price taker assumption using price transmission equations from relevant US grains prices.
The domestic meat demand system determines the consumption of beef, lamb, mutton, bacon and ham, pork and chicken as shares of the total domestic demand for meat. Export demand for Australian beef is represented within a system of beef trade equations which includes the determination of both US and New Zealand beef supplies, demands and prices. US beef supply is comprehensively modelled, taking into account the three inter-related US beef production systems, calf rearing, cattle feeding and non-fed cattle production. In addition, the impact of the US Meat Import Act of 1979 on US beef import levels is modelled on the basis of the "counter-cyclical" formulas contained in the legislation.

New Zealand beef supply is represented as a partial adjustment mechanism such that own price and cross price supply elasticities are constrained to be equal to those reported in Laing and Zwart (1983). A New Zealand meat demand system determines New Zealand demand for beef, lamb, mutton, chicken and pigmeat. The model also represents the demand for Australian beef in Japan, Taiwan, Singapore, Malaysia, Hong Kong, the Philippines and a 'rest of world' category. Domestic meat demand systems for both Taiwan and Japan - analogous to the Australian, US and New Zealand systems are also incorporated in the beef trade sub-model.

Export demand for Australian wool is determined by a system of wool trade equations which includes the determination of wool supply disappearance and price in New Zealand, South Africa, Argentina, Uruguay and a 'rest of world' category. In addition, the final product demand for wool is determined separately for the eight major wool consuming countries - Belgium, France, Germany, Italy, Netherlands, Japan, the UK and the USA, as well as a 'rest of world' category. Final product demand for wool is also based on a partial adjustment model, reflecting the influence of consumer habit persistence in consumption patterns. An individual wool-supplying country's share of
total final product wool demand is determined as a function of the price of that country’s wool relative to the weighted average wool price of all the other supplying countries.

Wool supply in New Zealand, South Africa, Argentina, Uruguay and the ‘rest of the world’ are all modelled in a partial adjustment framework. For New Zealand, the adjustment parameter is chosen to ensure that own and cross price elasticities are as reported in Laing and Zwart (1983). For all other suppliers the short run elasticity is constrained to 0.1 while a long run elasticity of unity is imposed.

Export demand for Australian lamb is represented as a share of total Australian and New Zealand lamb exports and is determined within the model according to the relative prices of lamb from these countries. In recognition of the importance of New Zealand in the world lamb trade, the model also contains a comprehensive representation of New Zealand lamb supply (Shaw 1986), demand and market price determination. The export demand for Australian mutton is represented by a single equation for exports to all countries.

The export elasticity of demand for Australian wheat and feed grains was assumed to be infinite for the purposes of this analysis. While this is something of an approximation, given that Australian grain is differentiated from foreign suppliers’ grain to some degree, it seems likely to be a reasonable approximation. Freebairn (1983) has suggested an export elasticity of demand for Australian wheat of -12.5 or larger, and it seems unlikely that an elasticity of this order of magnitude would give markedly different results from the price-taker assumption used for the type of experiment considered in this paper.
Export demand elasticities at the saleyard or farm level for the major livestock commodities are presented in Table 2. For wool, beef and lamb, these elasticities vary over time. The greatest change in export demand elasticities is evident for wool. In line with other studies of short-term demand for wool, the estimated elasticity of demand is very low after one year. Over time, however, the export responsiveness of demand increases substantially, as supplies from other countries become more price responsive and consumers adjust their behaviour. The relatively high elasticities for lamb and mutton reported in Table 2 reflect a fairly high degree of substitutability between Australian and New Zealand sheepmeat exports.

### TABLE 2: AUSTRALIAN FARM LEVEL EXPORT DEMAND ELASTICITIES\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>After 1 year</th>
<th>After 5 years</th>
<th>After 10 years</th>
</tr>
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<tbody>
<tr>
<td>Wool (greasy)</td>
<td>-0.31</td>
<td>-0.89</td>
<td>-1.20</td>
</tr>
<tr>
<td>Beef(^b)</td>
<td>-0.99</td>
<td>-1.05</td>
<td>-1.06</td>
</tr>
<tr>
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\(a\) These elasticities were calculated with respect to the principal market prices which link supply and demand. The corresponding elasticities would be higher with respect to changes in f.o.b. prices as discussed in the text.

\(b\) Based on the assumption that access levels to the USA are not constrained under the Meat Import Law.

The elasticity of export demand for beef reported in Table 2 is much lower than has been assumed in many earlier studies (e.g. Freebairn 1978). This primarily reflects...
the fact that Australia no longer supplies significant quantities of beef to the low priced but highly price responsive markets outside the Pacific Basin. Since the elasticities of demand for most markets in the Pacific Basin are zero because of binding import quotas, and the elasticity of demand for the small price-responsive residual sector of the market is less than infinite (the estimated value is -3.2 (Harris et al 1985, p.182)), the weighted average elasticity for small changes in export volumes is relatively low. When import restrictions in the US market are not binding, the elasticity of demand for Australian beef (1.7 with respect to Australian saleyard prices) is the most important source of price responsiveness. The aggregate elasticity of demand does not increase over time, as would normally be expected, because processing quality beef of the type supplied by Australia is a substitute for US domestic cow beef, the price of which is an important input cost in the US beef industry.

If Australia’s share of the US market is filled, the elasticity of demand for Australian beef in the US market drops to zero. Since this market accounts for around half of Australia’s exports, this reduces the aggregate elasticity of export demand considerably, to an estimated -0.22 at 1981-82 export levels. If Australia’s exports increased substantially above this level, the price would fall rapidly and the share of exports to the price responsive portion of the market would increase. The rising share of price responsive markets in the total would raise the share-weighted elasticity of total exports. If exports to the more price-responsive, but lower priced markets of the Atlantic Basin again became substantial, the overall elasticity of export demand for Australian beef could become substantially higher than at present, although it seems unlikely that it would be profitable to continue producing in that range.

The estimated export demand elasticities presented in Table 2 refer to changes in prices at the farm or auction levels at which prices are determined in EMABA (Dewbre et
al 1985). For this analysis, these prices were linked to the export unit value (BAE 1986, 193) by an additive margin reflecting handling, storage and processing costs prior to export. At the 1981-82 levels used in this experiment, this results in the export demand elasticities with respect to the export (f.o.b.) prices for wool, beef, mutton and lamb being higher by 7.5, 13.5, 63.5 and 29.5 percent respectively.

It should be emphasised that export demand elasticities reported in Table 2 are with respect to small price changes and rise as the producer price level rises relative to costs of processing, handling and shipping. While the elasticities as reported would be consistent with imposition of quite high optimal export taxes, it is likely that they would increase considerably if such a tax policy approach were adopted, making any gains considerably less than they would at first appear. However, the relatively low elasticities reported for wool and beef impose a constraint on the extent to which these industries are likely to expand following a devaluation.

The analysis was undertaken by first simulating the model with constant 1981-82 values for all exogenous variables until it reached a static equilibrium. This equilibrium solution then provided a stable "baseline" against which to compare the devaluation outcome. The experiment assumed an immediate, and sustained, reduction of 10 percent in the value of all the bilateral exchange rate variables (foreign currency per $A) appearing in the export demand equations of the model. The results from the perturbed simulation were compared with the stable baseline simulation to determine the magnitude of the effect in each year.

Given that the model was in equilibrium prior to perturbation, and the CPI and other relevant cost indexes were held constant, the nominal depreciation resulted in an equal real depreciation. As noted in Appendix B, the results refer to the effect of a
change in the real exchange rate brought about by, say, a nominal devaluation and a partially offsetting increase in the domestic CPI.

For the purposes of this analysis the US meat import 'trigger' level was set sufficiently high to ensure that restraints on Australian beef exports to the United States would not be invoked. Despite the existence of the US Meat Import Law, restraints have not been effective in most recent years. The sensitivity of the model to this assumption will be tested in subsequent analysis.

Although the model incorporates six crop and five livestock commodities which have important interactions in production, not all of these are significant in terms of exports. Of the six crops covered, wheat, barley and sorghum are important export commodities. Production of oats and summer and winter oilseeds is considerably more oriented towards the domestic market, with the result that domestic and export prices are not closely linked for much of the year, and these commodities are relatively minor exports. Given the minor nature of these exports and the paucity of satisfactory parameter estimates for domestic demand, it was decided not to include these items in the model. The remaining commodities (wheat, wool, beef, barley, mutton, lamb and live sheep) made up an estimated 73 percent of the total value of agricultural exports in 1985-86 (BAE 1986, p.193).

Results

The results of the simulation of a 10 percent devaluation of the Australian dollar are summarised in Table 3. For this experiment, all other exogenous variables were held constant, so that the resulting changes in nominal prices and export values are also real price changes. As well as the effect of the devaluation on the total value of exports from
the industries covered by the model, effects on production, producer price, export volume and export value are presented for individual commodities to illustrate the source of changes in the total. The results are presented for the initial five year period of greatest interest, and also for a ten year period to illustrate the extent of likely adjustment beyond the five year period.

The model corresponds to the analytical short-run in which land and farm operator labour are in fixed supply. If the incentive were sufficiently large and believed to be sufficiently long lasting, the effective levels of these factors may be significantly changed. Thus, the results presented for this model, even for the 10 year period, do not refer to the analytical long run. They do, however, allow the complex dynamics of livestock inventory adjustment and other dynamic phenomena incorporated in the model to approach a new equilibrium.

Interpretation of the experiment is relatively straightforward. If Australia were a price taker for the exports concerned, and if the quantities exported were unresponsive to price, then the effect of a 10 percent devaluation would be to raise the value of exports by 10 percent in the short run. In the longer term, the value of exports would be expected to increase further as the quantity exported responded to higher prices and, in some cases, export demand elasticities became more price responsive. For the experiment considered, a 10 percent increase in the value of exports thus provides a benchmark in any time period. The price effect of devaluation is also of interest. An increase of less than 10 percent in the price of any commodity would contribute to a worsening in Australia's measured terms of trade (Reserve Bank of Australia 1986) if Australia is a price taker in the market for its imports.
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1. Exogenously constrained.
2. All prices are at farm level for grains and auction level for livestock, as appearing in BAE (1986 p.197).
3. Expressed in Australian Dollars.
The variable of greatest interest in Table 3 is, of course, the change in Total Export Value. From the table, it is clear that the first-year effect of 9.6 percent is less than the 10 percent increase which would occur under our benchmark assumptions. Over time, the value of exports is estimated to increase as a consequence of volume increases and reallocations between commodities. In the second year, exports are 10.6 percent above their base level, slightly above the benchmark level of 10 percent. Export value continues to increase for roughly four years, reaching a maximum effect of around 12.7 percent in year four with a slight subsequent decline. In foreign currency terms, these changes range from a decrease of 0.4 percent in the first year to an increase of around 2.5 percent after four years.

Such a pattern of response is consistent with a J-curve phenomenon. Where the current account is initially in deficit, the 10 percent real increase in traded goods prices which is used as the benchmark in this analysis clearly results in an increase in the real current account deficit. Where components of exports increase by less than 10 percent, the current account deterioration will be exacerbated. Subsequent increases in the value of exports could potentially have marked effects on the current account deficit, because of its residual nature. However, only when the value of a particular category of exports increases by more than 10 percent will it, ceteris paribus, make a net contribution to improving the current account.

The increase in export value resulting from devaluation is primarily due to the direct price effect of the devaluation, with only a relatively small component attributable to subsequent volume effects. The main influences on this relatively small effect are the relatively low aggregate supply elasticity for agricultural products in the model, the relatively minor important of domestic consumption in the model, and the relatively low elasticity of export demand for some major products, particularly wool and beef.
effect of the relatively low elasticities of export demand is, however, partially offset by the scope for substitution between outputs.

In this case, it appears that the initial effect of a devaluation is to increase the value of exports by less than the extent of the depreciation, thus contributing to the initial deterioration of the current account. Only in the second year does the estimated effect on value exceed the benchmark of 10 percent and begin to contribute to a reduction in the current account deficit, other things remaining constant.

As might be expected, given the structural characteristics of each industry discussed in the second section of the paper, a devaluation appears to have markedly different effects on particular industries. The dynamic effects of the change are now examined for each of the industries.

Of the major industries, wheat benefits the most from a devaluation, since Australia is assumed to be essentially a price taker in this market. The effect of a devaluation on farm prices is estimated to be slightly more than proportionate, because the farm price is a residual after deduction of transport, handling and storage costs which do not respond directly to exchange rate changes. While the area of wheat sown does not respond in the first year, wheat exports increase immediately as a result of a reduction in stocks. The value of exports increases by over 60 percent more than the devaluation in the first year. In subsequent years, exports decline from this unsustainably high level, but remain above the baseline level because of higher production and reduced domestic consumption. Wheat plantings gradually expand in response to improved profitability relative to the other broadacre enterprises and to expansion of the sector as a whole. However, this expansion is relatively gradual and it is only in the fourth year that the export value of wheat exceeds its value in the first year.
Barley prices are assumed to rise slightly more than proportionately with the devaluation, and Australia is assumed to be a price taker in this market. As a consequence, barley plantings and production are therefore expected to increase gradually following devaluation. In contrast to wheat, however, domestic consumption of barley increases because of rising profitability of livestock feeding, and because of the rise in feed wheat prices. Barley exports therefore decline, despite increasing production, although the gradual increase in production reduces the extent of the decline in exports over time. The value of exports declines initially, but then eventually recovers back to above pre-devaluation levels by the third year.

Sorghum prices are estimated to increase by substantially less than wheat and barley prices, since Australian sorghum prices appear to be considerably less responsive than wheat and barley prices to the US price used as a benchmark in the model. Within the cropping system, this makes sorghum much less competitive than the other major grains. As a consequence, sorghum production declines. Domestic stockfeed consumption increases for similar reasons as for barley and, as a consequence, exports and export value decline substantially. The decline in export value for this commodity has relatively little effect on the overall results since sorghum accounted for only about 1.4 percent of the total value of agricultural exports in 1985/86 (BAE 1986 p.193).

Wool production does not respond to devaluation in the first year. However, exports increase as a consequence of reductions in stabilisation stocks. Because of the relatively inelastic demand for wool in the short term, prices decline by 8 percent in foreign currency, and increase by only a little over 2 percent in Australian currency. Thus, the increase in Australian export value is estimated to be only 5.0 percent in the first year. Since expectations are based on lagged prices in the model, this relatively small
increase in price, relative to other commodities, results in substitution away from wool production. Over the next few years, wool export demand becomes more elastic as importers and competing producers react to lower prices in their currencies. Strengthening overseas demand allows the rundown in stocks to continue and exports to rise for several years while prices continue to rise. The analysis presented here is based upon the assumption that the minimum reserve price is exogenous. The rate of stock rundown in the first few years following devaluation would be slower than estimated if the minimum reserve price were raised in response to the devaluation-induced increase in price. Eventually, these higher prices result in a small increase in production. The value of wool exports increases by only 4.5 percent in the first year, but then increases considerably more rapidly to a peak of almost 12 percent in the third year. It then begins to decline following a reduction in the volume of exports.

Lamb exports are only a small proportion of total lamb production, and this fact contributes to a relatively high elasticity of export supply. Further, the elasticity of export demand is reasonably high. Lamb exports are, therefore, able to rise substantially in percentage terms, despite static, or even declining, production. The rise of 5-6 percent in domestic market prices following the devaluation is substantial, given that exports were only around 10 percent of production, and reflects the relatively high elasticity of export demand relative to domestic demand. The value of lamb exports rises more than proportionately to the devaluation in all years, although this would have relatively little effect on the total value of exports since lamb contributes only around one percent of the total value of rural exports (BAE 1986, p.193).

Mutton prices are projected to increase by more than the actual devaluation, primarily because the costs of processing and handling this product are large relative to the farm level value. During the initial adjustment period, mutton supplies are increased
by a slight reduction in the sheep flock and reductions in lamb slaughter. In the final equilibrium, a slightly larger sheep flock and lower lamb production contribute to increases in mutton production and exports. Because of data deficiencies and structural changes in Middle East demand for live sheep, it has not been possible to model adequately the demand for Australian live sheep exports. As a consequence, live sheep exports were set exogenously in this experiment and the value of live sheep exports rises by exactly ten percent. This restriction contributes to the relatively large increase in slaughter of adult sheep and, hence, mutton supplies.

The response outlined in this section is dependent upon the assumption that beef exports to the USA are not constrained by import restrictions. If exports to this market were constrained then the elasticity of export demand facing Australia would be inelastic and beef production would be likely to decline, rather than increase in the long term, because of competition in production with industries facing more elastic demand. However, it is unlikely that this constraint would have a substantial, negative effect on the value of total exports. It would induce further substitution away from beef and allow a greater expansion of other industries.

Conclusions

The results of this study suggest that there are significant lags in the response of agricultural sector exports to changes in the exchange rate. It appears that, following a devaluation, the total value of Australia's major agricultural exports is likely to increase by slightly less than the magnitude of the devaluation, despite a substantial increase in the volume of wool and wheat exports from stocks. Only in the second and subsequent years is the real value of exports estimated to increase by more than the real amount of the depreciation. After five years, the effects of export volume increases and
reallocations between commodities are estimated to result in an increase in the real value of exports of 12.6 percent following a ten percent real devaluation.

Even at this peak, the estimated response of export value to an exchange rate change is not particularly large. If Australia were purely a price taker on world markets, then this result would be consistent with an export supply elasticity of around 0.25. This is the result of a relatively low aggregate supply elasticity, low elasticities of export demand for wool and wheat, and the export orientation of the major commodities considered. It is considerably lower than the price elasticities of demand for imports reviewed by Gordon (1986) or - on the limited evidence available - the price responsiveness of mineral exports. Thus, it seems likely that the agricultural sector is likely to contribute less than other sectors to any improvement of the current account resulting from a devaluation.

For two of the three major causes of the low response of export value response found in this paper, the evidence seems reasonably clear-cut. Clearly, the relatively low level of domestic consumption reduces the scope for adjustment of quantities exported. The evidence for relatively low elasticities of export demand for wool and for Australian beef also seems strong. On the third major influence, the low aggregate supply response, the evidence seems less clear-cut. While the set of supply elasticities in EMABA appears to be consistent with the sets of elasticities reported in the literature, it yields an aggregate supply elasticity which is lower than the constructed estimate used in ORANI or the directly estimated aggregate supply elasticity reported by Pandey, Piggott and Macaulay (1982). As Colman (1983) has previously argued, it seems likely that further effort devoted to obtaining more information about aggregate supply response in Australian agriculture would have a high payoff.
As previously noted, the analysis reported in this paper is inherently partial in nature and neglects the effects of other developments in the economy during the same period. Over the period of the recent, rapid, devaluation there have been a number of other major developments affecting the value of agricultural exports, with the most notable being the decline in world grains prices.

An indication of the importance of these factors can be obtained by comparing the actual change in the value of exports with that which would be expected given only the real exchange rate change. For 1985-86, it appears that the real exchange rate was 25-30 percent below its 1984-85 level. Based on the ceteris paribus results reported in this study, such a real devaluation would be expected to raise the real value of Australia's major agricultural exports by 23-28 percent or around 25 percent. In fact, based on the latest BAE assessment (BAE 1986, p.275) it appears likely that the value of the exports (for the commodities under consideration) increased by only around 7 percent in nominal terms. Given an inflation rate of around 8 percent over the period, this corresponds to a real decrease of 1 percent. This implies that factors other than the devaluation have reduced the value of Australia's major agricultural exports by over 20 percent relative to the outcome which would have resulted given only the exchange rate change. While some slight (3-4 percent) reduction in the volume of rural production was envisaged (BAE 1986, p.277), it seems clear that adverse developments on international markets for grains in particular have been the major factor.

The results also highlight important differences in the responses of particular agricultural industries. For instance, the value of agricultural exports is estimated to increase initially by less than the extent of a devaluation, primarily because of an increase in wool exports from stock, while the short run elasticity of demand for wool appears to be low. The gradual increase in wheat production, given a relatively high
elasticity of export demand, appears to be a major factor in the long term increase in the value of major agricultural exports.

The relatively low short-run elasticity of demand for wool is of particular importance in the first year. If wool prices in foreign currency did not fall so substantially in the first year, the value of exports would increase to a peak in that year. By contrast, wool prices appear to have less impact in the longer term as producers take advantage of the substitution possibilities to expand those industries with more elastic demand. It would clearly be difficult to aggregate these diverse responses into a simple, realistic agricultural sector model of a size such that it could be incorporated into a general macroeconomic model.

The results of this study point to a complex pattern of response to devaluation by Australia’s major agricultural industries. The total effect appears to be a gradual and relatively limited expansion of the value of exports, with the final outcome crucially dependent upon the aggregate supply elasticity as well as the elasticity of demand for exports. The results presented in this paper are for a change in the exchange rate with all other factors remaining constant and hence do not correspond with actual recent outcomes where marked changes in demand for some Australian agricultural exports have occurred.
APPENDIX A

Response of Enterprise Cost Indexes and the CPI to Exchange Rate Changes

For the exchange rate experiment conducted in this study, the set of enterprise cost indexes could be treated as exogenous only if they all responded in the same way to exchange rate changes. If one of these indexes differed substantially from others in its traded goods intensity then it would respond differently to an exchange rate change, irrespective of whether policy was targeted at fixing the price of nontraded goods or the CPI as a whole. Examination of their components (Australian Bureau of Statistics 1985, pp.97-103; Harris et al 1985, p.22) did not reveal any obvious, major differences in the importance of traded goods in these indexes, although such a comparison may fail to reveal differences due to the importance of traded goods as inputs into production of goods appearing in the index.

From plots of the deflators for the sheep, beef and crops enterprises, it appeared that the various indexes generally responded in the same direction to shocks, although the enterprise cost indexes had shown a generally higher rate of increase since the early 1970s. To address the question of relative response to exchange rate changes, it was decided to examine the response of the indexes to changes in the prices of traded goods. The BAE real effective exchange rate index (O’Mara, Carland and Campbell 1980) is of the form \( \sum w_i E_{AI} \cdot \frac{CPI_A}{CPI_i} \) where \( w_i \) is a trade weight, \( E_{AI} \) is the bilateral exchange rate between Australia and country \( i \) (in units of foreign currency per$A), and \( CPI_A, CPI_i \) are consumer price indexes for Australia and country \( i \) respectively. Dividing \( CPI_A \) by this BAE index yields an approximate weighted average of foreign prices converted into Australian dollars; this average was used as an index of
traded goods prices. The proportional changes in the ratio of each price index to the traded goods price index were then used to assess whether each index had responded in the same proportion to exchange rate changes. This proposition was examined using a log difference equation, which allows for the secular increase in the production cost indexes through the inclusion of a constant term:

$$\Delta \ln(C_i / P_T) = b_0 + b_1 \Delta \ln(C_1 / P_T)$$  \hspace{1cm} (A.1)$$

where $C_i$ refers to the enterprise specific cost index, $P_T$ to the index of traded goods prices and $C_1$ to the Australian consumer price index. Equation A.1 is based on the proposition that the log of each index can be written as a weighted average of traded and nontraded goods prices (in logs), that is as:

$$C_i = \alpha_i P_T + (1 - \alpha_i) P_N$$

where $\alpha_i$ is the share of traded goods in changes in index $i$ and $P_N$ is a composite price of nontraded goods appearing in the index. It follows that:

$$\hat{C}_i = \alpha_i \hat{P}_T + (1 - \alpha_i) \hat{P}_N$$

and

$$\hat{C}_i - \hat{P}_T = (1 - \alpha_i) (\hat{P}_N - \hat{P}_T)$$

where the $^\wedge$ superscript denotes the proportional derivative with respect to time. Substituting from the corresponding equation for index $j$ allows the unobservable $P_N$ term to be substituted out, yielding:

$$\hat{C}_i - \hat{P}_T = \left((1 - \alpha_j) / (1 - \alpha_i)\right) (\hat{C}_j - \hat{P}_T)$$
If $\alpha_i = \alpha_j$, then the coefficient on an OLS regression of this equation, or the corresponding log difference version, would not be significantly different from unity. Equation (A.1) is used to test this proposition. These equations were estimated for the period 1971-72 to 1984-85 for which the foreign price series was available, and in each case it was found that the coefficients corresponding to $b_1$ in equation (A.1) did not differ statistically from unity, as is evident from the results in Table A.1. These coefficients were, however, significantly greater than zero, implying that changes in traded goods prices relative to the CPI did change the ratio of traded goods prices to the other indexes.

### TABLE A.1

Comparison of Annual Changes in the CPI and Production Cost Indexes, 1971-72 to 1984-85, OLS

<table>
<thead>
<tr>
<th>Dependent Variable</th>
<th>Constant</th>
<th>$\Delta\log\text{(CPI/PSTAR)}$</th>
<th>$\Delta\log\text{(CPI/PSTAR)}$</th>
<th>DW</th>
<th>$R^2$</th>
<th>SER</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\Delta\log\text{(PPIAUSH/PSTAR)}$</td>
<td>$0.025^{(1.79)^b}$</td>
<td>1.016 $(0.05)^b$</td>
<td>1.80</td>
<td>0.49</td>
<td>0.05</td>
<td></td>
</tr>
<tr>
<td>$\Delta\log\text{(PPIAUBF/PSTAR)}$</td>
<td>$0.027^{(1.64)}$</td>
<td>1.020 $(0.06)$</td>
<td>1.83</td>
<td>0.40</td>
<td>0.06</td>
<td></td>
</tr>
<tr>
<td>$\Delta\log\text{(PPIAUCE/PSTAR)}$</td>
<td>$0.03^{(2.18)}$</td>
<td>1.039 $(0.15)$</td>
<td>1.77</td>
<td>0.51</td>
<td>0.05</td>
<td></td>
</tr>
</tbody>
</table>

---

a. PPIAUSH is the production cost index for the sheep industry, PPIAUBF for the beef industry, and PPIAUCE for cropping (see Harris et al. 1985, p.22 for details). PSTAR is a weighted average of foreign price levels, as discussed in the text.

b. Figures in parentheses are t-statistics. For the constant, $H_0: b_0 = 0$.

c. T-statistics on these real exchange rate variables are for $H_0: b_1 = 1$, rather than the usual null hypothesis of equality to zero.
APPENDIX B

Real Effects Of An Exchange Rate Change

The analysis reported in this paper refers to an exchange rate change with the CPI (and related deflators) held constant. The resulting nominal and real changes in the prices and values of exports are thus both of the same magnitude. If, however, homogeneity of degree zero is imposed in the behavioural equations of the model, and all nontraded goods prices entering the behavioural equations are incorporated in the general price level variables, then the estimates derived in this way will be appropriate for any real devaluation, defined as a change in the exchange rate adjusted for relative changes in the CPI (O'Mara, Carland and Campbell 1980). This proposition is illustrated for a simple two-country model of a single commodity.

Suppose that world supply and demand for a particular traded good can be represented as:

\[
S(p, C) = D(p^*, C^*, y) \\
p = p^* \cdot e
\]

(B.1)  \hspace{1cm}  (B.2)

where

- \(S\) = excess supply of the good from the exporting country
- \(p\) = the domestic currency price of the good
- \(C\) = the general price level in the home country
- \(D\) = excess demand from the importing country
- \(y\) = real income in the importing country (assumed constant)
- \(p^*\) = the price of the good in the importing country
- \(C^*\) = the general price level in the importing country
- \(e\) = the nominal exchange rate expressed as units of home currency per unit of foreign currency.
In formulating the model, it is assumed that the value of the good under consideration is sufficiently small so that its impact on the general price level is negligible. Further, the effect of income on excess supply from the exporting country is ignored, although this restriction could readily be relaxed.

Equation (B.1) may be rewritten in proportional change form as:

\[ \eta_s \hat{p} - \eta_c \hat{c} = \epsilon_{p^*} \hat{p} + \epsilon_{c^*} \hat{c} + \epsilon_{y^*} \hat{c} \]  \hspace{1cm} (B.3)

where

- \( \eta_i \) refers to the elasticity of excess supply with respect to variable \( i \).
- \( \epsilon_i \) refers to the elasticity of excess demand with respect to variable \( i \).
- the superscript * refers to proportional changes.

Homogeneity of degree zero in prices and incomes implies:

\[ \eta_s = \eta_c \]

and

\[ \epsilon_{p^*} = \epsilon_{c^*} + \epsilon_{y^*} \]

and these restrictions allow (B.3) to be rewritten as:

\[ \eta_s (\hat{p} - \hat{c}) = \epsilon_{p^*} (\hat{p} - \hat{c}) \]

Recalling that \( p = p^* \cdot e \), this can be rewritten as:

\[ \eta_s (\hat{p} - \hat{c}) = \epsilon_{p^*} (\hat{p} - \hat{c}) \]

yields:

\[ (\hat{p} - \hat{c}) = \left[ \epsilon_{p^*} / (\eta_s - \epsilon_{p^*}) \right] (\hat{e} + \hat{c} - \hat{c}). \]  \hspace{1cm} (B.5)
The coefficient on the real exchange rate change variable, \((\hat{e} + \hat{C}^* - \hat{C})\), in (B.5) is the same as would be obtained by holding constant the \(\hat{C}\) variables and solving (B.3). Thus, it is clear from (B.5) that the proportional change in the real price \((\hat{p} - \hat{C})\) resulting from a given real devaluation is the same as the nominal (and real) change resulting from a given nominal devaluation with the \(C\) and \(C^*\) variables held constant. This equivalence also extends to the value of exports since the change in their supply is given by \(\eta_{e} (\hat{p} - \hat{C})\) and the change in the value of exports is given by \(\hat{V} = \hat{p} + \hat{S}\), or \((1 + \eta_{e})(\hat{p} - \hat{C})\).
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