THE EFFECTS OF AGRICULTURAL PRICE CHANGES ON REGIONAL ECONOMIES IN WESTERN AUSTRALIA

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ABSTRACT Australian agricultural commodities are often subject to significant and frequent shocks in prices. This paper provides a synthesis of modelling techniques that can be used to estimate the effects that changes in broadacre prices have on the employment and income levels of regional economies. As an example this modelling framework is applied to the Western Australian state economy and to the regions within it to estimate the effects of the recent GATT proposals for trade in agriculture.

1. INTRODUCTION

The large fluctuations in agricultural prices in the early 1990s, particularly in broadacre industries - which comprise the majority of Australia's agricultural output - has led to renewed interest by policy makers in the effects that changes in agricultural prices have on the rest of the economy. This paper presents a modelling framework which can be used to estimate the effects that changes in broadacre prices have on employment and income at the regional level within the economy. For illustration, the framework is used to estimate the effects of price changes of the three main broadacre commodities - wool, wheat and beef - on the seven regions within Western Australia. Specifically, the regional impacts will be estimated of the agricultural price changes forecast to occur as a result of the December 1993 General Agreement of Tariffs and Trade (GATT) agreements.

To estimate the economic effects of broadacre price changes, agricultural producer supply responsiveness to these changes must first be determined. Estimating producer supply response involves utilising own-price and cross-price supply elasticities. The cross-price elasticities are required because of the multi-product nature of many farms throughout Australia, where agricultural producers are able to substitute between products. For example, if the price of wool falls, while wheat prices remain constant, farmers are able to reduce their production of wool and instead produce more wheat.

Once producers' responses to price changes have been estimated, the total economic impact that these changes in agricultural output levels have on the economy can be estimated, by the application of multipliers. Multipliers account for the linkages and flow-on effects between individual industries and the rest of the economy, and hence enable the measurement of the total effect on employment and household income levels that result from an initial change in agricultural output levels. For example, if there is a decrease in agricultural output levels, there will also be a decrease in the use of fuels, labour, stock feed, fertiliser, the use of transport and marketing services, and so on. Therefore a change in agricultural output levels will not only affect employment and income levels in the agricultural sector, but will also affect the employment and income levels in the other sectors with which it is linked.

In the following sections the alternative models that can be used to estimate agricultural supply responsiveness to price changes and the supply elasticities used in this analysis are reviewed. The various methods used to generate regional multipliers are presented and the multipliers used in this analysis are discussed. The modelling framework is applied to the regions of Western Australia, to estimate the employment and household income effects resulting from the 1993 GATT agreement to reduce agricultural protection levels in participating countries. The final section concludes with an examination of the uses of this estimation framework for the purpose of regional policy.

2. SUPPLY RESPONSE TO PRICE CHANGES

There are three alternative modelling techniques that have been used to estimate own-price and cross-price supply elasticities for the main broadacre industries. One technique used is the direct econometric estimation of supply functions, from which elasticities are then generated. This method has been used by Vincent, *et al.*, (1980); Dewbre, *et al.*, (1985); and Harris and Corra (1990). Agricultural supply responsiveness has also been estimated by using the dual relationship between the cost function and the supply function. The dual approach has been used by McKay, *et al.*, (1983); Lawrence and Zietsch, (1989); Fisher and Wall, (1990); Low and Hinchy, (1990); and Kokic, *et al.*, (1993). Finally, linear programming has been used by Wicks and Dillon (1978) and Hall, Fraser and Purtill (1988) to generate supply elasticities.

Garnett and Lewis (1996), after considering each approach in detail, argued that the most appropriate model for an exercise of this type is the one produced by Kokic, *et al.*, (1993). The superiority of their model lies in the fact that it is specifically designed to take account of regional differences in producer responsiveness, and produces elasticities for the three main broadacre products for all states at a very disaggregated regional level. In terms of statistical performance, its parameters are all statistically significant, and the explanatory power of the model is high, accounting for over 95 per cent of the variations in supply.

The own-price and cross-price supply elasticities for Western Australia and for its regions (as defined by statistical division) used in this paper are presented in Tables 1 and 2. The elasticities measure short-run producer responsiveness to broadacre price changes. The short-run is taken to be two years, which is the time required for producers to adjust input levels and output mix. These elasticities are

Table 1. Own-price and Cross-price Supply Elasticities for Broadacre Products in Western Australia

	Response Due to a One Per Cent Change in the Farm Level Price of		
Product	Wool	Wheat	Beef
Wool	0.5	-0.06	-0.03
Wheat	-0.09	0.28	-0.005
Beef	-0.08	-0.04	0.18

Source: Kokic, Beare, Topp and Tulpulè (1993).

Table 2. Regional Own-Price and Cross-Price Supply Elasticities for Broadacre Products in Western Australia

		Response Due to a One Per Cent Change in the Farm Level Price of		
Product	Region	Wool	Wheat	Beef
Wool	South West	0.53	-0.01	-0.02
	Great Southern	0.50	-0.06	-0.01
	Midlands	0.51	-0.10	-0.01
	South Eastern	0.54	-0.10	-0.02
	Central	0.53	-0.10	-0.04
	Pilbara	0.45	0.0	-0.01
	Kimberley	0.0	0.0	0.0
Wheat	South West	-0.10	0.26	-0.004
	Great Southern	-0.10	0.27	-0.004
	Midlands	-0.08	0.26	-0.003
	South Eastern	-0.10	0.29	-0.020
	Central	-0.09	0.29	-0.005
	Pilbara	0.0	0.0	0.0
	Kimberley	0.0	0.0	0.0
Beef	South West	-0.06	-0.003	0.12
	Great Southern	-0.06	-0.02	0.13
	Midlands	-0.07	-0.03	0.17
	South Eastern	-0.08	-0.05	0.19
	Central	-0.08	-0.04	0.19
	Pilbara	-0.08	0.0	0.15
	Kimberley	0.0	0.0	0.0

Source: Kokic, Beare, Topp and Tulpulè (1993).

based on the assumption that producers expect the price change to continue in the short-run. From Tables 1 and 2 it can be seen that producer responsiveness is inelastic, which is the conclusion of almost all supply response models of Australian agriculture (Garnett and Lewis 1996). For example, from Table 1, a 10 per cent fall in the price received for wool in Western Australia, assuming the prices of the other broadacre products remained constant, would lead to a 5 per cent reduction in wool output. The cross-price elasticities of wheat with respect to a price change in wool, and beef with respect to a price change in wool, indicate that the 10 per cent fall in the wool price would also lead to a 0.9 per cent increase in wheat production and a 0.8 per cent increase in beef production.

It is important to note that although agricultural supply responsiveness is inelastic, the respective changes in output levels translate into very large absolute quantities and dollar amounts for the agricultural sector as a whole. For example, total wool output in Western Australia in 1993 was 180,367.4 tonnes. A 5 per cent reduction in production levels amounts to over 9 million kilograms, which at 1993 prices amounts to a reduction in the value of agricultural output by over $43 million. The resultant multiplier effects would significantly magnify the total effect on the State as a whole.

Table 1 also shows that own-price responsiveness is greatest for wool with an elasticity of 0.5, followed by wheat 0.28 and beef at 0.18. In terms of the degree of responsiveness of commodities to price changes of other commodities, wheat and beef respond relatively more to a price change in wool, wool and beef to a price change in wheat, with the responsiveness of all commodities to a beef price change being the smallest.

The regional supply elasticities for Western Australia in Table 2, show that the size of the elasticities do differ between most regions. In particular the Pilbara and Kimberley regions differ considerably from other regions, where the supply elasticities are zero in some instances. These regions cover over one third of Western Australia, and are located in the northern area, where the majority of the land is arid. The only broadacre activity carried out is uncontrolled stock grazing, therefore the ability of producers to substitute between alternative outputs is very limited. Specifically, looking at the Kimberley region, beef is the only broadacre commodity produced, and there is, therefore, no opportunity for substitution into other products if the price of beef falls, therefore all cross-price supply elasticities are zero. The own-price supply elasticity is almost zero, because if the price falls, farmers have no alternative use for the land, and if the price increases, farmers cannot increase herd sizes much due to the sparse vegetation. This means that if the price of beef falls, the effect on household income for the farmers in this region would be large as farmers cannot substitute into other products to minimise income reductions. However, as agricultural output levels remain largely unchanged, there would be minimal flow-on effects to other sectors within the region.

3. FLOW-ON EFFECTS TO REGIONAL ECONOMIES

The direct effects of the agricultural sector on national or state employment and income levels are relatively small. For Western Australia, the agricultural sector is responsible for around 7 per cent of gross state product and 6 per cent of employment. However, the agricultural sector is strongly linked to other sectors in the economy and is therefore indirectly responsible for a far more significant proportion of gross product, employment and income. Powell (1988), for instance, has suggested that the agricultural sector contributes about 20 per cent to GDP when all the flow-on or linkage effects are fully accounted for. Changes in agricultural output levels lead to changes in demand for inputs, transport, marketing services and so on, and, therefore, strongly affect the employment and income levels of other sectors. Powell also argues that the apparent fall in the contribution of the agricultural sector to the economy over time is due to many of the activities which were once classified as agriculture now being carried out off-farm and classified as part of the manufacturing sector.

The main linkages between the agricultural sector and other sectors are illustrated in Figure 1 (adapted from Powell, Jensen and Gibson, 1985). It can be seen that the agricultural sector is strongly linked to the service sector, as transport and marketing services are utilised extensively following on from the initial production of the agricultural commodities. The purchased inputs and capital expenditure reflect the agricultural sector's link with the manufacturing sector, with inputs including machinery, storage units, fertiliser and pesticides.

A regional level analysis within the State is important, as both direct and indirect effects of agriculture vary substantially between regions within Western Australia. In some regions, the agricultural sector employs up to half of the total regional workforce, and is indirectly responsible for almost all regional employment. Also, these particular regions are by no means necessarily an insignificant component of total state employment. For example, in the Great Southern region, the agricultural sector directly employs over 50 per cent of the

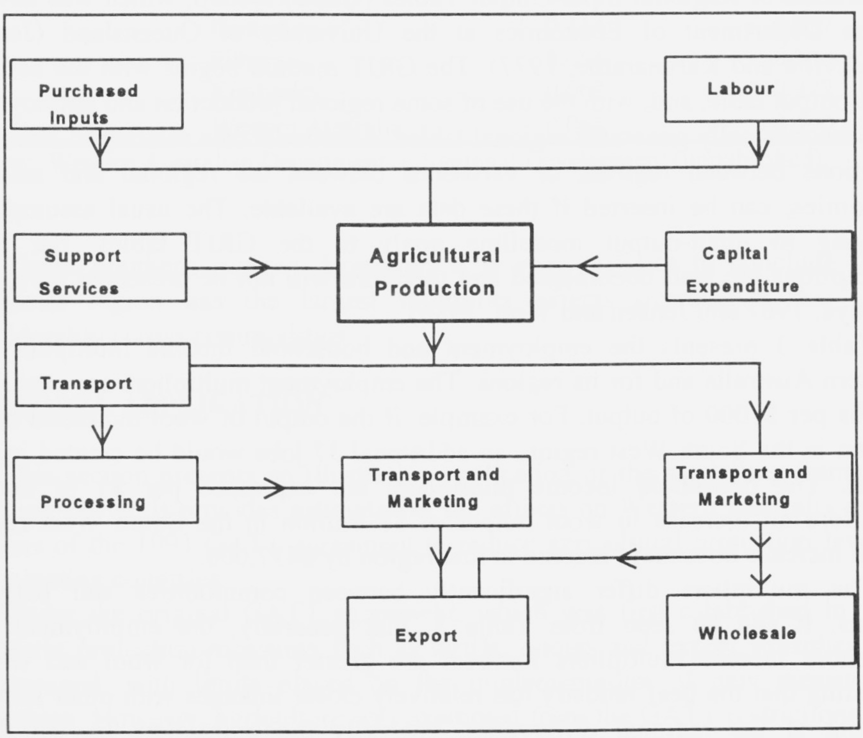

Figure 1. The Major Production Linkages in Agriculture

region's workforce, agriculture is strongly linked to the other sectors within the region, and in terms of direct contribution to state employment, contains over 5 per cent of the State's labour force. Clearly if agricultural output levels changed significantly in this region, both regional and state effects would be substantial. However, in contrast, in the Pilbara region, agriculture employs only 1.5 per cent of the region's workforce, makes a negligible contribution to total state employment, and is not strongly linked to other regional sectors. Therefore, the impact of a change in agricultural output levels in this region, while significantly affecting the region's agricultural producers, would have little impact on the region as a whole, or the State.

To estimate the total effect that the agricultural sector has on state or smaller regional economies, multipliers are needed. Multipliers account for the linkages and flow-on effects and, hence, measure the total effect that a change in agricultural output will have on an economy. Therefore, after the changes in broadacre output levels are estimated, multipliers are applied to estimate the effects on regional employment and income levels.

The multipliers chosen for this analysis are those generated from regional input-output tables produced by the Western Australian Department of Regional Development. These are the only multipliers available at the statistical division level for Western Australia for individual broadacre industries. These tables were produced by a combination of survey and non-survey means, utilising the Generation of Regional Input-Output Tables (GRIT) system, which was devised at the Department of Economics at the University of Queensland (Jensen, Mandeville and Karunaratne, 1977). The GRIT method begins with the national input-output table, and, with the use of some regional production and employment data, mechanically generates regional tables. Additional data relating to structural variations between regions, or variations between the regional and national economies, can be inserted if these data are available. The usual assumptions applying to input-output modelling apply to the GRIT tables, but these assumptions are well documented and therefore will not be presented here, (see Miernyk, 1967 and Jensen and West, 1986).

Table 3 presents the employment and household income multipliers for Western Australia and for its regions. The employment multipliers are expressed as jobs per $1000 of output. For example, if the output of wool increased by $1 million in the South West region, an additional 37 jobs would be created in that region. The household income multipliers are expressed per $1 of output. Therefore an increase in wool output of $1 million in the South West region would increase household income in that region by $437,000.

The multipliers differ significantly between commodities and between regions. It can be seen from Table 3, that generally, the employment and household income multipliers for beef are greater than for wool and wheat, indicating that the beef industry has relatively closer linkages with other sectors. Looking at the regional differences, generally the multipliers for all three industries in the Kimberley and Pilbara regions are the smallest of all regions. The linkage and flow-on effects appear to be relatively higher in the Midlands

Table 3. Regional Multipliers for Western Australia

Industry	Region	Jobs (per $1000 of output)	Household income (per $1 of output)
Wool	South West	0.037	0.437
	Great Southern	0.034	0.429
	Midlands	0.049	0.489
	South Eastern	0.035	0.410
	Central	0.038	0.426
	Pilbara	0.027	0.351
	Kimberley	0.0	0.0
	Western Australia	0.041	0.532
Wheat	South West	0.036	0.435
	Great Southern	0.036	0.442
	Midlands	0.033	0.395
	South Eastern	0.037	0.436
	Central	*0.033*	*0.396*
	Pilbara	0.0	0.0
	Kimberley	0.0	0.0
	Western Australia	0.046	0.582
Beef	South West	0.073	0.516
	Great Southern	0.096	0.693
	Midlands	0.081	0.481
	South Eastern	0.078	0.529
	Central	0.114	0.637
	Pilbara	0.054	0.344
	Kimberley	0.069	0.422
	Western Australia	0.064	0.590

Source: Western Australian Department of Regional Development (unpublished).

and Great Southern regions. However, it is very difficult to conclude that a particular region has the largest multiplier effects overall, as this varies considerably across commodities.

4. MODEL APPLICATION

This section presents an illustrative application of the modelling framework outlined above. It provides estimates of the effects on Western Australia and its regions of the 1993 GATT agreement to reduce agricultural protection levels in participating countries.

Under the original GATT agreement, which was first established in 1947, domestic protection measures such as tariffs, quotas and export subsidies were discouraged, with limits placed on the implementation of new measures of protection. However, agriculture was exempted from the GATT restrictions. This led to many countries heavily protecting their agricultural industries, particularly since the 1980s, when the European Union (EU) and the United States (US) both rapidly increased their agricultural protection programs. The EU's Common

Agricultural Policy and the US's Export Enhancement Program are key components of their respective countries' protection programs. These heavy levels of protection are a major financial burden, costing billions of dollars to maintain each year, lead to domestic consumers in those countries paying a higher than world price for their agricultural commodities, and have driven down world agricultural prices, which has been to the detriment of relatively lightly protected agricultural producers such as Australia.

The recent GATT round contained agreements by these and other countries to reduce domestic support levels and export subsidies, and to increase market access to imported agricultural products. Specifically, commencing in 1995 and continuing for the next six years, the following measures to reduce world agricultural protection are to be phased in:

- non-tariff barriers are to be converted to tariffs, which are then to be reduced by a minimum of 15 per cent, and by an average of 36 per cent across products (with 1986-88 as the period upon which calculations are based).
- countries are to allow at least 3 per cent of domestic consumption levels to be met by imported goods. This minimum market access is to be expanded to 5 per cent by the year 2001.
- on average across agricultural products, the value of support for domestic agricultural industries is to be reduced by 20 per cent (with 1986-88 as the base period).
- on average across agricultural products, the volume of subsidised exports is to be reduced by 21 per cent (based on 1986-90 averages).
- budget expenditure on export subsidy programs is to be reduced by 36 per cent, (based on 1986-90 average expenditures) (Andrews, *et al*., 1994).

There are exemptions and special conditions for some countries, especially developing countries, and there are numerous variations between countries on the implementation time frame and on the base period to be used for some products.

The reduction in world agricultural protection levels should cause world agricultural prices to rise above their previously artificially low levels. The effect on world agricultural prices has been estimated by ABARE (Andrews, *et al*., 1994). Table 4 shows the estimated effect on world broadacre prices relative to what these prices would otherwise have been. It should be noted that while the ABARE estimates are not large, others studies have estimated even smaller effects on prices due to the GATT agreement (Martin and Winters, 1995).

Table 4 shows no change in the price received for wool, as world trade barriers on unprocessed or slightly processed wool are not large and are not directly affected by the GATT agreements. Processed wool products will be affected, as the Multifibre Agreement (MFA), which restricts textile exports from developing to developed countries, is to be phased out by the year 2005. Other textile trade barriers that are not part of the MFA are also to be phased out by 2005 or, if not, are to be brought into conformity with the GATT conditions. The freeing up of textile trade could lead to increased demand for these products and, if so, may lead to an increase in the demand for wool. However, the effect on wool prices is thought to be small, and is almost impossible to estimate given the

Table 4. The Change in World Broadacre Prices Due to the 1993 GATT Agreement

Commodity	Percentage Change in Price
Wheat	+8
Beef	+6
Wool	0

Source: Andrews, Robert and Hester (1994).

Table 5. The Regional and State Effects, by Industry, of the 1993 GATT Agreement

Product	Region	Employment (in persons)	Household Income ($)
Wool	South West	-2	-34,172
	Great Southern	-49	-1,006,770
	Midlands	-49	-809,403
	South Eastern	-19	-370,902
	Central	-26	-487,821
	Pilbara	0	-1,587
	Kimberley	0	0
	Western Australia	-143	-3,039,869
Wheat	South West	0	11,804
	Great Southern	137	13,138,212
	Midlands	214	20,852,782
	South Eastern	26	2,412,620
	Central	92	8,340,703
	Pilbara	0	0
	Kimberley	0	0
	Western Australia	654	63,973,382
Beef	South West	29	3,212,697
	Great Southern	16	1,763,035
	Midlands	9	781,629
	South Eastern	5	478,308
	Central	8	629,144
	Pilbara	4	352,648
	Kimberley	1	1,274,778
	Western Australia	75	10,081,709

uncertainties of if and by how much demand for wool may be affected.

Table 5 shows the estimated effects resulting from each broadacre industry adjusting to the price changes, on regional and state employment and household income levels, using the approach described in the previous sections. It is important to note that the sum of the economic effects within the regions will not be equal to the total effect calculated for Western Australia. This is because this modelling technique utilises multipliers generated from regional input-output tables rather than from interregional tables. Conventional regional input-output tables do not account for the spatial distribution of impacts. Interregional studies are very rare as detailed interregional trade data are necessary to construct interregional tables.

The second point to note from Table 5 is that although the price of wool is not expected to change as a result of the GATT negotiations, the levels of employment and household income generated by the wool industry are estimated to fall. Looking at Western Australia as a whole, total employment generated by the wool industry is estimated to fall by 143 jobs and household income is estimated to fall by nearly $3.4 million. This is because although the price of wool is not affected, the beef and wheat industries will become relatively more attractive to farmers due to the price rises in these products. Therefore, farmers will substitute to some extent out of wool production and into beef and wheat production.

The third point to note from Table 5 is that although the price of beef is forecast to rise by 6 per cent, the change in the production of beef and hence the flow-on effects are relatively small. Again, this is due to the ability of agricultural producers to substitute between products. Wool producers are estimated to substitute out of wool and into wheat production, as the price of wheat is forecast to rise the most, by 8 per cent, and because the ability and willingness to substitute from wool production to wheat production is greater than from wool to beef, as evidenced by the cross-price elasticities in Table 1. In fact, it is estimated that there will even be a small substitution effect out of the production of beef, into wheat production, as the gains to be made from the increased wheat production are greater than the gains to be made from the increased beef production. Therefore, the net positive effect on the production of beef is small, meaning that the total regional and state effects caused by the beef industry's response to the GATT price effects are also small.

It is, therefore, the wheat industry and industries dependent on wheat that are estimated to benefit most from the price changes. From Table 5, total employment in Western Australia is estimated to increase by 654 jobs (0.1 per cent of the labour force) and household income by almost $64 million as a result

Table 6. Net Regional and State Effects of the 1993 GATT Agreement

Region	Employment (in persons)	Household Income ($)
South West	27	3,190,329
Great Southern	104	13,894,477
Midlands	174	20,825,008
South Eastern	12	2,520,026
Central	74	8,482,026
Pilbara	4	351,061
Kimberley	1	1,274,778
Western Australia	586	71,015,222
	(0.08 per cent of WA employment)	(0.3 per cent of WA household income)

of the increase in wheat production.

Table 6 shows the estimated *net* effects on employment and household income levels of Western Australia and its regions due to the broadacre price changes as a result of the GATT agreements. It clearly shows there are significant differences in the regional impact of the broadacre price changes. The benefits of the GATT effects are unequally distributed, with most of the employment and household income being generated in the Midlands, Great Southern and Central regions, which produce large amounts of all three broadacre commodities. These regions have the highest regional levels of own-price supply responsiveness to wheat and beef price changes, and their ability to substitute out of wool and into wheat production is also among the highest in the State. Therefore, producers in these regions are able to transfer production away from wool and into wheat and beef to maximise their own benefits by a greater degree than producers in other regions. Further, the employment and household income multipliers in these regions are generally the highest in the State, therefore, the flow-on effects to the other sectors in these regions are also relatively large.

It is estimated that the Pilbara and Kimberley regions will benefit very little from the GATT agreement. As discussed earlier, the agricultural sector in the Pilbara and Kimberley regions produce mainly beef but, due to the arid land, their responsiveness to price changes is very limited. Further, the employment and household income multipliers for beef in these regions are the lowest in the State, therefore the effects from the small benefits received by the agricultural sector are not greatly magnified throughout these regions.

The gains to the South West region are estimated to be modest. The South West produces mostly beef and wool, has a very low beef own-price supply elasticity and also a relatively small cross-price elasticity of beef with respect to the price of wool. Therefore, with very little responsiveness from beef producers, and almost no wheat being produced, the gains in the South West are modest.

Finally, the gains to the South Eastern region are estimated to be relatively small. The agricultural sector in this region is a comparatively small part of the region's economic activity, and the wheat industry is much smaller than the beef and wool industries in this region. The levels of producer responsiveness are relatively high, but as agricultural output is relatively small, the impact of this responsiveness is not significant for the region. Also, the multiplier effects from broadacre products in this region are not large, their size being approximately the mode of all the regions.

5. CONCLUSION

This paper has outlined a modelling framework that can be used to estimate the effects that changes in broadacre prices have on the State and regional economies of Western Australia. The above application has shown the importance of supply response and multiplier analyses when attempting to determine regional impacts of broadacre price changes. Looking at the economic base alone can be very misleading. For example, the impact on the Kimberley region of a small increase in the price of beef is close to zero. While beef producers in this region would receive modest revenue gains from the sale of existing levels of production, they are largely unable to increase production levels, hence flow-on effects to the region are almost zero. Also, the multipliers for this region are relatively small, so any small change in agricultural production levels would have minimal flow-on effects.

The above application has also shown the significant differences between the regions in the estimated economic impact of broadacre price changes. This highlights the necessity for policy makers to recognise and address these regional differences.

Finally, the estimated effects on Western Australia of the forecast broadacre price changes resulting from the 1993 GATT agreement are modest. The price changes are relatively small, especially when comparing them to the price changes that occurred in the 1989/90 to 1990/91 rural downturn. Apart from the price changes being relatively small, the fact that wool prices are not forecast to change greatly reduces the GATT effects. Over the past five years, Australia has, on average, supplied 60 per cent of the world's exports of wool. Over the same period, Australia supplied 11 per cent of the international exports of wheat and 26 per cent of the international exports of beef (ABARE, 1995). Clearly, a change in the price of wool would have far more substantial effects on Australia than a price change in the other broadacre commodities. This was evidenced by the significant effects resulting from the 1990/91 plunge in wool prices, following the removal of the guaranteed minimum price for wool in Australia.

However, the 1993 GATT agreement is a very important step forward in the reduction of world agricultural protection levels. Further, on average over the past five years, Western Australia has produced 37 per cent of Australia's total wheat output, 7 per cent of beef output and 21 per cent of the total wool output (ABARE, 1995). The effects of the GATT price changes may, therefore, be far more significant for other states in Australia that produce higher proportions of beef and wheat.

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