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Agricultural processing and the Western Australian economy

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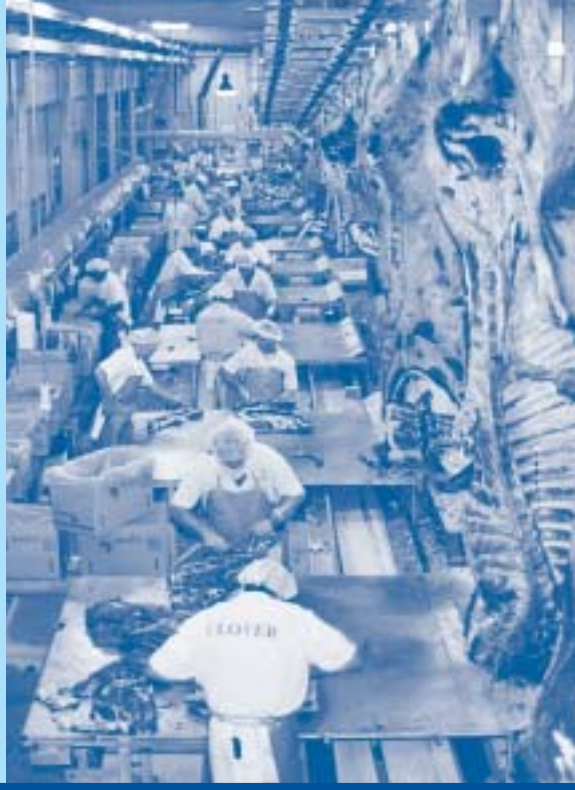

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ABSTRACT

This paper investigated the impact that an expansion in agricultural processing would have on the Western Australian economy by developing and applying a Computable General Equilibrium economic model of Western Australia (called WAM). WAM was used to simulate the effects of a $1 million expansion in eight agricultural processing industries.
In addition, based on a review of the literature and two case studies, impediments to agricultural processing in Western Australia were identified.

The results show that agricultural processing produces a range of positive impacts. On average, a $1 million expansion in agricultural processing is estimated to increase the State's GSP (Gross State Product) by $649,000, and total output by $1.9 million. The expansion of the Wine and spirits industry is estimated to have the largest impact, while the Textile fibres, yarns and woven fabrics industry has the least beneficial effect on the Western Australian economy.

The study identified several factors that hinder the expansion of agricultural processing in Western Australia. Inefficient support mechanisms and industries, strict marketing and quarantine regulations, and costly and inadequate supplies of raw materials are the major impediments. It appears that, if essential logistic and institutional supports are made available, the WA food processing industry has the potential to expand rapidly, even with its small local market and less competitive supply of raw materials. In the absence of adequate private sector investment, the public sector needs to play an important role in developing and implementing appropriate policies so that barriers to private sector investment and agricultural processing are removed.

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EXECUTIVE SUMMARY

Western Australia is a major producer of agricultural commodities and has a wealth of natural advantages, including a clean environment, as well as a stable and strong economy. However, not much agriculture-based processing has taken place in the State. Downstream processing is important for ensuring the continued growth of WA agriculture.

Given the marked difference between the prices of processed agricultural products and unprocessed agricultural commodities, one might suspect that the WA economy is losing heavily by not processing its primary products before export. In the face of greater market access (due to multilateral trade negotiations under the auspices of GATT/WTO and APEC) and growing demands for processed food, especially in Asian countries, the prospect for the downstream processing of primary products in WA appears to have improved. In spite of this, the low level of agricultural processing in Western Australia implies that the State is failing to take advantage of these opportunities.

In the light of this situation, it is necessary to ask what are the deterrents to agricultural processing in WA? Whether or not potential private producers will engage in agricultural processing will obviously depend on profitability. Therefore, it is important to investigate the factors that make processing so unattractive for potential private investors. Do the impediments to agricultural processing come from input markets for example, or from labour, or trade and transport services, or are they associated with regulations affecting output markets?

Against this background, the main objective of this study is to apply a Computable General Equilibrium model of the Western Australian economy to measure the State-wide impact that would emanate from further processing of the State's primary agricultural products. In addition, this study examines some current literature on impediments to agricultural processing in Australia in general, and Western Australia in particular, and supplements this information with two case studies on Western Australian food processing.

The key results of the study are summarised below.

- Western Australia accounts for only six percent of the total value adding of the food manufacturing sector in Australia (Figure 1).
- Cereals (mainly wheat) account for more than one third of the State's gross value of agricultural production (GVAP) but less than 3 percent of it is processed. In general, less than 15 percent of the primary commodities produced are processed (Figure 2). (Note that wool scouring is considered as processed here.)
- Grains (cereals plus pulses and oilseeds) and wool (the second dominant agricultural commodity in WA) jointly account for about 60 percent of the GVAP. However, on average, less than 20 percent of these commodities are exported in processed form (see second columns in Figure 2 for the individual commodity level of processed exports).
- Over the period 1996/97 to 2000/01, the export of live cattle grew by 14 percent per annum; while beef export growth remained stagnant (Figure 3).

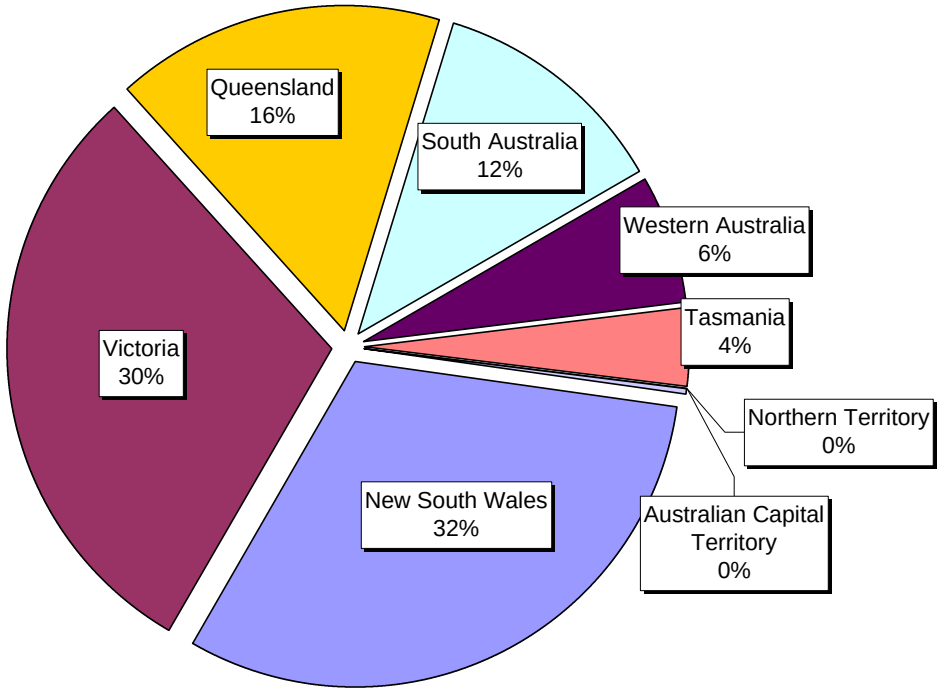

Figure 1. Share of States and Territories in total value-added of the food manufacturing sector in Australia, 1999-2000.

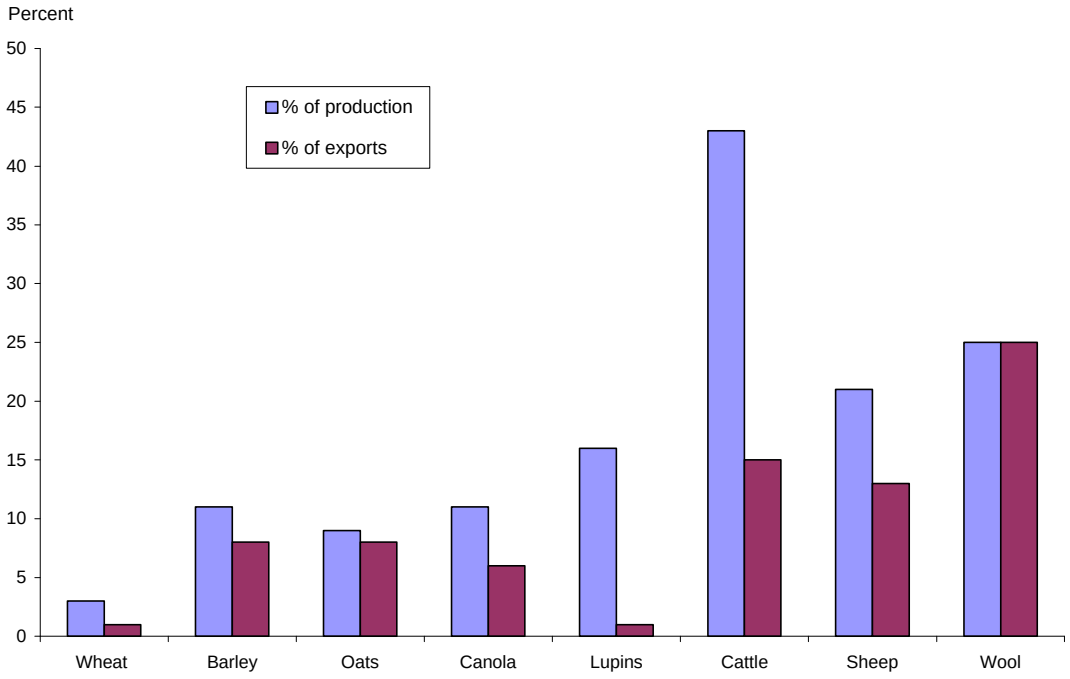

Figure 2. Extent of processing in major agricultural commodities in WA.

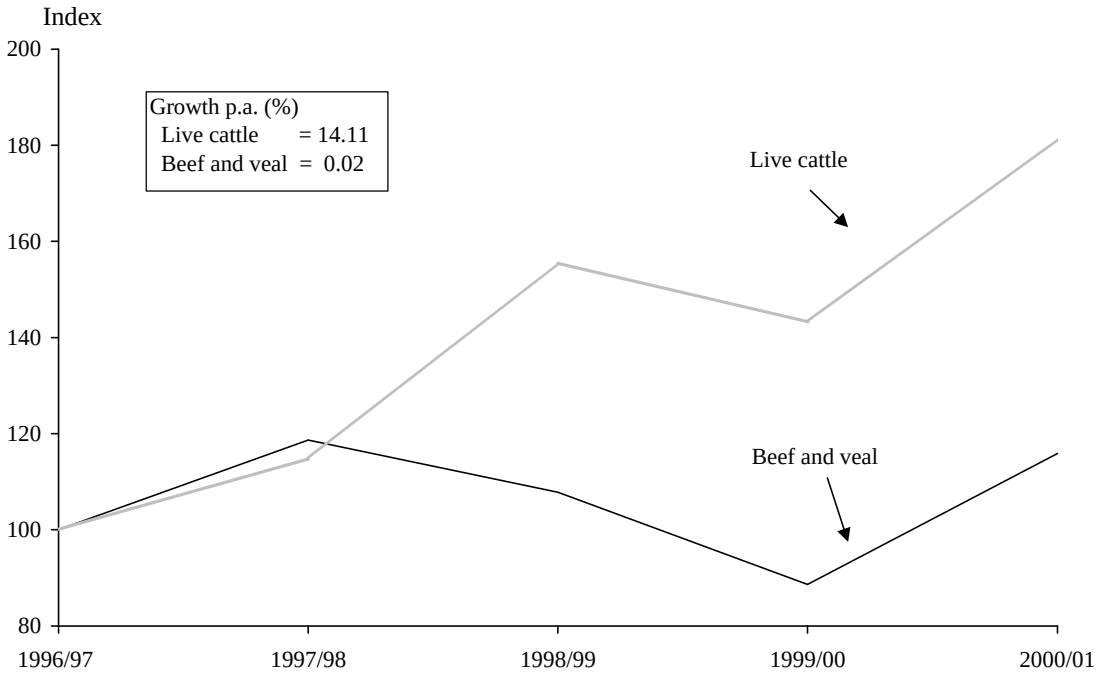

Figure 3. Live cattle and beef export trends in WA, 1996/97-2000/01.

- A review of the literature reveals that the progress of food processing industries in Australia, in general, appears to be mainly affected by the following factors: the size and foreign ownership structure of the existing companies; distortions in export markets; the high cost of some raw materials; passive attitudes of firms towards achieving cost-competitiveness along the value chain; inadequate investment in innovation; inefficient labour markets; substandard corporate management skills; low levels of awareness of, and confidence in, government support; regulated marketing structures for some major agriculture commodities; and quarantine restrictions and controls. The effect of these factors would, of course, vary from company to company and from industry to industry.
- The results of the two case studies indicate that inefficient supporting industries, strict marketing and quarantine regulations, and costly and inadequate supplies of raw materials, are major impediments to the expansion of agricultural processing in Western Australia.
- The modelling results reveal that the expansion of agricultural processing in WA has a positive impact on the State's economy. Real GSP, total employment, and exports, increase significantly due to the expansion of agricultural processing.
- Horticulture based processing industries appear to have the most beneficial impact on GSP. In particular, Wine and spirits and Fruit and vegetable products are major contributors. These two industries also make the largest contribution to increasing employment opportunities
- For agricultural sectors, the expansion in agricultural processing proves to be something of a mixed blessing. While those primary agricultural industries supplying the expanding sector benefit, they do so at the expense of other agricultural industries, with whom they compete for land and capital.

- As expected, the output of the manufacturing sector increases the most due to the expansions in agricultural processing, as these processing sectors are themselves manufacturing industries. Of the remaining sectors, Trade and transportation and Services both perform well.

In conclusion, the study suggests that although the expansion of agricultural processing has only mixed benefits for the primary agricultural sector, it has a highly beneficial impact on the overall economy of the State. Due to the existence of some major impediments, however, the private sector has not been investing in this sector adequately, with the result that the food-processing sector in Western Australia still remains in its infancy. As the food-processing sector currently operates in imperfect market conditions, this situation makes government support essential in enabling the State's food processing industry to become self-sufficient and viable.

1. INTRODUCTION

With its favourable factor endowments, Western Australia enjoys a comparative advantage in agricultural production and exports. The State produces a wide range of export oriented agricultural commodities, including broadacre crops (predominantly wheat), wool, sheep, cattle and other livestock. In 1998/99, the gross value of agricultural production in WA stood at $4.9 billion[1], which represents about 15 percent of national production. During the past two decades, the agricultural sector in WA grew at an average rate of over 6 percent per annum (Islam, 2000). Although WA is a major producer of agricultural commodities, and has a wealth of natural advantages including a clean environment, as well as a stable and strong economy, not much agriculture-based processing has taken place in the State. For a long time, an important policy objective has been to expand the local processing of primary products in the State before export. Downstream processing is important for ensuring the continued growth of WA agriculture.

WA accounts for only about 7 percent of the gross product of the food manufacturing industry (ABS, 2001a). Currently, about 75 percent of WA's agricultural output are exported, but mostly in unprocessed form. Between 1995 and 1999, on average, only about 12 percent of the total WA agricultural exports were in processed form. By comparison, over 50 percent of agricultural exports in the rest of Australia were in processed form. For some individual commodities, the lack of processing in WA is even worse. For example, WA accounts for only 4 percent of the national exports of meat products, while its share in national live animal exports is over 40 percent. Australia as a whole lags behind other exporters of agricultural processed commodities[2] and WA clearly lags behind the rest of Australia in agricultural processing activities.

Given the marked differences between the prices of processed agricultural products and unprocessed agricultural commodities, one might suspect that the WA economy is losing heavily by not processing its primary products before export. With market access improving (due to multilateral trade negotiations under the auspices of GATT/WTO and APEC) and growing demands for processed food, the prospect for downstream processing of primary products in WA has improved. At the federal level, the government has adopted a number of programs and initiatives to improve the international competitiveness and export orientation of agricultural processing industries (see, e.g., National Food Industry Strategy Report, AFFA, 2002). With WA's low level of agricultural processing, the State is failing to take advantage of these opportunities.

What are the deterrents to agricultural processing in WA? Several past attempts to establish processing plants in WA (e.g. pig processing) were not successful. Currently, several processing projects in WA are under consideration (e.g. the Ultra-High-Temperature milk processing plant). Whether or not potential private producers will engage in agricultural processing will obviously depend on profitability. Therefore, it is important to investigate the factors that make processing so unattractive for potential private investors. Do the impediments come from input markets for example, from labour, trade and transport services, or, are they associated with regulations affecting output markets?

1 Department of Agriculture Western Australia (AGWEST) web page, http://www.agric.wa.gov.au/programs/trade/html/12compb.htm.

2 During 1994 to 1998, Australia's processed food exports grew by just 1.8 percent compared with 21 percent for the USA, 10 percent for Germany and 9 percent for France (International Trade Centre, 1998). Australia's global market share decreased from 3 percent to 2.8 percent. However, Australia's exports of unprocessed food grew by 40 percent during the period (DFAT, 1998).

1.1 Study objectives

The main objective of this study is to develop and apply a Computable General Equilibrium (CGE) model of the Western Australian economy to measure the economy-wide impact of further processing of the state's primary agricultural products. In addition, this study examines the existing literature on impediments to agricultural processing in Australia in general, and Western Australia in particular, and supplements this information with two food processing case studies in Western Australia.

1.2 Distinction between processing and value-adding

It is frequently lamented that there is insufficient 'value-added' to the products of Western Australia's primary industries - in particular to the products of the agricultural and mining sectors. What is really meant by those making this type of statement is that there is insufficient secondary processing of our State's primary products. In this report, when discussing the transformation of agricultural commodities to higher unit value goods, we will describe the activity as 'processing'. Throughout this report, the term 'value-added' will be given a specific meaning, different from its more common usage; value-added is the difference between the price received for a commodity and the cost of the goods and services used to produce it. This difference reflects the labour costs, taxes and returns to capital and land that contribute to the final worth of the commodity. This concept is very important in economic analysis, because by summing together the value-added from all production in Western Australia, the State's Gross State Product, or GSP, is determined. By reserving the term 'value-added' for this specific meaning, we avoid the confusion that may result when we discuss the value-added impact of expanding the processing of primary agricultural products.

The rest of the paper is divided into four more sections. Based on a literature review and two case studies, constraints and potentials for agricultural and food processing in WA are examined in Section 2. In Section 3, the characteristics of the CGE model for the WA economy are described. The empirical application and the results of the model are discussed in Section 4. The paper is concluded in Section 5, along with a summary of major findings.

2. FOOD AND AGRICULTURAL PROCESSING IN WESTERN AUSTRALIA

The development of agricultural and food processing in Western Australia appears to have started almost immediately after the Swan River Colony was founded in 1829. However, the expansion of food processing, and of manufacturing in general, was slow due to the State's low population growth. Peterkin (1942) recorded that until 1850 there were only 23 factories in the State. It can be said that the serious commencement of manufacturing, particularly food processing, did not begin in WA until the mid 1890s, and was a result of gold being discovered[3]. The in-flux of people resulting from the discovery of gold led to an increase in the State's population from 50,000 in 1890 to 180,000 in 1900 (Perry, 1934), and the number

3 The prominent food processing companies associated with the early history of Western Australia can be identified as:

- W. Thomas & Company (W.A.) Limited (Flour Millers and Grain Merchants, Cottesloe) used to control three of the largest mills in WA. Its development is associated with the early history of WA in 1849.
- Watsonia Brand Products (Bacon and Butter, Fremantle and Perth). It is possible to trace the character of Watsons Foods back to William Watson, the founder. (http://watsonia.com/watsonia/).
- Mills & Ware Ltd. (Biscuit Manufacturers, Fremantle). It is the oldest and largest firm of Biscuit Manufacturers in Western Australia. It was founded at Cottesloe in 1897. (http://www.millsandware.com.au/about/history.html).

of processing (including food) units increased to 632 (Peterkin, 1942). This sudden increase in demand triggered the establishment of manufacturing industries and thus Western Australia began to meet its own requirements for manufactured commodities. However, the growth of the State's manufacturing sector did not proceed unhindered. Over the last century, local, national and international events affected the development and progress of the manufacturing sector in WA. Both State and national policies and immense competition in domestic and external fronts have shaped the WA manufacturing sector into its present form[4].

In this section, we deal with the contemporary situation of the food and agricultural processing industries in WA. The relative composition and contribution of the food and agricultural processing industries to the State economy provide a background for analysing the economy-wide impact of the expansion of the food processing industries in WA. We also make an attempt to identify the factors affecting the expansion of these industries. Finally, the condition of a successful, and a failed, food-manufacturing firm is described.

2.1 Present composition

The average economic structures of WA and the rest of Australia (ROA), over the five years to 1999/2000, are demonstrated in Table 2.1. Column 2 of the table shows that the primary industry sectors (agriculture, forestry and fishing and mining) are far more significant in the WA economy than the manufacturing sector, which includes both agricultural and mineral processing. The share of the combined primary sectors is 22 percent of the State's GSP (Gross State Product) whereas it is 8.4 percent for the manufacturing sector. In contrast, the manufacturing sector is the most significant in the ROA's economy, and contributes more than 12 percent (Column 3 of Table 2.1). The combined primary sectors contribute less than six percent in the ROA's GSP.

Western Australia's contribution to each national industry is presented in Column 4 of Table 2.1. It shows that WA manufacturing accounts for a little more than seven percent of the Australian manufacturing industry; whereas, the WA Agriculture, forestry and fishing sector represents nearly 15 percent of the national total. In addition, the WA Mining industry represents 45 percent of the national industry.

- Great Southern Roller Flour Mills Limited (Narrogin and North Fremantle). The company was originally founded at Narrogin in 1903 as the Narrogin Co-operative Flour Milling Company.
- Peters American Delicacy Company (W.A.) Ltd (Roe Street, Perth). The firm commenced operations in Perth in 1929 when it purchased the business of The Western Ice Company (1919) Limited. (http://www.pbfoods.com.au/history.asp).
- The Swan Brewery Co Ltd is one of Western Australia's largest companies since the beginning of the 20th century (Welbourne, 1992).

4 For details see Austen (2000), Snooks (1974), Stone and Garden (1978), Burvill (1979), Fitzpatrick (1991), Barker (1991), Olney (undated), Pratt (1934), Firkins (1979), and Commonwealth of Australia, (1997, 2000 and 2001)

Table 2.1. Share in gross state product by broad industry sectors in WA and the ROA (five-year average, 1995/96 to 1999/00)

Sectors	Western Australia	Rest of Australia	WA as percent of Australia
(1)	(2)	(3)	(4)
	Percent		
Agriculture, forestry and fishing	4.1	2.9	14.7
Mining	17.4	2.6	44.9
Manufacturing	8.4	12.4	7.4
Electricity, gas and water	2.4	2.1	12.2
Construction	6.6	5.3	13.2
Wholesale trade	4.4	5.0	9.7
Retail trade	4.7	5.1	10.1
Accommodation, café and restaurants	1.4	2.1	7.5
Transport and storage	4.9	4.8	11.0
Communication	2.4	2.8	9.4
Finance and insurance	3.2	5.7	6.4
Property and business	8.6	10.4	9.1
Government admin. and defence	2.3	3.5	7.4
Education	3.2	4.1	8.7
Health and community	5.1	5.3	10.5
Cultural and recreational	1.2	1.6	8.4
Personal and other	2.0	2.1	10.4
Ownership of dwellings	6.1	8.6	7.9
General govt.	1.7	1.9	9.8
Other principal components	9.9	11.8	9.3
GSP total ($ million)	61,415	504,790	10.8

Source: ***ABS (2001).***

As food and agricultural processing industries are components of the manufacturing sector, a decomposition of the manufacturing sector into food and non-food processing components will help demonstrate the relative position of the WA food processing industries. Such decompositions are made in Table 2.2, and allow us to compare the relative share of the food processing industries in terms of the value of production and exports. Column 3 shows that the production share of food processing industries is 20 percent in WA and slightly higher, at 24 percent (column 5), for the ROA. In terms of exports, the share of processed food in WA is only 14 percent (column 4), whereas, it is 32 percent in the ROA (column 6). This information reinforces the belief that, currently, the WA food processing industries are less significant to the WA economy than they are to the ROA.

Table 2.2 Production and exports of food and non-food manufacturing sectors in WA and the ROA, 1999-2000

ANZSIC[1] code	Manufacturing industry	Western Australia		Rest of Australia	
		Production[2]	Exports	Production[2]	Exports
(1)	(2)	(3)	(4)	(5)	(6)
		Share of total value			
21	Food[3] (%)	20	14	24	32
22 to 29	Non-food industries (%)	80	86	76	68
21 to 29	Total value ($m)	16,975	4,728	193,696	32,106

Notes:
1. Australian and New Zealand Standard Industrial Classification (ABS, 1993).
2. Production refers to sales and transfers out of goods produced.
3. Processed agricultural products, including beverages and tobacco.

Source: ***ABS (2001a and 2001b).***

Further analysis is done in Table 2.3 to compare the relative value-added shares of the WA food and total manufacturing sectors with the other Australian states and territories. It is revealed that in 1999/2000 WA's share in the national value adding was only 6.5 percent (column 3) and 7.4 percent (column 5), respectively, for the food and total manufacturing sectors, ranking WA fifth among the six Australian states. New South Wales and Victoria presently dominate food processing and manufacturing in Australia. These two states combined contribute more than 60 percent to the national food processing industry.

Column 6 of Table 2.3 shows the food processing industry's share (in value-added terms) of the manufacturing sector in each state and territory in Australia. It shows that WA's position is the lowest of any state, at 18 percent.

Table 2.3. Food[1] manufacturing value-added in Australian States, 1999-2000

States	Food[1] manufacturing		Total manufacturing		Food as % of manuf-acturing
	Value added[2] $m	% of Australia	Value added[2] $m	% of Australia	
(1)	(2)	(3)	(4)	(5)	(6)
New South Wales	4,439	31.2	23,103	33.7	19
Victoria	4,249	29.8	22,159	32.4	19
Queensland	2,343	16.4	9,597	14.0	24
South Australia	1,698	11.9	61,79	9.0	27
Western Australia	922	6.5	5,058	7.4	18
Tasmania	535	3.8	1,769	2.6	30
Northern Territory	36	0.3	352	0.5	10
Australian Capital Territory	23	0.2	245	0.4	9
Australia	14,244	100.0	68,462	100.0	21

Notes:
1. Processed foods including beverages and tobacco.
2. Value added is Gross Domestic Product equivalent.

Source: ***ABS (2001a and 2001b)***

2.2 The extent of agricultural processing in WA

To assess processing opportunities for WA agricultural commodities, it is helpful to establish the condition of the current level of food processing in the state. Unfortunately, such information is not always readily available. The information presented in Figure 2.1 and in Table 2.4 is based on Islam (1997), and does not relate to a particular year; rather it relates to a typical-year or average contemporary situation, and it gives an indication of the extent to which the major primary agricultural commodities in WA are produced, processed and exported.

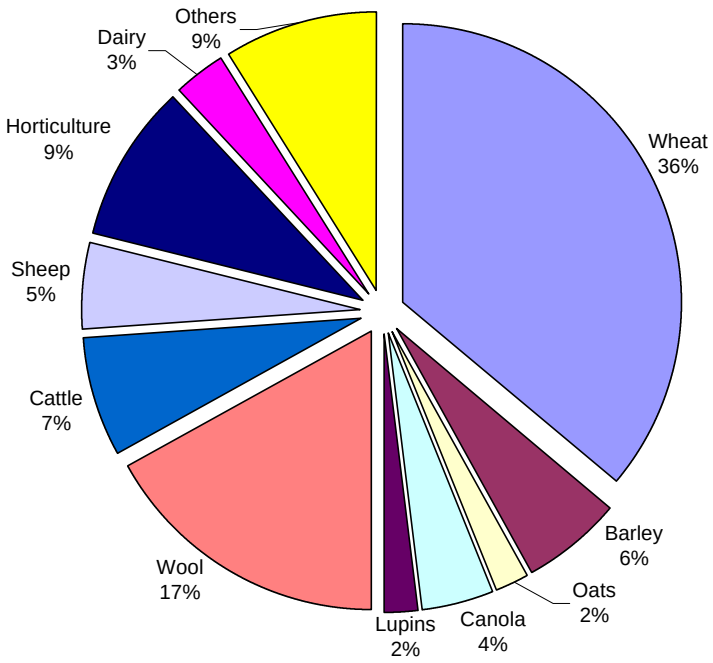

Figure 2.1. GVAP share of major agricultural commodities in WA. ***Source: Islam (1997).***

In Column 1 of Table 2.4, the major commodities are listed. They are grouped according to the Industry Programs of the Department of Agriculture Western Australia that prevailed during the last half of the 1990s, and modified to make them compatible with the agricultural industry and commodity components of the WA Input-Output table (see Islam and Johnson, 1997).

Figure 2.1 shows each commodity's share of the gross value of agricultural production (GVAP). It can be seen that the share of cereals (include wheat, barley and oats), mainly wheat, is more than one third of the State's GVAP. It is the single most dominant agricultural commodity produced in WA. However, only a small proportion of its total production is processed and exported (Table 2.4). Since cereals, mainly wheat, is the biggest industry in WA agriculture, and only a very small proportion of it is processed for export, there appears to be a large opportunity for the WA economy to gain by expanding its cereals processing industry.

TABLE 2.4. Percentage distribution of processed and unprocessed agricultural commodities produced in WA for domestic use and exports in a typical year

Commodities (1)	Domestic		Exports		Total
	Processed (3)	Unprocessed (4)	Processed (5)	Unprocessed (6)	(7)
Cereals					
Wheat	2	2	1	95	100
Barley	3	20	8	69	100
Oats	1	84	8	7	100
Pulses and Oilseeds					
Canola	5	3	6	86	100
Lupins	15	31	1	54	100
Meat					
Cattle	28	51[a]	15	6	100
Sheep	8	68[a]	13	11	100
Pigs	99		1	0	100
Chickens	100				100
Eggs		94	6		100
Horticulture					
Apples	15	65		20	100
Bananas	1	98		1	100
Carrots		22		78	100
Cauliflower	3	14		83	100
Potatoes	49	42		9	100
Grapes (wine)	32		68		100
Dairy[b]					
Milk	46	45	9		100
Wool					
Wool			25	75	100

Notes:

[a] Refers to cattle and sheep stocks.

[b] For the dairy industry the unprocessed amount of milk refers to white fresh milk. Technically, all milk goes through some form of processing, bottling and packaging.

Source: ***Islam (1997)***

The GVAP share of the pulses and oilseeds industry is only about six percent (Figure 2.1). Although its share is small, the industry also appears to have a major opportunity for increased processing and exports. Presently, on average, only about 10 percent of the production are processed, and exports from the sector are mostly in unprocessed form.

Overall, the meat (i.e. cattle, sheep, pigs, chicken and eggs) industry's contribution to the GVAP is about 17 percent (see Figure 2.1). In general, meat is mostly processed and a greater proportion is domestically traded. However, over the last 10 years many older and less competitive meat processors have closed (AGWEST, 1999). Strict processing regulations, increased live cattle exports (as evident in Figure 2.2), the 'cost-price' squeeze, urban expansion and the move towards bigger regional processors are considered to be the

major factors responsible for the closure of meat processing plants (Rolfe and Reynolds, 1999). Figure 2.2 shows that over the last five years the export of live cattle grew by 14 percent per annum. In contrast beef export growth was close to zero.

The horticulture industry in WA comprises about nine percent of the State's GVAP (Figure 2.1). Except for wine producing grapes, which are 100 percent processed, most of the commodities are traded without processing. Wine is exported at relatively higher export margins, and is also sold with a relatively high mark-up in the domestic market.

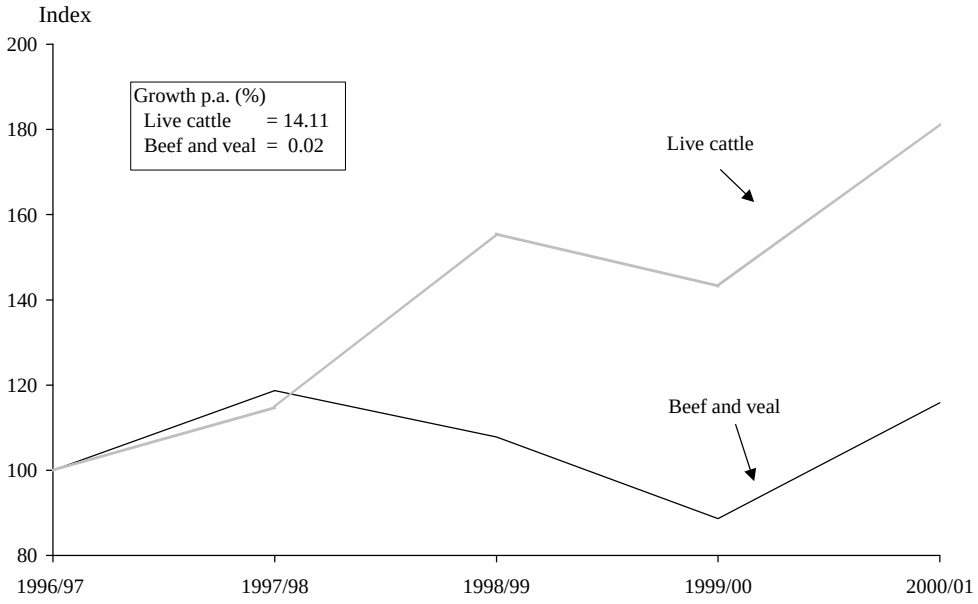

Figure 2.2. Live cattle and beef export trends in WA, 1997/97-2000/01. ***Source: Annan (2001).***

The other relatively processed horticultural commodity is the potato. Up until the closure in August 1999 of Simplot Australia's potato processing factory[5] in Manjimup, about 50 percent of potatoes were processed as chips and french-fries. The closure has significantly reduced this share in recent years.

The WA dairy industry is very small and its GVAP share is only three percent. All the milk produced in WA is processed in one form or another. About 45 percent of the milk produced are processed as white market milk (see column 4 and note 'b' of Table 2.4) and 55 percent is processed as manufacturing milk. Only nine percent is exported as processed. Islam (1997) found that the milk-processing sector adds twice as much added values as the dairy farm sector per litre of milk. Before July 2000, the WA dairy industry's market milk component operated under regulated domestic market conditions, where most dairy farms were issued a quota license to supply fresh milk at a premium price fixed by the Dairy Industry Authority. The fresh milk price was two times higher than the processed milk price. Today, with the deregulation of the dairy industry, farmers are free to operate in response to

5 Simplot Australia is a food processing company. See Section 2.5 for details of the closure.

market conditions. Since farms were paid a premium price under the quota system, the farm price of milk is now likely to decline with market deregulation. Given the static domestic demand for fresh milk, the industry can contribute more by producing more milk for processing and exports.

Wool is the second largest commodity produced in WA agriculture. Most of the State's wool production is exported in unprocessed form. Depending on its quality[6] wool goes through a number of processing steps before it gets transformed into different final products[7]. Scouring is the very first step of wool processing and only 25 percent are scoured in WA before it is exported in greasy form (Table 2.4). Given the volatile global market for raw wool, this industry may have an opportunity to add value to the WA economy by developing a wool-based textile industry in the State.

2.3 Balance of trade in agricultural processing industries

In Table 2.5, the trade in food products at various stages of processing, is presented for WA and the ROA. These trade figures are averages for the period 1992/93 to 1998/99. The percentage of minimally transformed food exports is about 80 percent in WA (column 3),

Table 2.5. Average food trade per year by level of processing in WA and the ROA, 1992/93 to 1998/99

Level of transformation	WA		ROA		WA as percent of Australia
	Average ($m)	% of total	Average ($m)	% of total	
(1)	(2)	(3)	(4)	(5)	(6)
Exports					
Minimally transformed[1]	2,045	79	3,146	25	39
Substantially transformed[2]	531	21	9,536	75	5
Total	2,576	100	12,682	100	17
Imports					
Minimally transformed[1]	11	9	313	9	3
Substantially transformed[2]	118	91	3050	91	4
Total	129	100	3,363	100	4
Net exports					
Minimally transformed[1]	2,034	83	2,833	30	42
Substantially transformed[2]	413	17	6,485	70	6
Total	2,447	100	9,319	100	21

Notes:

1. This is equivalent to the unprocessed food commodities. This includes live animals except fish, fish or shellfish, horticulture, vegetables, fruit and nuts, total grains, oilseeds, and food n.e.c. (wool is not included).
2. Meat processing, poultry processing, bacon, ham and small goods, seafood, milk and cream processing, ice cream, other dairy products, fruit and vegetables, oil and fat, flour mill products, cereal food and baking mix, bakery products, bread, cake and pastry, biscuits, other food, sugar, confectionery, soft drink, cordial and syrup, beer and malt, wine, spirit, other n.e.c.

Source: ***AFFA (2000) and Western Australian statistics was collected from Perry Smith of ABARE through personal correspondence.***

6 Wool quality varies with respect to its length, staple strength and diameter.

7 The processing steps include: scouring, carbonising, tops, yearns, fabrics and garment making and so on.

Whereas, it is only 25 percent for the ROA (column 5). Most of the agricultural commodities (about 75 percent) in the ROA are exported in substantially transformed forms.

In terms of imports, the relative shares for the two levels of transformed food products are almost the same for WA and the ROA. More than 85 percent of the imported foods in Australia are of the substantially transformed variety. On balance, WA is a net exporter of minimally transformed food items. More than 80 percent of the State's positive balance in food trade is generated from this level of processed foods. Conversely, the ROA is a net exporter of substantially transformed food items. About 70 percent of the ROA's positive balance of food trade are generated from this category of processed foods.

Column 6 of Table 2.5 shows that WA's share in the total national food exports is 17 percent; however, for minimally transformed foods, the share is much higher at 39 percent. Conversely, WA's share of national food imports is around only 4 percent for both levels of transformed food categories. In terms of net exports, WA's share of minimally transformed foods is about 42 percent. This analysis reconfirms that, to a great extent, WA agricultural commodities are exported without processing.

2.4 Impediments to agricultural processing

There is a general perception among agri-industry stakeholders that a substantial increase in the size of the food processing industry in WA is not sustainable. The general view is that the more processing that occurs in Australia, the less cost competitive in foreign markets the final product is likely to become. Industry analysts and commentators put forward a number of issues and reasons in support of this view. However, so far, no comprehensive studies have been undertaken to examine the constraints to, and opportunities for, the expansion of food processing industries in WA. Although reviews of some industries were commissioned in WA, these mainly dealt with the production, export marketing, and legislative issues related to a particular primary industry, such as the dairy industry (RMS, 1997) and grain industries (DAWA, 2002). In the absence of such information for WA we relied on Australia wide studies, considering that, in most cases, the general issues would be the same for food industries in WA. Based on a review of the following reports and papers, the general issues identified as impeding agricultural processing in Australia in general, and in WA in particular, are outlined below (INSTATE, 2000; Commonwealth of Australia, 2000 and 2001; AGWEST, 1999; and Rolf and Reynolds, 1999).

The major factors affecting the food and agricultural processing industry have been identified as export competitiveness and market development issues (INSTATE, 2000). The prime concerns expressed by the industry stakeholders in building the export capability of the industry pertain to the issues outlined below.

Issues surrounding the size and ownership of firms: A small number of large firms dominate the industry and more than 50 percent of these firms are foreign owned. Larger firms are less committed to exporting at the higher end of the value chain than the industry

as whole. The main reason for this is that they see few opportunities for profitable investment in exporting highly processed food from Australia. The other reason is that the strategy of the foreign-owned companies is to manufacture as close as possible to the market they supply. Small firms are both willing to invest and seriously interested in expanding exports, but they lack the scale to sustain exports or make a significant contribution to the sector's overall performance. Some industry leaders fear that the food processing industry is under serious threat from foreign competitors, partly because it receives too little effective support and recognition from the government and the community.

Highly competitive export markets: Industry protection and export subsidies in competing countries are seen to be substantial impediments. In addition, firms' operational inadequacies and lack of effective government support are the most serious domestic impediments to food processing for export.

The high cost of many raw materials: The cost of raw materials is identified as a serious impediment to processing food and exporting. In a few cases, Australian raw materials confer a distinct comparative advantage on Australian processors. In most cases, Australian processors pay the same world price for their raw material inputs as their competitors. In some cases they pay more. Foreign governments focus on export subsidies in sectors and markets where competitor countries, such as Australia, compete strongly on price terms. The main reasons for uncompetitiveness in raw materials are lack of scale at the primary producers' level and relatively less developed vertical integration with the food processors, compared with some competing countries. The competitiveness of primary producers is also hampered by the relatively high cost of some agricultural input - for example, labour and feed. Regulatory structures, in some cases, impede the flow of raw materials to processors and increase the cost of some raw materials.

The failure of processing to achieve competitive gains: Total competitiveness depends on how creatively and cost-effectively firms augment raw materials, not just in processing and packaging, but also in quality, uniqueness of product, service, market positioning, channel development, promotion and brand development, and support. There is a general consensus of opinion among firms that very little cost competitiveness is gained during the intermediate stages of the value chain in Australia - in manufacturing, packaging, financing, freight, and international marketing.

Low levels of labour productivity and investment in innovation: Labour productivity in some segments of the industry in Australia lags behind the levels achieved by competitors in the United States, Europe and some other countries. Investment in research and development (R&D) is declining in Australia. Too often, the Australian product is not price-competitive, not highly differentiated, and not successful in capturing the 'value of values' (for example, by promoting products, where appropriate, as 'eco-efficient', clean or safe). Industry in general, believes in the proposition that, as it stands, the more processing is done in Australia, the less cost competitive the final product is likely to become in foreign markets. While industry clearly understands that differentiation and total competitiveness comes from investment in R&D and other forms of investment, such as marketing, Australian firms generally under-invest in these areas.

Substandard corporate capabilities: Firms often subscribe to the view that management, technical and export skills in the industry are often not competitive on the world stage and impede their export ability. There is little evidence of genuinely innovative approaches undertaken by firms for export market development and few companies intentionally focus on value chain or demand chain management issues for export markets.

A lack of confidence in government efforts to provide support: Too often firms possess limited knowledge and understanding of many government policies and programs designed to support exporters, including those in processed foods. They are not confident that the government is fighting hard to reduce foreign protection and export subsidies. Most are fatalistic, believing that things are not likely to get much better, especially in the short and medium term. Moreover, Austrade's[8] fee structure is considered to be inappropriate, and the Australian Quarantine Inspection Services (AQIS) is seen to be too concerned with its role as 'policeman' and not sufficiently interested in helping exporters. This suggests, at the very least, a failure of communication on the part of the two agencies.

Issues specific to the grain industry: The wheat marketing arrangements aim to ensure an export premium for growers. Too often however, these arrangements place additional costs on the domestic food market, including both the manufacturers and consumers. Under current wheat marketing arrangements, the tender system is very cumbersome for domestic food producers. It places priority on the export market, and, therefore, the domestic market comes a distant second. Post-harvest access to wheat is restricted, and that poses additional constraints on the flexibility of producers and exporters. The Australian Wheat Board (AWB) has a veto power over bulk exports that constrains shipping wheat to places other than those designated by the AWB. The AWB also has sole responsibility for setting standards, and typically does so, without consultation with domestic users. This makes it very difficult for domestic users to deal with them at times, especially when an attempt is made to include a wide variety of grains in food processing. In recent years, the wheat industry has increasingly shifted from exporting flour to exporting bulk wheat. Despite support in the grains industry for the processing of wheat in Australia for export, as expressed at the Grains 2000 conference held in 1991, in recent times, hundreds of flourmills have closed down in Australia. The closures are a result of overseas buyers preferring to buy wheat in bulk rather than in the form of flour. Consequently, flour exports have plummeted.

Issues pertaining to the meat industry: The meat processing industry in Australia is under substantial pressure to improve. The capacities of existing meat-processing plants are increasingly under utilised (Rolf and Reynolds, 1999; and Agriculture Western Australia, 1999). In Queensland, the largest meat producing state in Australia, the major factors believed to be responsible for declining meat processing in the State are, the loss of supplies through the live cattle trade, changed industrial relations and a move to enterprise bargaining agreements, and the impost and structure of government regulations. A similar situation also exists in Western Australia. Strict quarantine and processing restrictions, higher profits from live animal exports, pricing pressure on international commodity markets, urban expansion and upgrade costs, have contributed towards this declining trend.

In summary, the progress of food processing industries in Australia appears to be affected principally by the size and foreign ownership structure of the existing companies, distortions in export markets, the high cost of some raw materials, the passive attitude of firms towards achieving cost-competitiveness along the value chain, inadequate investment on innovation, inefficient labour markets, below world standard corporate management skills, little awareness of and confidence in government support, the regulated marketing structure for

8 Austrade (The Australian Trade Commission) is the Federal Government agency that helps Australian companies win overseas business for their products and services by reducing the time, cost and risk involved in selecting, entering and developing international markets (More about Austrade is provided in their webpage <http://www.austrade.gov.au/generic_template/0,,ContentGroup%253Daboutaustrade,00.htm>.

some major agriculture commodities, and quarantine restrictions and control. From company to company and industry to industry, however, the effect of these factors varies. Since the scope of the present study is on the WA food processing industries, an investigation into some WA food processing industries is considered to be helpful and presented below.

2.5 Two Western Australian case studies

A firm's success or failure can be assessed in a number of ways. The most simple and common way is to follow the trend in its annual turnover over a considerable period. If the trend is consistent, then that gives an indication that the firm is competitive and successful. Based on this criterion we have chosen two food processing firms: Harvey Fresh in Harvey, which is considered to be successful, and Simplot-Australia's potato processing plant in Manjimup, which has failed and closed down. Harvey Fresh is located in the southwest region of WA. The potato processing plant was also located in this region but farther south. Using as a basis Porter's (1990) four major interrelated determinants of the competitiveness of industries and nations, we examine the factors affecting these two food-processing firms after briefly describing their respective operational backgrounds.

2.5.1 Harvey Fresh[9]

Harvey Fresh is a food processing company located 140 kilometres south of Perth in the farming town of Harvey. The business commenced producing fruit juices in 1986. Harvey Fresh is basically a family business, with a background in citrus fruit farming, horticultural business and some sheep and cattle grazing. In 1986 it had 50 acres of orange trees, and to add value to the fruit, the firm decided to make orange juice and sell primarily to the local market. It started by producing freshly squeezed and refrigerated orange juice with a short shelf life. Gradually, the firm expanded by producing other juices, including mixed-flavoured juice such as orange-mango, orange-pineapple, passion fruit and lemon. Subsequently, they included the production of apple juice by purchasing concentrated apple juice from the Eastern States. After two years, having achieved a reasonable market share, they invested in the construction of a small apple processing plant within their own operation, and processed the apples from Donnybrook, Manjimup and the Perth Hill areas[10]. The investment proved to be successful.

Following this success, they improved the cost- effectiveness of their apple juice production by expanding their purchase of second grade apples, which are not appealing to consumers as fresh fruit, but are of sufficient quality to produce juice. Thus, by using cheaper apples, Harvey Fresh expanded the volume of its apple juice production and utilised its plant capacity more effectively. Subsequently, the firm invested in more equipment and moved to produce concentrated apple juice with a longer shelf-life for local and overseas markets.

While the business of other fruit juice production was expanding successfully, the orange juice business continued to grow and the citrus tree plantation increased from the original 50 acres to an area totalling 200 acres. However, the company's own supplies, in addition to the local fruit supply is still not enough to sustain the full operation of the plant, and therefore, they import fruit from South Australia. Unlike apples, there is no restriction on importing orange and other fruit from the Eastern States for processing.

9 The information about Harvey Fresh is based on a personal interview with Mr. Kevin Sorgiovanni, Manager, Sales, Marketing and Export, Harvey Fresh, Harvey.

10 Because of quarantine restrictions, sourcing apples from the Eastern States is not possible.

Harvey Fresh has taken an innovative approach and adopted technologies to become internationally competitive. For example, the company developed and adopted the PET[11] long life concentrated fruit juice technology, in response to consumers' changing tastes and preferences. This type of concentrated apple and orange juice is 'shelf-stable', with a shelf life of 12 months. The sale of this product has gained momentum in the export market. Currently, this product is sold in the Philippines, Vietnam, Hong Kong, India and Bangladesh and in small volumes to the Middle East.

Prior to this technology being introduced, airfreighting short shelf-life fruit juice had been very expensive. The advent of long shelf-life fruit juice over a four to five year period has increased competitiveness and aided the firm in capturing a larger share of the export market.

At present, the firm utilises the capacity of the fruit juice processing plants more efficiently by processing a variety of fruits and vegetables, including carrots. On different days, different fruits and vegetables - such as pears, carrots and apples - are processed. Now, the firm has grown into a large company operating juice and dairy factories, and more recently, a winery. It is producing wines under the Harvey River Bridge Estate and Joseph River labels. At present, the firm produces a wide range of products for local and export markets[12].

2.5.2 Simplot-Australia's potato processing plant in Manjimup

For our purposes, Simplot-Australia's potato processing plant in Manjimup (henceforth, the Simplot-Manjimup plant or S-M plant for short) can be described as a failure. Located about 300 km south of Perth, the S-M plant was closed in August, 1999. The primary reason for selecting this failed potato processing plant, is that the potato industry is an important component of the economies around Manjimup, and since its closure, several attempts have been made by other firms to revive the processing plant, all of which have proved unsuccessful[13].

Failure is rarely discussed in business history. McCarthy (1992) observed that the historical record of entrepreneurship is inevitably skewed towards survival and success. So, it is not surprising that this study found it difficult to obtain information on the closure of the S-M plant. However, as closure of the S-M plant has been a significant event in terms of its impact on the local economy, it received a lot of political and media attention. Relying on a review of some news articles published in The West Australian[14], and on records of the correspondence between the Department of Agriculture Western Australia and Simplot Australia, we attempted to understand the causes of its failure.

Simplot-Australia is a foreign owned multinational company. It began with potato and onion farming in Idaho in the 1920s. While the name 'Simplot-Australia' is relatively new in Australia, its brands and factories have a long history in this country. Its well know brand

11 PET is the terminology used for plastic bottling of juice for long shelf-life. It is filled hot at 84º Celsius and chilled down immediately to room temperature. In this way, with no preservative and no additives, the product stays shelf-stable.

12 See Harvey Fresh's web page www.harveyfresh.com.au for details on the company's products.

13 Since April 23, 2002 the Bendoti family has operated the potato chip processing facility at the 'Manjimup Coolstores' site in Manjimup. Between 2,000 to 3,000 tonnes of potatoes are expected to be processed per year, and this may increase to 6,000 tonnes in the near future.

14 The following articles from The West Australian were reviewed: 'Jobs blow for Manjimup', 3 July 1999; 'Don't Forget Us, Say Potato Workers', 11 August 1999; 'Manjimup misses the joys of Spring', 2 September 1999; 'Manjimup executive plans new direction', 2 August 2001; 'Firms fight back', 1 November 2001; 'Simplot pool-out mixed blessing', 1 November 2001; 'Some story at Manjimup', 21 March 2002; 'Growers hold out little hope', 21 March 2002; 'Closure poor timing', 4 April 2002; 'Chips are down for Simplot factory', 4 April 2002 and 'Spud saviours in nick of time', 25 April 2002.

names are, Birdseye, Chiko, Edgell, Four'n Twenty, Harvest, Herbert Adams, I&J, Leggo's, Nannas, Plumrose, and Sealord. It manufactures and sells frozen, canned and baked products. The products are distributed through an extensive network of major supermarkets, convenience stores and food service outlets such as restaurants, cafes and caterers. Presently, Simplot-Australia operates 9 processing facilities and six sales offices in Australia. It has total sales of A$740m and it is one of the top ten food and beverage companies in Australia[15].

The history of the Simplot-Manjimup plant began in the mid 1990s, prior to which the plant was operated by Birdseye-Edgell. Immediately before its closure in August 1999, the Manjimup factory employed 112 full and part-time workers, and had 40 contract potato growers who harvested 30,000 tonnes of potatoes for the factory. In 1999, the potato industry was worth $34m a year to Manjimup, and the S-M plant's contribution represented half of that.

Before Simplot-Australia bought the S-M plant from Edgell-Birdseye, then owned by Pacific Dunlop, the plant produced less than 30,000 tonnes of potato chips and wedges. Simplot-Australia bought the plant as a part of its Australia-wide food processing business takeover from Pacific Dunlop, with a plan to increase production to about 80,000 tonnes per annum over a period of three to five years. Records indicate that the company had accurately assessed the issues that needed to be addressed in order to accomplish the plan. The company seemed to be aware that the cost-effective supply of raw materials was the critical factor that would lead to the success of the plant. In this respect, the important issues considered were: (a) expanding the potential potato growing area near Manjimup; (b) establishing longer harvesting seasons; and (c) adopting and developing improved varieties of potatoes with improved nutritional quality and out of season harvest. The company sought assistance from the WA government in this regard. The immediate assistance sought was to get quarantine clearance for (a) introducing improved potato varieties in WA from Victoria and Tasmania, and (b) moving harvesting machines from the Eastern States on a trial basis to achieve significant cost effectiveness. As a long-term strategy, the company also sought government assistance to resolve issues relating to land clearing, environmental protection and bore licensing for irrigation in potential potato growing areas. The Department of Agriculture in Western Australia (DAWA) provided assistance on matters within its jurisdiction. However, not all of these issues were resolved. Perhaps for this reason, for four consecutive years the S-M plant did not process more than 30,000 tonnes of potatoes, which is less than 50 percent of its processing capacity. Hence, in 1999, during a detailed examination of some loss making assets, Simplot-Australia decided to shutdown the operation of the plant.

The S-M plant mainly produced potato chips and wedges, mostly for the WA market. High production costs and a difficulty in obtaining the required quantity and quality of potatoes had forced the closure. Simplot-Australia has two more processing plants in Tasmania. Part of the S-M plant's processing capacity may have moved to these operations.

15 See Simplot-Australia's web page www.simplot.com.au for details on the company's background and processed food products.

2.5.3 A comparative analysis

The fundamental differences between the two food processing companies are given in Table 2.6. By applying Porter's (1990) 'four-diamond' framework for industry competitiveness, we made an attempt to analyse the above information to understand the reasons for success and failure of food processing firms in WA.

Table 2.6. Key differences between the Harvey Fresh and Simplot-Manjimup plant for potato processing

Items	Harvey Fresh	S-M plant
Ownership	Local	Foreign
Management	Owner managed	Corporate executives
Size	Family business	Multinational company
Products	Diversified processed fruits, milk and wine products	Only two types of processed potatoes: chips and wedges
Markets	Domestic (WA) and export	Mainly domestic (WA)
Factors availability	Adequate	Inadequate
Government regulations	Do not affect much	Indirectly affected
Competing firms	Exist	No local competitor.
Complementary industries	Exist	Do not exist

Porter (1990) breaks down the determinants of the competitiveness of industries and nations into four interrelated components, as shown in Figure 2.2. These four determinants are generic factors. Within each of these four determinants, there are several factors whose effects could vary from one industry/firm to another. The factors, which are relevant to the performance of the above firms, are analysed below.

The first major component of the four determinants is the 'Firm's Strategy, Structure and Competitiveness'. This component helps to analyse how companies are created, organised, and managed, as well as the nature of domestic rivalry (Porter, 1990). Competitive firms are dynamic, innovative, efficient and flexible. In this context, Harvey Fresh appears to have all the necessary attributes to be a competitive firm. It is dynamic, in the sense that it has diversified its products in response to changes in consumers' preferences. It has developed and adopted new technologies to increase the efficiency of its production capacity. Also, Harvey Fresh has strong competitors, who supply similar products in the domestic market.

On the other hand, the S-M plant did not possess these essential attributes. Although Simplot-Australia appears to have had a strategy to make the plant competitive, it failed to do so. The products it produced were only of two kinds, chips and wedges, and consequently, it had less flexibility in terms of product diversification. In WA there were no other competing firms producing chips and wedges. Moreover, Simplot-Australia has two more potato processing plants in Tasmania, and as a result, had less incentive to improve the efficiency and continue the operation of the plant.

The second major component for a firm to be competitive is 'Factor Conditions'. Standard economic theory indicates that success in a business is determined by its factor endowments, such as labour, land, and capital. However, in the world of modern business,

while initial factor endowments form the backbone of a firm or an economy, they do not necessarily make a firm productive and efficient. To be competitive, modern businesses have to create these factors (Porter, 1990). Examples of this might include, improving land and soil conditions, strengthening human resource skills, increasing the productivity of capital equipment, and developing and adopting improved technologies. In this context, Harvey Fresh seems to have successfully developed its factor conditions. Over the years it acquired more land, which was cultivated to make it suitable for planting citrus fruit, and developed and adopted technologies for increased shelf life and low-cost bottling of juices. It also established efficient contracts with suppliers to supply quality raw materials in sufficient quantities, and on time for processing.

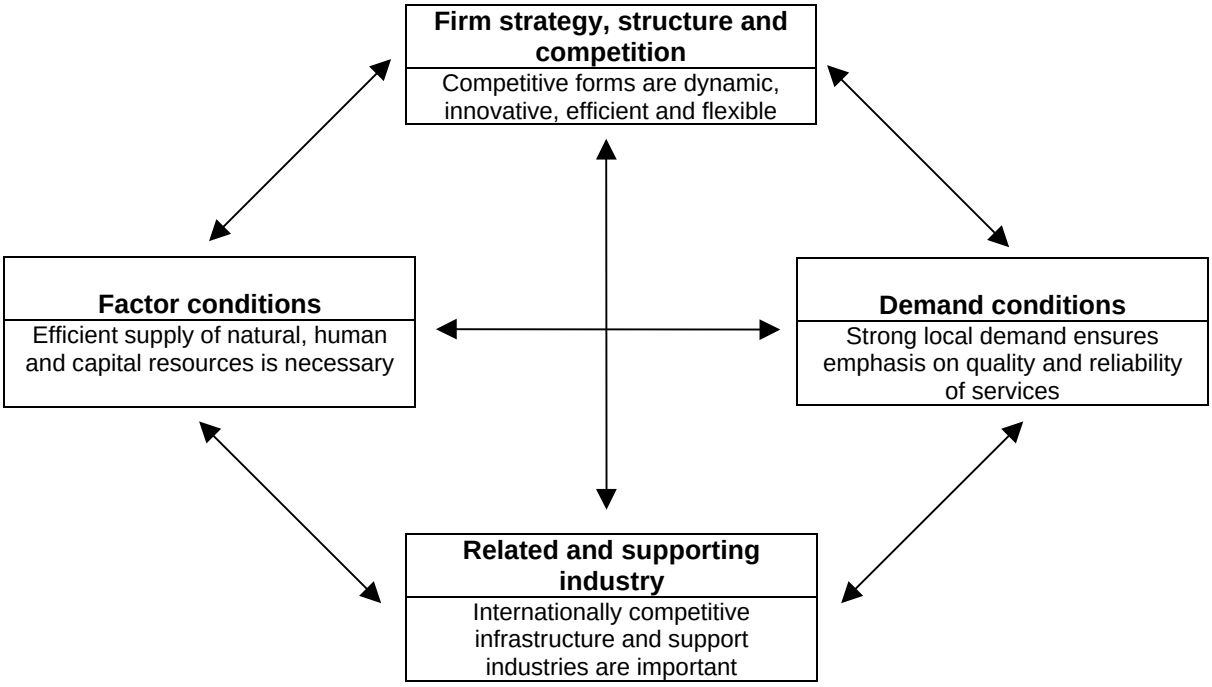

Figure 2.2 Determinates of competitiveness. ***Source: Porter (1990).***

Simplot-Australia, on the other hand, failed repeatedly to get the required quantity of potatoes as raw materials. Even with assistance from the Department of Agriculture in Western Australia, the company could not create the factor conditions necessary for the adequate year-round supply of potatoes. Since potatoes are a seasonal crop, the firm needed to develop new land and new potato varieties in order to be a consistent supplier. It was also necessary to develop and maintain skilled human resources year-round for cost-effective production. However, as mentioned above, issues such as land clearing, environmental protection, bore licensing for irrigation, and quarantine restrictions to import seeds and machinery seem to have been the major impediments in getting the required amount of raw materials.

The success and competitiveness of firms and companies also depends on 'Demand Conditions'. In other words, how firms and companies perceive, interpret and respond to buyer needs will determine their competitiveness. Sometimes buyers in the domestic market may demand particular types of goods, which must conform to qualities that are not required for the export market. This may result in the production of goods or services that are not suitable for export markets, but intended to secure an advantage in the local market. Clearly, strong local demand for fruit juice, dairy and wine products has induced Harvey Fresh to

concentrate on giving priority to the reliable supply of quality goods and services to domestic markets over the needs of export markets. As Mr Kevin Sorgiovanni, the owner, as well as the marketing manager stated during a personal interview, 'No matter what business you are in, a substantial local presence is necessary to ensure daily turnover of stock, to keep your factory operating, and to retain your employees; and, in this way, to ultimately achieve success and be competitive.

For the S-M plant demand conditions have not been favourable. As the plant produced only chips and wedges, with limited local demand for these products, the company would have had to sustain heavy losses over long periods. Moreover, since the company also produces the same products far more efficiently at its Tasmanian plants, and given that chips (French fries) and wedges do not have the same high degree of export potential in nearby Asian markets as enjoyed by Harvey Fresh products, the company, at least from a managerial perspective, seems to have made the right decision to close the plant.

The fourth broad determinant of competitive advantage is the presence of related and supporting industries that are internationally competitive (Porter, 1990). These industries deliver cost-effective inputs in an efficient, rapid and often preferential way. More important, is the development of close relationships between suppliers, buyers and related industries. Close relationships along the supply chain lead to faster responses to consumer preferences and changing demands. Harvey Fresh has established strong vertical integration along the supply chain. Both in domestic and export markets, it has its contracted buyers and distributors, and it has its own transport to deliver goods to local markets and ports. Raw materials are efficiently supplied by contracted suppliers and also sourced from its own fruit and vegetable farm and vineyard. With regard to its nationwide operation, although Simplot-Australia products are distributed through an extensive network of major supermarkets, convenience stores and food service outlets, and it has efficient suppliers of raw materials in other parts of Australia, the failure of its S-M plant was principally caused by an inadequate supply of raw materials.

The above analysis suggests that an expansion of food processing industries in WA is possible. However, a reasonable level of local demand and access to competitive supplies of raw materials, along with essential logistic and institutional support, are required for this to occur. In the following sections, we consider the economic benefits that may occur to WA if local processing industries were to expand. This analysis in conducted using a model of the Western Australian economy.

3. THE CGE MODEL

The use of Computable General Equilibrium (CGE) models for economic analysis began in Australia with the creation of the ORANI model (Dixon *et al.* 1982). ORANI, in its original form, is a single-region model of the Australian economy; that is, it models the entire Australian economy, without any consideration of state level activities. Since the inception of ORANI, a variety of CGE models have been developed in Australia, including models which capture state level activities. One such model is WAM (the WA model) (Clements *et al.* 1996) which is used for the analysis in this report.

3.1 Characteristics of CGE Models

CGE models have many advantages over other simpler methods of economic analysis, such as input-output analysis. Whereas input-output analysis assumes the economy remains static (i.e. that price levels, labour to capital ratios and import shares remain unchanged throughout the analysis), CGE models are able to incorporate and predict changes to the economic structure. CGE models are able to do this because they contain equations

describing a wide range of economic activities, including production, consumption, investment, employment, taxation and trade.

CGE models can be formulated to work in one of two ways, either in levels or percentage change terms. Models working in levels provide results that show directly the new state of the economy; for example, such a model would show the total level of employment, the new level of taxation revenue, and the total output from each industry. Models that work in percentage changes, on the other hand, provide results that show the percentage deviation from some predetermined base level in the economy. From such a model we get results that show, for example, the percentage increase or decrease in employment, and the percentage change in output of each industry. CGE models formulated in percentage change terms are the most common type used in Australia. The ORANI model, and its successor MONASH (Adams et al. 1994), are formulated in percentage changes.

CGE models consist of two major components: the equations and the database. While the equations give the model its predictive power, they are of no use without a comprehensive data set. The data incorporated into the model specifies the structure of the economy being analysed, and tells the model how variables react to changes in other variables. The economic structure is specified in CGE models with the inclusion of an input-output table. Input-output tables describe the transactions occurring within the economy in great detail, including, the transactions occurring between industries and the transactions occurring between industries and final consumers. How variables react to each other is specified by the elasticities of the database. Elasticities describe how, for example, consumers respond to changes in their income, or to changes in prices.

3.2 The WA Model

The WA model (WAM), used for the analysis in this report, is similar in many respects to ORANI. Just like ORANI, WAM is formulated in percentage change terms. WAM also treats Western Australia as a single region, and contains an extensive set of equations describing production, consumption, investment, employment, taxation and trade within the State's economy. Therefore, it can be said that WAM is structured in a fairly standard way for CGE models in Australia. What distinguishes WAM, and makes it such a useful tool for economic analysis in Western Australia, is the model's database. The WAM database contains the most detailed information available on the economy of Western Australia. The input-output table currently used in WAM is a 108-sector table for the financial year 1994-95. The table is based on the 105-sector table for WA developed by Johnson (2001), with additional detail provided in primary agricultural industries (see Appendix 1). While the main reason for creating this table has been for use within the WAM database, the table itself is useful for input-output analysis. To assist users within the agriculture sector who wish to perform this simpler type of analysis, a full set of agricultural industry multipliers, derived from this expanded table, is available in Appendix 1, along with definitions of each multiplier type.

The original version of WAM (Clements *et al.* 1996) contained less detail than the current version, as the input-output table used in its database was based on the 42-sector input-output table for 1989-90 by Clements and Ye (1995). Even though it was less disaggregated than the current version of the model, it was still a highly effective tool for economic analysis, and was used to analyse such issues as:

- the impact of new mining and minerals processing projects on the economy of Western Australia (Clements *et al.* 1996);
- the impact of increased minerals production on the economy of Western Australia (Ahammad and Clements, 1999);
- the impact of minerals industry growth on employment in different regions of Western Australia (Clements and Johnson, 2000);

- the impact of tariffs on the Western Australian economy (Ahammad and Greig, 2000); and
- the impact of lower energy costs on the Western Australian economy (Clements *et al.* 2002, Chapter 3).

WAM also became the basis for a variety of more specialised models: models such as WAT - a two-regional model of the WA economy - which was used to determine the impact of the Hot Briquetted Iron plant on the economy of the Pilbara region (Johnson, 1999), and WAE - a CGE model that incorporates energy substitution - which was used to investigate the impact of greenhouse gas reduction policies on the WA economy (Ahammad *et al.* 2001).

WAM also provided the basis for the construction of one further model of the Western Australian economy: WAG. WAG (short for the WA Agriculture model) was developed specifically for the modelling of agriculture within Western Australia (Ahammad, 2000a, b). The obvious question is therefore, why was WAG not used for the analysis in this report? The treatment of agriculture within WAG is relatively complex. This complexity was introduced in order to account for the joint nature of agricultural production. Jointness in agriculture refers to the fact that farm inputs may be used in the production of more than one output, and that decisions about the production of one farm commodity will influence the production of other farm commodities.[16] In WAG, the jointness assumption was applied to the following primary agricultural industries: Sheep meat, Wool, Cereals, Pulses and oilseeds, Beef cattle, Pigs, Poultry, Horticulture, and New industries. In fact, the only primary agricultural industry left out of the jointness assumption was Dairy cattle. By applying the jointness assumption to the above nine primary industries, the WAG model allows inputs to be shared between these industries, including the primary inputs of land, labour and capital. This assumption implies that, for example, the land and capital used in the production of Poultry can also be used for the production of Wool and/or Cereals. In evaluating the suitability of the WAG model for use in the analysis conducted in this report, the breadth of industries covered by the assumption of jointness was considered inappropriate, and so the WA model was preferred. However, some aspects of the jointness approach to production have been incorporated into the WAM, as will now be described.

3.3 Modifications to WAM

While the WAG approach was considered inappropriate for the analysis in this report, some of the concepts upon which WAG is based have been incorporated into WAM. In WAM, there are only two primary factors of production, labour and capital - where capital, in agricultural sectors, is a composite of land and capital. It is assumed in WAM simulations that labour is mobile across industries, and that the total supply of labour is not limited. Therefore, all industries can demand as much or as little labour as they require. Capital, on the other hand, is assumed to be industry specific, and fixed in supply. Now, for certain primary agricultural industries this treatment of capital is unnecessarily, and unrealistically restrictive. In the application of WAM in this report, we follow the example of the WAG model, and assume that some agricultural industries can 'share/swap' capital. The industries covered by this assumption are separated into two groups:

- Group A: Sheep meat (1), Wool (2), Cereals (3) and Pulses and oilseeds (4); and
- Group B: Horticulture (8), New industries (9) and Dairy cattle (10).

16 Jointness in agriculture may arise because of interdependent production processes and interdependent technologies, or from fixed supply of farm inputs (e.g. land).

The numbers after each industry represent their position within WAM's industry structure. For the industries within each group, the capital stocks are allowed to vary; however, the capital stock for the group as a whole is assumed to be fixed, so that the following equations hold:

(3.1) $K_A = K_1 + K_2 + K_3 + K_4$, and

(3.2) $K_B = K_8 + K_9 + K_{10}$,

where K_i (i = 1-4, 8-10) represents the capital stock in each industry, and K_A and K_B are both fixed.

As part of WAM's determination of economic variables, the change in the price paid to units of capital is calculated. This price, P_i^K (where i = 1-4 for Group A industries, and i = 8-10 for Group B industries), provides the signal for capital redistribution within each group. For example, if the price paid to capital in the Sheep meat industry (P_1^K) exceeds the price paid to Cereals (P_3^K), then capital will shift from the Cereals industry to the Sheep meat industry until the prices are equal. In other words, capital stocks redistribute between Group A industries until

(3.3) $P_1^K = P_2^K = P_3^K = P_4^K$.

Similarly, for Group B industries capital redistribution occurs until

(3.4) $P_8^K = P_9^K = P_{10}^K$.

Equations (3.1) to (3.4) are in levels, while, as stated previously, WAM is formulated in percentage changes. The percentage change versions of these equations are not presented here; however, they are contained in Appendix 2. Appendix 2 also contains an alternative approach for deriving the percentage change versions of equations (3.3) and (3.4).

3.4 Impact of the modifications

With the modifications described above, there is, potentially, a significant effect on model outcomes for those industries in Groups A and B. To describe the nature of these effects, we present a simple graphical analysis using production possibility frontiers. To do this, we assume the existence of an economy which produces only two goods: A and B. Panel 1 of Figure 3.1, presents the production possibility frontier for these two goods. The quantity of good A produced (Q_A) is shown on the vertical axis, while the quantity of good B produced (Q_B) is shown on the horizontal axis. The curve shown in panel 1 is the production possibility frontier for the production of these two goods, under the assumption that the capital employed in this two-good economy is industry specific, and cannot be shifted from the production of A to the production of B, and vice versa. In this simple system, the point at which production occurs is the point where the slope of the production possibility frontier is equal to the slope of the price line; where the slope is given by the price of good B (P_B) relative to the price of good A (P_A).

Initially, with the relative price at P_B/P_A, the economy produces at point x on the production possibility frontier - which we assume to be a position of long-run stability, where capital in each industry is employed at maximum efficiency. Next, due to some disturbance in the economy, prices shift to P_A' and P_B' and a new equilibrium is established at the point y, where the production of good A has diminished, and the production of good B has increased.

Now, consider panel 2 of Figure 3.1. Here, it is assumed that capital is not industry specific, but may be shifted between industries. The original production possibility frontier is shown as the dotted curve in panel 2, with the new frontier shown as the solid curve. Note that the

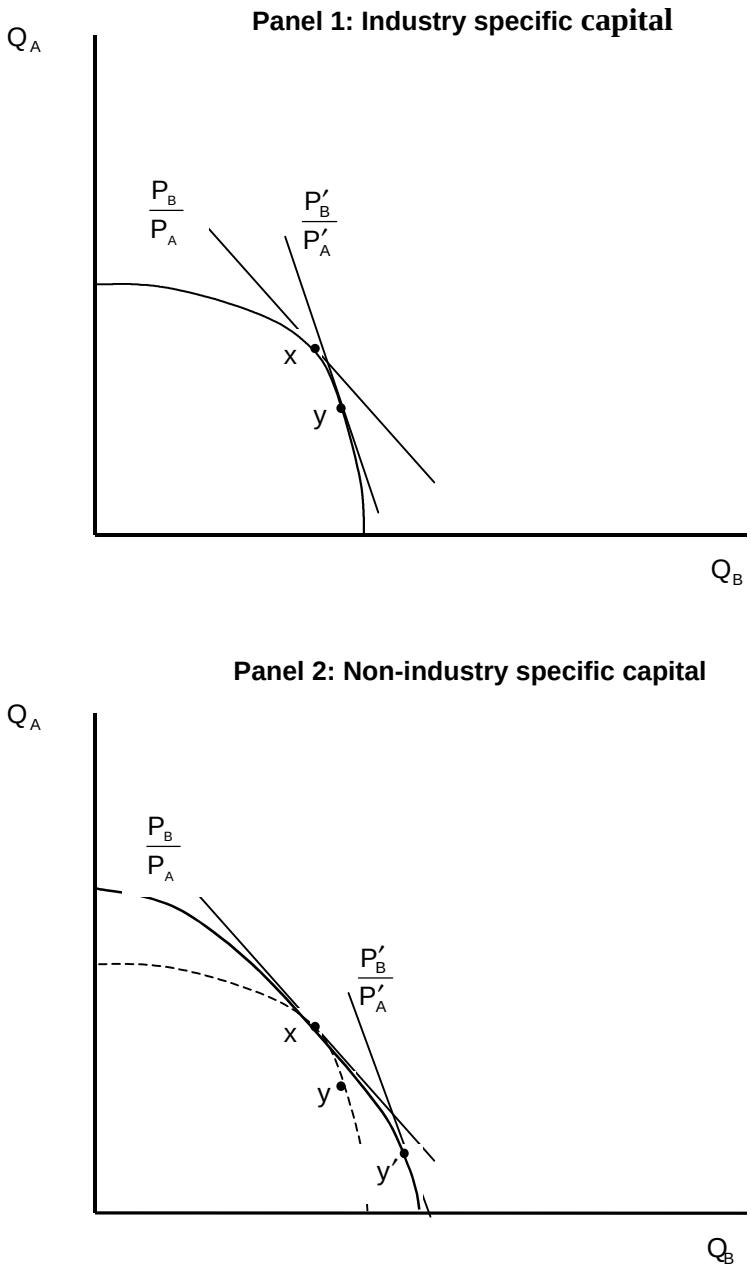

Figure 3.1 Production possibilities under different capital assumptions.

new curve touches the old at only one point: x. Recall that it was stated above, that point x represents a position of long-run stability, where capital in each industry is employed at maximum efficiency; therefore, no additional production of A or B is available at point x by

redistributing capital. The remainder of the new production possibility frontier is outside the old frontier, and is the envelope of all possible capital-constrained production possibilities.

Given the same economic disturbance and the same shift in prices that we saw in panel 1, a new equilibrium is established at point y' in Panel 2. As is clear, the movement from point x to point y' represents a more dramatic shift in the production pattern than does the movement from x to y, i.e. there is a greater reduction in the production of good A, and a greater increase in the production of good B. These larger changes occur because of the ability of capital to shift between the two industries. This analysis establishes that within WAM, under the assumption that capital can be shifted between selected primary agricultural industries (the Group A and Group B industries described above), it is expected that more pronounced changes in production will occur within Group A and Group B industries, than would have been the case if the assumption of joint capital was not made. The magnitude of these effects will be studied in Section 4.

3.5 The simulations

The industry structure used in WAM includes ten primary agricultural industries. Also within WAM's industry structure are numerous industries that process the output of these primary agricultural sectors. These include:

- Meat and meat products
- Dairy products
- Fruit and vegetable products
- Oils and fats
- Flour mill products and cereal foods
- Beer and malt
- Wine and spirits; and
- Textile fibres, yarns and woven fabrics.

In Section 4, we use WAM to estimate the impact of an expansion in these sectors on the economy of Western Australia. So as to provide easily comparable results, the simulations are performed on the basis of a $1 million expansion in the output of each of these industries. In order to conduct these simulations, the $1 million expansions must first be converted into a percentage change in the output of these industries. These changes then provide the inputs or 'shocks' to the model. The calculation of these shocks is presented in Appendix 3.

4. SIMULATION RESULTS

In this section, we present the results of the simulations designed to predict the impact on the WA economy of a $1 million expansion in each of eight agricultural processing industries.[17] The simulations were performed using the WA model (WAM) described in the previous section. We begin by looking at the impact of the expansion on key macroeconomic variables, before considering industry level impacts.

17 In Appendix 4 an alternative set of results are presented. These demonstrate the impact arising from a 10 percent increase in the output of the agricultural processing sectors.

4.1 Macroeconomic impacts

Consider the results presented in Table 4.1. For the $1 million increase in the output of the eight agricultural processing industries shown in column 1, the resulting increases in real Gross State Product (GSP), the consumer price index (CPI), employment, imports and exports, are provided in columns 2 to 6 of the table. Clearly, the table shows that the agricultural processing industry with the most beneficial impact on the State's GSP is the Wine and spirits industry, with GSP estimated to grow by $1,035,000 for every $1 million increase in its output. Beer and malt is the next most expansionary agricultural sector, followed by Fruit and vegetable products. Textile fibres, yarns and woven fabrics, with a GSP impact of $381,000, has the lowest impact. Not surprisingly, the CPI and employment impacts follow a similar pattern, with the $1 million expansion in Wine and spirits creating the most jobs, 22, and increasing the CPI by 0.0015 - this CPI increase is rather insignificant, but remember we are dealing with a relatively small increase in output. The expansion in the Textile fibres, yarns and woven fabrics industry increases employment by only 11 persons, and increases the CPI by 0.0005.

Consider the impact on imports, shown in column 5 of Table 4.1. The expansion of the Textile fibres, yarns and woven fabrics industry produces the smallest increase in imports. The Oils and fats industry produces the largest increase. This is not a surprising result, as the Textile fibres, yarns and woven fabrics industry has one of the lowest import propensities among the agricultural processing industries (just over three percent), while oils and fats has the highest (22 percent), as can be seen from row 24 of Table 4.2.

Table 4.1. Macroeconomic impact of an expansion in agricultural processing industries

Agricultural processing industries	Real GSP ($'000)	CPI (%)	Employment (jobs)	Imports ($'000)	Exports ($'000)
(1)	(2)	(3)	(4)	(5)	(6)
Meat and meat products	521	0.0008	14	137	293
Dairy products	407	0.0007	11	126	233
Fruit and vegetable products	764	0.0011	20	282	457
Oils and fats	627	0.0009	17	349	492
Flour mill products and cereal foods	648	0.0010	17	189	356
Beer and malt	812	0.0012	20	259	454
Wine and spirits	1,035	0.0015	22	255	313
Textile fibres, yarns, fabrics etc.	381	0.0005	11	71	131
Mean impact	649	0.0010	17	209	341

Next, column 6 of Table 4.1 shows the increase in exports resulting from the expansion in agricultural processing. The smallest increase in exports occurs with the expansion of the Textile fibres, yarns and woven fabrics industry, and the largest occurs with the Oils and fats industry. This is the same result as we found for imports, which is to be expected. Industries that consume few imports will consume more locally produced commodities when they expand. Much of this increased domestic consumption will be at the expense of exports. So, while most of the expanding industries output may be exported, there will be a high level of absorption by that industry of local commodities that would otherwise have been exported. Likewise, high importing industries have lower domestic absorption, and consequently their expansion results in higher exports.

Table 4.2 Input coefficients for agricultural processing industries (percentages)

Supplying industries	Consuming industries							
	Meat and meat products	Dairy products	Fruit and vegetable products	Oils and fats	Flour mill products and cereal foods	Beer and malt	Wine and spirits	Textile fibres, yarns fabrics, etc
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
1. Sheep meat	12.09	0.00	0.00	0.00	0.00	0.00	0.00	0.00
2. Wool	0.00	0.00	0.00	0.00	0.00	0.00	0.00	57.90
3. Cereals	0.00	0.00	0.70	0.00	18.12	10.15	1.79	0.00
4. Pulses and oilseeds	0.00	0.00	0.09	4.05	0.00	0.00	0.23	0.00
5. Beef cattle	28.16	0.00	0.00	0.00	0.00	0.00	0.00	0.00
6. Pigs	5.34	0.00	0.00	0.00	0.00	0.00	0.00	0.00
7. Poultry	8.68	0.00	0.00	0.00	0.00	0.00	0.00	0.00
8. Horticulture	0.00	0.04	2.53	0.00	0.02	0.03	5.41	0.00
9. New industries	0.00	0.07	5.17	0.00	0.04	0.07	11.06	0.00
10. Dairy cattle	0.00	33.86	0.00	0.00	0.00	0.00	0.00	0.00
11. Meat and meat products	1.62	0.01	0.40	4.60	0.05	0.00	0.01	0.00
12. Dairy products	0.02	14.22	0.67	0.36	1.59	0.00	0.06	0.00
13. Fruit and vegetable products	0.00	0.02	4.98	0.02	0.46	0.00	0.19	0.00
14. Oils and fats	0.00	0.00	0.35	10.33	0.35	0.00	0.00	0.00
15. Flour mill products and cereal foods	0.09	0.03	1.40	0.12	11.65	0.01	0.01	0.00
16. Beer and malt	0.00	0.01	0.00	0.00	0.03	7.12	0.25	0.00
17. Wine and spirits	0.01	0.00	0.09	0.00	0.02	0.00	4.82	0.00
18. Textile fibres, yarns, fabrics etc.	0.00	0.00	0.00	0.00	0.02	0.00	0.00	11.15
19. Other goods and services	22.32	26.60	44.03	35.05	36.56	40.59	41.12	14.78
20. Total intermediate inputs	**78.34**	**74.87**	**60.42**	**54.53**	**68.91**	**57.97**	**64.96**	**83.84**
21. Compensation of employees	13.39	10.14	13.13	9.84	9.61	8.63	11.29	8.50
22. Gross operating surplus	3.93	9.98	15.91	11.83	13.81	23.55	13.28	2.16
23. Taxes	2.53	1.29	1.82	1.54	1.71	1.51	3.09	2.29
24. Imports	1.81	3.72	8.72	22.27	5.96	8.35	7.37	3.21
25. Total	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**	**100.00**

4.2 Industry impacts

In addition to its ability to estimate impacts at an economy wide level - the macroeconomic effects - WAM is able to estimate impacts for each of the 108 industries in the model. Here, we consider these industry level impacts. However, before examining the results of the WAM simulations, it is useful to discuss the industry-industry interactions in the model's input-output database, as the relationships revealed will help us to interpret the modelling results.

Table 4.2 contains a summary of the key industry relationships from the input-output table used in the WAM database. The columns of the table present the consumption shares (in percentages) for intermediate inputs and primary factors in agricultural processing industries. For example, column 2 summarises the purchases made by the Meat and meat products industry when producing its output. To save space, consumption from all of the 108 industries in the database is not provided. What is provided is a full list of the input shares of the primary agricultural industries (rows 1 to 10 of Table 4.2), a full list of input shares from the eight agricultural processing industries (rows 11 to 18), the total share of inputs of other – non-agricultural – goods and services (row 19), the share of total intermediate inputs in production (row 20), and finally (in rows 21 to 24), the share of inputs/costs covered by Compensation of employees (wages), Gross operating surplus (profits), Taxes and Imports. As the figures in each column represent cost/input shares in percentage terms, they sum to one hundred, as shown in row 25.

From the information in Table 4.2 we can see which industries - particularly which primary agricultural industries - are most closely associated to the eight agricultural processing industries. Starting with the Meat and meat products industry (column 2 of Table 4.2), we see that the industry takes inputs from the Sheep meat (12 percent), Beef cattle (28 percent), Pigs (5 percent) and Poultry (9 percent) sectors, all of which will benefit from any expansion in the output of Meat and meat products. The expansion of the Dairy products industry (column 3) will be of most benefit to the Dairy cattle industry, as Dairy cattle supplies 34 percent of its inputs. An expansion in the Fruit and vegetable products industry (column 4) will benefit Horticulture (with 3 percent of inputs) and New industries (5 percent) the most. The Pulses and oilseeds industry (with 4 percent of total inputs) is the most significantly linked primary agriculture sector to the Oils and fats industry (column 5). In spite of this, it is interesting to note that Oils and fats gains an even higher share of its inputs from the Meat and meat products industry (5 percent), with an even larger share still supplied from within the industry itself (10 percent). Flour mill products and cereal foods (column 6) derives 18 percent of total inputs from Cereals, while the Beer and malt industry (column 7) derives 10 percent of its inputs from Cereals. The Wine and spirits industry (column 8) takes significant inputs from Horticulture (5 percent) and New industries (11 percent). Finally, the Textile fibres, yarns and woven fabrics industry (column 9) derives a massive 58 percent of it total inputs from Wool, clearly the most significant relationship demonstrated in Table 4.2.

Keeping the relationships between the agricultural processing and primary agriculture industries in mind will aid with the interpretation of the WAM simulation results presented in Table 4.3. The impact of the expansion of the agricultural processing industries on the primary agricultural sectors are shown in rows 1 to 10 of the table. Consider first the results for the expansion of the Meat and meat products industry (column 2). As expected, we see an expansion in the primary agricultural industries of Sheep meat, Beef cattle, Pigs and Poultry, although the expansion in the later three sectors is relatively small compared to the expansion in Sheep meat output of $134,000. Recall that the industry Sheep meat is part of a group of agricultural industries which share capital (the Group A industries described in the

Table 4.3. Industry impact of an expansion in agricultural processing industries ($'000)

	Impacted industries	Expanding industries: Meat and meat products	Dairy products	Fruit and vegetable products	Oils and fats	Flour mill products and cereal foods	Beer and malt	Wine and spirits	Textile fibres, yarns, fabrics, etc	Mean impact
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
1.	Sheep meat	134	-26	-14	-15	-43	-30	-24	-98	-14
2.	Wool	-8	-5	-4	-4	-10	-7	-6	490	56
3.	Cereals	-66	20	17	-9	53	37	25	-388	-39
4.	Pulses and oilseeds	-15	0	-8	33	-23	-17	-8	-47	-11
5.	Beef cattle	1	0	0	0	0	0	-1	0	0
6.	Pigs	14	0	0	0	0	0	0	0	1
7.	Poultry	60	-1	-1	-1	-1	-1	-1	-1	7
8.	Horticulture	0	-140	2	0	0	0	4	0	-17
9.	New industries	0	-286	5	1	0	1	8	0	-34
10.	Dairy cattle	-1	367	-4	-2	-1	-2	-6	-1	44
11.	**Total primary agriculture**	**118**	**-70**	**-7**	**2**	**-26**	**-19**	**-8**	**-46**	**-7**
12.	Meat and meat products	1,000	-9	-17	-13	-16	-18	-19	-18	111
13.	Dairy products	-3	1,000	-11	-5	-3	-5	-16	-1	120
14.	Fruit and vegetable products	-1	-3	1,000	-1	-1	-4	-7	-1	123
15.	Oils and fats	0	0	0	1,000	0	-1	-1	0	125
16.	Flour mill products and cereal foods	-1	-1	-1	0	1,000	-1	-2	-1	124
17.	Beer and malt	-1	-1	-3	-1	-1	1,000	-3	-1	124
18.	Wine and spirits	-1	-3	-4	-1	-1	-2	1,000	-1	123
19.	Textile fibres, yarns, etc.	-6	-1	-3	-4	-5	-5	-4	1,000	121
20.	**Total agriculture processing**	**987**	**981**	**961**	**975**	**972**	**965**	**950**	**977**	**971**
21.	All other industries	749	601	1,147	949	988	1,211	1,289	561	937
22.	**Total output**	**1,854**	**1,511**	**2,101**	**1,926**	**1,935**	**2,157**	**2,231**	**1,492**	**1,901**

previous section). These industries are capable of shifting capital (which includes agricultural land) between the production of the different Group A commodities (Sheep meat, Wool, Cereals, and Pulses and oilseeds) even though the total stock of capital available has not changed. With the expansion of the Meat and meat products industry, the demand for Sheep meat, Beef cattle, Pigs and Poultry all increase. For the industries Beef cattle, Pigs and Poultry, most of the increased domestic demand for their output is met by reducing exports, with only a small increase in their total production. Sheep meat, which is able to gain access to more capital - at the expense of the Wool, Cereals and Pulses and oilseeds sectors - is able to meet more of the increased domestic demand by increasing production, and less by reducing its exports

With the ability of the Sheep meat industry to command more capital at the expense of the Group A industries, it is not surprising to see that the output of these other industries diminishes, with the output from the Cereals industry falling by $66,000. It is interesting to note that the output of the Wool industry falls by a far less significant $8,000. This indicates that farmers will not increase Sheep meat production by significantly shifting capital away from Wool, but, rather, by decreasing the capital (which we should remember includes land) available to Cereals, and to a lesser extent Pulses and oilseeds.

Table 4.4 shows for the eight simulations the estimated changes in capital dedicated to the industries in Group A and Group B. The first thing to note about this table is that the elements all represent very small changes in capital stocks. However, it should be remembered that the expansion of WA's agricultural processing sectors by $1 million caused only a relatively minor disturbance to the primary agricultural sectors, and so minor adjustments are to be expected. The second thing to note is that within each group the adjustments to capital stocks sum to zero,[18] demonstrating that within each group the capital stocks remain fixed.

As expected, Table 4.4 shows that an expansion in the Meat and meat products industry causes capital in Group A to be redistributed to Sheep meat, and away from Wool, Cereals, and Pulses and oilseeds. At the same time, the expansion in the output of Meat and meat products has little impact on capital stocks in Group B.

Returning our attention to the changes in industry output shown in Table 4.3, we find that the total impact of the expansion in Meat and meat products on primary agricultural industries, presented in row 11 of the table, is an expansion of $118,000. This increase is due largely to the expansion in output in the Sheep meat industry of $134,000.

The output in some of the sectors within primary agriculture - Wool, Cereals and Pulses and oilseeds - actually falls due to the expansion in output of the meat and meat products industry. This occurs as a result of the Sheep meat sector demanding more capital at the expense of these other Group A industries (see Section 3 for more detail on these effects). It should be noted that the total change in primary agriculture, while positive for meat and meat products expansion, is not positive for all processing developments shown in columns 3 to 9. The reasons behind the negative values will be discussed later in this section.

18 Where, the summation is carried out on a share-weighted basis.

Table 4.4. Adjustments to capital stock in agricultural industries (percentages)

Affected industries	Expanding industries								
	Capital share	Meat and meat products	Dairy products	Fruit and vegetable products	Oils and fats	Flour mill products and cereal foods	Beer and malt	Wine and spirits	Textile fibres, yarns, fabrics etc.
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
					Group A				
1. Sheep meat	9.3	0.0406	-0.0078	-0.0041	-0.0044	-0.0132	-0.0090	-0.0071	-0.0298
2. Wool	23.6	-0.0015	-0.0009	-0.0007	-0.0008	-0.0019	-0.0013	-0.0010	0.0911
3. Cereals	62.0	-0.0048	0.0015	0.0013	-0.0007	0.0038	0.0027	0.0018	-0.0280
4. Pulses and oilseeds	5.1	-0.0089	0.0003	-0.0046	0.0198	-0.0139	-0.0104	-0.0046	-0.0284
5. Group A weighted sum[1]	100.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
					Group B				
6. Horticulture	25.4	0.0002	-0.0814	0.0010	0.0003	0.0002	0.0003	0.0016	0.0001
9. New industries	51.8	0.0002	-0.0814	0.0010	0.0003	0.0002	0.0003	0.0016	0.0001
7. Dairy cattle	22.8	-0.0005	0.2754	-0.0033	-0.0011	-0.0008	-0.0012	-0.0053	-0.0003
8. Group B weighted sum[1]	100.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000

Note: 1) The summation of industry effects (columns 3 to 10) are share weighted sums (see column 2 for capital shares).

Next, consider the impact of the expansion of the Meat and meat products industry on industries outside of primary agriculture. Rows 12 to 19 of Table 4.3 show the impact on the agricultural processing industries. Amongst the agricultural processing industries there are only minor changes, with the exception, of course, of meat and meat products, where a million-dollar expansion is shown. Overall, the expansion in agricultural processing industries is just less than the $1 million dollar expansion experienced by Meat and meat products.

Despite the fact that several agricultural processing industries are themselves suppliers (although of relatively small quantities) to the meat and meat products industry, the impact on these sectors of the expansion in meat and meat products output is zero or slightly negative. To understand why this occurs, it is important to remember that, like the primary agricultural industries, the agricultural processing industries are themselves exporters of their products. With an expansion of the domestic economy, and the subsequent - although small - rise in the general level of prices, the local currency experiences a real appreciation against foreign currencies (whose price levels remain unaffected by the local economy). The effect of such an appreciation is to reduce local exports.[19] It is clear that for industries such as dairy products, the negative impact of the real appreciation outweighs the increase in demand from local industry.

Growth in non-agricultural based industries is given in row 21 of Table 4.3. These sectors experience growth of $749,000 as a result of the expansion in the Meat and meat products industry. When this is added to the output growth expected in the primary agricultural and agricultural processing industries, the total growth in output in the Western Australian economy is $1.85 million (row 22).

A similar examination of the impacts of the other seven agricultural processing industries could be performed; however, it would be rather time consuming, and so only some of the key features will be discussed. Most interestingly, we see that the change in the output of total primary agriculture (row 11) for many of the expanding industries is in fact negative. This can occur for two reasons. The first is the real appreciation of the local currency, which we discussed earlier in relation to agricultural processing industries. The same principles apply to primary agricultural industries that are exporting. That is, the real appreciation of the local currency makes exports of primary agricultural products less competitive relative to international primary agricultural products, and so exports fall. The other reason for the fall in output is to do with the capital adjustments occurring to industries in Groups A and B. Within these groups, capital is shifted so as to equate payments to capital, which in turn maximises the overall returns to capital. Maximisation of returns does not necessarily mean maximisation of output, and so it is possible that a farm that adjusts its usage of capital to maximise its returns, may in fact reduce its output.

To this point we have considered the industry impacts of expansion in agricultural processing industries at a very detailed level. To complete this section we take a step back, and consider the broad sectoral effects of the expansion in agricultural processing, which are shown in Table 4.5. (Appendix 5 contains a list of the industry components of each of the

19 The negative impact that expanding export industries have on other exporters is known in Australia as the 'Gregory Thesis' (Gregory, 1976) and as the 'Dutch Disease' in Europe and elsewhere (**the Economist**, 26 November 1977, pp.82-83).

Table 4.5. Change to broad sectoral outputs ($'000)

Affected industries	Expanding industries							
	Meat and meat products	**Dairy products**	**Fruit and vegetable products**	**Oils and fats**	**Flour mill products and cereal foods**	**Beer and malt**	**Wine and spirits**	**Textile fibres, yarns, fabrics etc.**
(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**	**(7)**	**(8)**	**(9)**
Agriculture	118	-70	-7	2	-26	-19	-8	-46
Forestry, logging and fishing	0	-2	0	0	0	-1	0	0
Mining	-12	-11	-17	-13	-15	-19	-19	-8
Manufacturing	1,018	1,038	1,159	1,078	1,038	1,091	1,120	1,034
Construction	37	40	61	50	54	78	61	29
Trade and transportation	309	241	355	329	346	389	340	191
Services	344	249	501	436	488	582	666	266
Government administration and defence	40	26	51	44	51	55	72	25
Total	**1,854**	**1,511**	**2,101**	**1,926**	**1,935**	**2,157**	**2,231**	**1,492**

eight sectors shown in Table 4.5). Here we note that it is the Manufacturing sector that increases its output by the largest amount; but this, of course, is to be expected, as the agricultural processing industries are themselves part of manufacturing. The other sectors doing particularly well from the expansions in agricultural processing are Trade and transportation and Services.

5. SUMMARY AND CONCLUSION

This study investigated the economy-wide benefits available to Western Australia through further processing of the State's primary agricultural products. This investigation was undertaken utilising a Computable General Equilibrium (CGE) economic model of Western Australia. This model - known as WAM - is a multi-sectoral model of the WA economy with a specific focus on the State's agricultural sectors. In addition, based on a review of existing literature, this study has attempted to identify impediments to agricultural processing in Australia in general, and in Western Australia in particular, in Section 2. Also, in this section, by applying Porter's (1990) determinants of industry competitiveness, two food processing companies in Western Australia were examined as case studies.

In Section 3, the characteristics of CGE models in general and the WA model in particular, were described. The theoretical structure underpinning WAM was also described in this section. The empirical application of the model and its results were discussed in Section 4.

5.1 Major findings of the study

The investigation made in Section 2 reveals that in general, the major impediments to the progress of food processing industries in Australia are:

- the size and foreign ownership structure of the existing companies;
- distortions in export markets;
- the high cost of some raw materials compared to competing countries;
- the passive way firms approach the goal of achieving cost-competitiveness along the supply chain;
- inadequate investment on innovation;
- an inefficient labour market;
- substandard corporate management skills;
- low awareness of and confidence in government support;
- regulated marketing structures for some major agricultural commodities; and
- quarantine restrictions and control.

However, from company to company and from industry to industry the effect of these factors vary. Results of the two case studies indicate that inefficient supporting industries, strict marketing and quarantine regulations, and costly and inadequate supply of raw materials are major impediments to the expansion of agricultural processing in Western Australia.

Section 4 of this report investigated the impact that an expansion in agricultural processing would have on the Western Australian economy. In order to do this, WAM was used to simulate the effects of a $1 million expansion in eight agricultural processing industries. The broad impacts of such growth in agricultural processing are summarised in Table 5.1. Table 5.1 shows that there is a range of potential impacts from agricultural processing. Clearly, the

most significant impact is derived from the expansion of the Wine and spirits industry. Table 5.1 demonstrates that such an expansion is estimated to increase the State's GSP (Gross State Product) by $1,035,000, and to increase total output by $2.2 million. The expansion of the Wine and spirits industry is also estimated to have the largest impact on employment, with 22 new jobs created. Table 5.1 also shows that expansion of the Textile fibres, yarns and woven fabrics industry has the least beneficial effect on the economy, with GSP rising by just $381,000, and only 11 new jobs created.

Apart from providing a means of comparing the impact of growth in different agricultural processing sectors, the information in Table 5.1 has been derived and presented in such a way as to make it useful for proponents of new agricultural processing projects. As the impacts calculated are for $1 million expansions in the eight agricultural processing industries (valued in 2001/02 dollars, see Appendix 3), project proponents need only multiply the results presented in Table 5.1 by the value of the output of their project (in millions of 2001/02 dollars) to estimate its impact. As the results presented in Section 4 are also on the basis of a $1 million expansion, they too can be used in this way. As an example, consider a proposal to build a new flourmill in Western Australia, with output valued at $15 million annually (in 2001/02 dollars). Using the information in the Flourmill products and cereal foods row of Table 5.1, it can be shown that the impact on the State's GSP would be $15 \times \$648{,}000 = \$9.72$ million (in 2001/02 dollars) annually. Additionally, employment would rise by 15×17 jobs = 255 jobs.

Table 5.1. Impact of an expansion in agricultural processing industries

Agricultural processing industries	Real GSP ($'000)	Total output ($'000)	Employment (jobs)
Meat and meat products	521	1,854	14
Dairy products	407	1,511	11
Fruit and vegetable products	764	2,101	20
Oils and fats	627	1,926	17
Flour mill products and cereal foods	648	1,935	17
Beer and malt	812	2,157	20
Wine and spirits	1,035	2,231	22
Textile fibres, yarns and woven fabrics	381	1,492	11
Mean impact	649	1,901	17

5.2 Conclusions

Although food and agricultural processing in WA started from the beginning of European settlement in 1829, the industry as a whole remains in its infancy. As mentioned above, several factors hinder the expansion of this sector. In the last decade or so, globalisation of the industry offered the potential to attract a new generation of investment opportunities focused on supplying the Asia-Pacific region, but it appears that the food processing industry in Australia as a whole, has squandered this opportunity (IPA, 2001). Global forces provide both opportunities and threats, but the failure of industry to take advantage of those opportunities only increases potential threats.

Since this study indicates that the Western Australian economy gains from the expansion of agricultural processing industries, and private investment is insignificant, the government sector has an important role to play in helping the industry to capture those benefits. As the

case studies suggest, if essential logistic and institutional supports are made available, the food processing industries in WA can still expand even with its small local market and less competitive supply of raw materials. It is, therefore, important for the public sector to develop and implement appropriate policies to remove barriers to private investment in food and agricultural processing in Western Australia.

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APPENDIX 1.

INPUT-OUTPUT MULTIPLIERS FOR THE PRIMARY AGRICULTURAL INDUSTRIES OF WESTERN AUSTRALIA

The Input-Output Table

The database of the original WA model (WAM) was based on the input-output table for Western Australia for 1989-90 developed by Clements and Ye (1996). For the application of WAM in this report, it was desirable to have the database based on a more recent Western Australian input-output table. The most recently published State table is for 1994-95 (Johnson, 2001). However, before this table was incorporated into the WAM database it was enhanced to provide more detail for primary agricultural industries. In the original 1994-95 table, there were seven primary agricultural industries. Three of these industries, Sheep, Grains, and Other agriculture, were disaggregated into Sheep meat and Wool; Cereals, Pulses and oilseeds; and Horticulture and New industries.

To achieve this disaggregation, use was made of a previous input-output table for Western Australia developed by Islam and Johnson (1997). Islam and Johnson's table was developed for the year 1992-93, and the primary agricultural sectors in that table had already been disaggregated in the manner specified above. Therefore, the primary agricultural sectors of Sheep, Grains and Other agriculture in the 1994-95 table were split, based on the proportions demonstrated in the 1992-93 table. With this split, the new table for 1994-95 contained 10 primary agricultural sectors:

- Sheep meat
- Wool
- Cereals
- Pulses and oilseeds
- Beef cattle
- Pigs
- Poultry
- Horticulture
- New industries
- Dairy cattle.

With the disaggregated table determined, the structure of the agricultural sectors was reviewed, with particular emphasis on the newly disaggregated industries. Only one anomaly was discovered, the Gross operating surplus (GOS) - which represents profits accruing to the owners of capital - of the Wool industry represented only 16 percent of total costs for that industry, whereas the GOS of the Sheep meat industry was 46 percent of its total costs. Such a large disparity is difficult to understand and was traced back to an error in the 1992-93 table of Islam and Johnson (1997). The anomaly was removed by assuming that the GOS of the Wool industry corresponded to the national share for the Sheep industry: 44 percent.

It is important to note that this error was removed after a set of multipliers for agricultural industries were calculated and published by the Department of Agriculture, Western Australia (Islam and Johnson, 2002). Therefore, the multipliers provided in the following tables, which

were calculated from the corrected WA table, supersede the Islam and Johnson (2002) multipliers.

Multiplier definitions

From the disaggregated input-output table, output, income, employment and value-added multipliers have been derived for Western Australia's agricultural industries. For each category of multiplier (output, income, employment and value-added.), various types of multipliers are derived. The definitions for each multiplier type are provided below.

A1 Output multipliers

A1.1 Initial effect: The initial effect is an increase of one dollar in the output of a given industry in response to a one dollar increase in final demand for its product.

A1.2 First round effect: The amount of output required from all industries in the economy to produce the initial one dollar increase in output from the given industry.

A1.3 Industrial support effect: The second-round and subsequent effects of the change induced by the one dollar increase in final demand.

A1.4 Production induced effect: The amount of output required from all industries in the economy to produce the initial one dollar of extra output and all the subsequent induced output. The sum of A1.2 and A1.3 gives the production induced effect.

A1.5 Consumption induced effect: To generate the initial and production induced output, wage and salary earners derive extra income, which they spend on commodities produced by industries in the economy. This spending induces further production by industries. The increased output resulting from this consumer spending is the consumption induced effect.

A1.6 Simple multiplier: The sum of the direct and indirect output effects arising from the initial one dollar change in final demand. The sum of A1.1 and A1.4 gives the simple multiplier.

A1.7 Total multiplier: The sum of the direct, indirect and consumption induced output effects arising from the initial one dollar stimulus to final demand. The sum of A1.5 and A1.6 gives the total multiplier.

A1.8 Type-1A multiplier: The ratio of the initial effect plus the first round effect, to the initial effect. In the case of an output multiplier, since the initial effect is assumed to be one, the Type-1A multiplier is equal to the initial effect plus the first round effect (i.e. A1.1 plus A1.2 above).

A1.9 Type-1B multiplier: The ratio of the sum of the initial and the production-induced effect, to the initial effect (recall that the initial effect plus the production induced effect is the simple multiplier). Since the initial effect is one, the Type-1B multiplier is equal to the simple multiplier.

A1.10 Type-2A multiplier: The ratio of the total multiplier to the initial effect. As the initial effect is one, the Type-2A multiplier is equal to the total multiplier (i.e. A1.7 above).

A1.11 Type-2B multiplier: The ratio of the difference between the total multiplier and the initial effect, to the initial effect. Since the initial effect is equal to one, the Type-2B multiplier is equal to the total multiplier minus one.

A2 Income multipliers

A2.1 The first seven effects/multipliers defined above (i.e. the initial, first round, industrial support, production induced and consumption induced effects, plus the simple and total multipliers) are not individually defined for income multipliers. They differ from the output multipliers only in that they relate to the additional 'compensation of employees' paid to workers producing the extra output induced by A1.1 to A1.7.

A2.2 Type-1A, Type-1B, Type-2A, and Type-2B multipliers are derived in the same way as described in A1.8 to A1.11. However, as the initial effect is not one, as is the case for output multiplier, the Type-1B and Type-2A multipliers are no longer equal to the simple and total multipliers respectively.

A3 Employment Multipliers

A3.1 The employment multipliers are analogous to the income multipliers mentioned above. The difference is that they relate to the additional employment generated, rather than to the additional compensation of employees. It is important to note, that of all the multipliers described here, only the employment multipliers have units. For the other multipliers the units are $ per $ and so cancel. For the employment multipliers (with the exception of the Type-1 and Type-2 multipliers, which are ratios and hence unit-less) the units are persons employed per thousand dollars of final demand, or more simply, persons per $'000.

A4 Value-added multipliers

A4.1 The value-added multipliers are analogous to the income and employment multipliers. The difference is that they relate to the additional value-added, which is the sum of the compensation of employees, gross operating surplus and mixed income, and taxes less subsidies.

The multipliers

The multipliers derived for the agricultural industries are presented in the following tables. Table A1.1 presents the output multipliers; Table A1.2, the income multipliers; Table A1.3, the employment multipliers; and Table A1.4 presents the value-added multipliers.

Table A1.1. Output multipliers of Western Australian agricultural industries

Industries	Initial effects	First round effects	Industrial support effects	Production induced effects	Consumption induced effects	Simple multipliers	Total multipliers	Type-1A multiplies	Type-1B multipliers	Type-2A multipliers	Type-2B multipliers
	Primary agricultural industries										
Sheep meat	1.0000	0.3345	0.2542	0.5887	0.3103	1.5887	1.8990	1.3345	1.5887	1.8990	0.8990
Wool	1.0000	0.3355	0.5637	0.8992	0.5378	1.8992	2.4370	1.3355	1.8992	2.4370	1.4370
Cereals	1.0000	0.2352	0.1612	0.3963	0.2240	1.3963	1.6204	1.2352	1.3963	1.6204	0.6204
Pulses and oilseeds	1.0000	0.3404	0.2369	0.5772	0.3298	1.5772	1.9070	1.3404	1.5772	1.9070	0.9070
Beef cattle	1.0000	0.5106	0.3509	0.8615	0.4647	1.8615	2.3262	1.5106	1.8615	2.3262	1.3262
Pigs	1.0000	0.4770	0.4169	0.8939	0.4103	1.8939	2.3043	1.4770	1.8939	2.3043	1.3043
Poultry	1.0000	0.5431	0.4864	1.0295	0.7130	2.0295	2.7425	1.5431	2.0295	2.7425	1.7425
Horticulture	1.0000	0.3905	0.2917	0.6823	0.5328	1.6823	2.2151	1.3905	1.6823	2.2151	1.2151
New industries	1.0000	0.3905	0.2917	0.6823	0.5328	1.6823	2.2151	1.3905	1.6823	2.2151	1.2151
Dairy cattle	1.0000	0.3709	0.2553	0.6262	0.4468	1.6262	2.0730	1.3709	1.6262	2.0730	1.0730
Average (primary agriculture)	1.0000	0.3928	0.3309	0.7237	0.4502	1.7237	2.1740	1.3928	1.7237	2.1740	1.1740
	Agricultural processing industries										
Meat and meat products	1.0000	0.7834	0.6708	1.4542	0.6463	2.4542	3.1005	1.7834	2.4542	3.1005	2.1005
Dairy products	1.0000	0.7487	0.6128	1.3615	0.6087	2.3615	2.9703	1.7487	2.3615	2.9703	1.9703
Fruit and vegetable products	1.0000	0.6042	0.4648	1.0690	0.6216	2.0690	2.6905	1.6042	2.0690	2.6905	1.6905
Oils and fats	1.0000	0.5453	0.4698	1.0151	0.5249	2.0151	2.5400	1.5453	2.0151	2.5400	1.5400
Flour mill products and cereal foods	1.0000	0.6891	0.5158	1.2048	0.5720	2.2048	2.7768	1.6891	2.2048	2.7768	1.7768
Beer and malt	1.0000	0.5797	0.4008	0.9805	0.4991	1.9805	2.4796	1.5797	1.9805	2.4796	1.4796
Wine and spirits	1.0000	0.6496	0.4778	1.1274	0.6208	2.1274	2.7482	1.6496	2.1274	2.7482	1.7482
Textile fibres, yarns, fabrics etc.	1.0000	0.8384	0.7953	1.6337	0.6550	2.6337	3.2887	1.8384	2.6337	3.2887	2.2887
Average (agriculture processing)	1.0000	0.6798	0.5510	1.2308	0.5936	2.2308	2.8243	1.6798	2.2308	2.8243	1.8243

Table A1.2. Income multipliers of Western Australian agricultural industries

Industries	Initial effects	First round effects	Industrial support effects	Production induced effects	Consumption induced effects	Simple multipliers	Total multipliers	Type-1A multiplies	Type-1B multipliers	Type-2A multipliers	Type-2B multipliers
					Primary agricultural industries						
Sheep meat	0.0818	0.0615	0.0553	0.1168	0.0707	0.1985	0.2692	1.7519	2.4283	3.2931	2.2931
Wool	0.1126	0.0584	0.1141	0.1725	0.1225	0.2851	0.4076	1.5186	2.5317	3.6196	2.6196
Cereals	0.0470	0.0438	0.0354	0.0792	0.0510	0.1262	0.1773	1.9317	2.6841	3.7696	2.7696
Pulses and oilseeds	0.0759	0.0591	0.0510	0.1101	0.0751	0.1859	0.2611	1.7794	2.4511	3.4416	2.4416
Beef cattle	0.0711	0.1122	0.0785	0.1907	0.1059	0.2618	0.3677	2.5774	3.6812	5.1697	4.1697
Pigs	0.0799	0.0673	0.0841	0.1514	0.0935	0.2313	0.3248	1.8424	2.8957	4.0662	3.0662
Poultry	0.2118	0.0933	0.0977	0.1910	0.1625	0.4028	0.5653	1.4403	1.9017	2.6686	1.6686
Horticulture	0.1509	0.0836	0.0657	0.1493	0.1214	0.3002	0.4216	1.5538	1.9891	2.7936	1.7936
New industries	0.1509	0.0836	0.0657	0.1493	0.1214	0.3002	0.4216	1.5538	1.9891	2.7936	1.7936
Dairy cattle	0.1230	0.0721	0.0567	0.1288	0.1018	0.2518	0.3536	1.5867	2.0478	2.8756	1.8756
Average (primary agriculture)	0.1105	0.0735	0.0704	0.1439	0.1026	0.2544	0.3570	1.7536	2.4600	3.4491	2.4491
					Agricultural processing industries						
Meat and meat products	0.1339	0.1052	0.1378	0.2430	0.1472	0.3769	0.5241	1.7855	2.8148	3.9145	2.9145
Dairy products	0.1014	0.1154	0.1261	0.2415	0.1387	0.3428	0.4815	2.1382	3.3824	4.7507	3.7507
Fruit and vegetable products	0.1313	0.1166	0.1020	0.2186	0.1416	0.3499	0.4915	1.8885	2.6656	3.7444	2.7444
Oils and fats	0.0984	0.0989	0.0987	0.1976	0.1196	0.2960	0.4156	2.0041	3.0072	4.2219	3.2219
Flour mill products and cereal foods	0.0961	0.1145	0.1114	0.2259	0.1303	0.3220	0.4523	2.1913	3.3501	4.7061	3.7061
Beer and malt	0.0863	0.1048	0.0902	0.1949	0.1137	0.2812	0.3949	2.2147	3.2601	4.5786	3.5786
Wine and spirits	0.1129	0.1293	0.1070	0.2363	0.1414	0.3493	0.4907	2.1447	3.0925	4.3449	3.3449
Textile fibres, yarns, fabrics etc.	0.0850	0.1093	0.1541	0.2634	0.1492	0.3483	0.4976	2.2863	4.0996	5.8561	4.8561
Average (agriculture processing)	0.1057	0.1118	0.1159	0.2277	0.1352	0.3333	0.4685	2.0817	3.2090	4.5147	3.5147

Table A1.3. Employment multipliers of Western Australia agricultural industries

Industries	Initial effects	First round effects	Industrial support effects	Production induced effects	Consumption induced effects	Simple multipliers	Total multipliers	Type-1A multiplies	Type-1B multipliers	Type-2A multipliers	Type-2B multipliers
					Primary agricultural industries						
Sheep meat	0.0164	0.0027	0.0018	0.0044	0.0026	0.0208	0.0234	1.1633	1.2705	1.4276	0.4276
Wool	0.0226	0.0025	0.0039	0.0064	0.0045	0.0290	0.0334	1.1100	1.2844	1.4821	0.4821
Cereals	0.0094	0.0016	0.0011	0.0027	0.0019	0.0121	0.0140	1.1729	1.2863	1.4836	0.4836
Pulses and oilseeds	0.0152	0.0027	0.0016	0.0042	0.0027	0.0194	0.0222	1.1754	1.2787	1.4587	0.4587
Beef cattle	0.0150	0.0043	0.0025	0.0068	0.0039	0.0218	0.0257	1.2871	1.4565	1.7133	0.7133
Pigs	0.0080	0.0028	0.0030	0.0059	0.0034	0.0139	0.0173	1.3514	1.7320	2.1572	1.1572
Poultry	0.0070	0.0029	0.0038	0.0067	0.0059	0.0137	0.0196	1.4126	1.9571	2.8016	1.8016
Horticulture	0.0120	0.0030	0.0021	0.0051	0.0044	0.0171	0.0215	1.2471	1.4231	1.7912	0.7912
New industries	0.0120	0.0030	0.0021	0.0051	0.0044	0.0171	0.0215	1.2471	1.4231	1.7912	0.7912
Dairy cattle	0.0120	0.0030	0.0018	0.0048	0.0037	0.0168	0.0205	1.2521	1.4021	1.7107	0.7107
Average (primary agriculture)	0.0130	0.0029	0.0024	0.0052	0.0037	0.0182	0.0219	1.2419	1.4514	1.7817	0.7817
					Agricultural processing industries						
Meat and meat products	0.0050	0.0090	0.0053	0.0143	0.0054	0.0193	0.0247	2.8050	3.8674	4.9390	3.9390
Dairy products	0.0020	0.0062	0.0046	0.0108	0.0050	0.0128	0.0179	4.1100	6.4071	8.9305	7.9305
Fruit and vegetable products	0.0030	0.0043	0.0032	0.0075	0.0052	0.0105	0.0156	2.4203	3.4927	5.2104	4.2104
Oils and fats	0.0010	0.0033	0.0034	0.0067	0.0044	0.0077	0.0121	4.3180	7.7445	12.0959	11.0959
Flour mill products and cereal foods	0.0030	0.0047	0.0036	0.0084	0.0047	0.0114	0.0161	2.5816	3.7848	5.3657	4.3657
Beer and malt	0.0010	0.0041	0.0027	0.0068	0.0041	0.0078	0.0119	5.0559	7.8025	11.9407	10.9407
Wine and spirits	0.0030	0.0055	0.0034	0.0089	0.0051	0.0119	0.0170	2.8273	3.9524	5.6680	4.6680
Textile fibres, yarns, fabrics etc.	0.0040	0.0146	0.0062	0.0208	0.0054	0.0248	0.0302	4.6554	6.1964	7.5541	6.5541
Average (agriculture processing)	0.0028	0.0065	0.0041	0.0105	0.0049	0.0133	0.0182	3.5967	5.4060	7.7130	6.7130

Table A1.4. Value-added multipliers of Western Australian agricultural industries

Industries	Initial effects	First round effects	Industrial support effects	Production induced effects	Consumption induced effects	Simple multipliers	Total multipliers	Type-1A multiplies	Type-1B multipliers	Type-2A multipliers	Type-2B multipliers
					Primary agricultural industries						
Sheep meat	0.5543	0.1438	0.1139	0.2577	0.1592	0.8120	0.9712	1.2594	1.4649	1.7521	0.7521
Wool	0.5732	0.1373	0.2435	0.3808	0.2759	0.9539	1.2299	1.2395	1.6643	2.1458	1.1458
Cereals	0.5904	0.0943	0.0730	0.1673	0.1150	0.7578	0.8727	1.1597	1.2834	1.4781	0.4781
Pulses and oilseeds	0.4566	0.1297	0.1063	0.2360	0.1692	0.6927	0.8619	1.2840	1.5168	1.8874	0.8874
Beef cattle	0.4190	0.2303	0.1586	0.3889	0.2384	0.8079	1.0463	1.5495	1.9282	2.4972	1.4972
Pigs	0.4228	0.1771	0.1811	0.3582	0.2106	0.7810	0.9915	1.4188	1.8472	2.3453	1.3453
Poultry	0.4009	0.1989	0.2158	0.4147	0.3659	0.8156	1.1815	1.4960	2.0343	2.9469	1.9469
Horticulture	0.4913	0.1615	0.1316	0.2931	0.2734	0.7844	1.0578	1.3288	1.5967	2.1533	1.1533
New industries	0.4913	0.1615	0.1316	0.2931	0.2734	0.7844	1.0578	1.3288	1.5967	2.1533	1.1533
Dairy cattle	0.5264	0.1636	0.1144	0.2780	0.2293	0.8044	1.0337	1.3108	1.5281	1.9637	0.9637
Average (primary agriculture)	0.4926	0.1598	0.1470	0.3068	0.2310	0.7994	1.0304	1.3375	1.6461	2.1323	1.1323
					Agricultural processing industries						
Meat and meat products	0.1985	0.3408	0.2981	0.6388	0.3316	0.8373	1.1689	2.7172	4.2191	5.8901	4.8901
Dairy products	0.2141	0.3187	0.2688	0.5875	0.3124	0.8016	1.1140	2.4886	3.7438	5.2027	4.2027
Fruit and vegetable products	0.3086	0.2414	0.2026	0.4440	0.3189	0.7526	1.0715	1.7822	2.4387	3.4722	2.4722
Oils and fats	0.2321	0.2003	0.2023	0.4026	0.2693	0.6346	0.9039	1.8631	2.7347	3.8952	2.8952
Flour mill products and cereal foods	0.2514	0.3059	0.2281	0.5340	0.2935	0.7854	1.0789	2.2170	3.1246	4.2924	3.2924
Beer and malt	0.3368	0.2597	0.1793	0.4390	0.2561	0.7759	1.0320	1.7711	2.3035	3.0639	2.0639
Wine and spirits	0.2767	0.2829	0.2107	0.4935	0.3186	0.7702	1.0888	2.0224	2.7839	3.9353	2.9353
Textile fibres, yarns, fabrics etc.	0.1295	0.4085	0.3383	0.7468	0.3361	0.8763	1.2124	4.1549	6.7672	9.3629	8.3629
Average (agriculture processing)	0.2435	0.2948	0.2410	0.5358	0.3046	0.7792	1.0838	2.3771	3.5144	4.8893	3.8893

APPENDIX 2.

ADDITIONAL WAM EQUATIONS

The full set of equations for the WA model (WAM) will not be presented here, but are available in Clements, Ahammad and Ye (1996). In this appendix, we consider only those equations added to WAM to incorporate jointness in primary agricultural production. As was described in Section 3 of this report, selected primary agricultural sectors are able to swap capital. In the basic WAM structure this is not possible, as capital (really a composite of land and capital) is industry specific and cannot be used by another industry. To incorporate this aspect of 'jointness' in agricultural production, two groups of industries are assumed to be capable of sharing capital:

Group A: Sheep meat (1), Wool (2), Cereals (3) and Pulses and oilseeds (4)

Group B: Horticulture (8), New industries (9) and Dairy cattle (10),

where the numbers after each industry represent the industry's position within the WAM industry structure. Letting K represent the capital stock in each industry, it follows that:

(A.1) $K_A = K_1 + K_2 + K_3 + K_4$, and

(A.2) $K_B = K_8 + K_9 + K_{10}$,

where K_A and K_B are both fixed.

As WAM is formulated in percentage change terms, the above equations need to be rewritten in percentage change form before they can be incorporated into the model. By convention, the percentage change form of WAM variables are written as lower case letters. Equation (A.1) therefore becomes

(A.3) $k^A = \sum_{j=1}^{4} \sigma_j^{kA} k_j$,

and (A.2) becomes

(A.4) $k^B = \sum_{j=7}^{10} \sigma_j^{kB} k_j$.

In equation (A.3), k^A is the percentage change in the capital stock of all Group A industries, k_j (j = 1-4) is the percentage change in the capital stock of individual Group A industries, and σ_j^{kA} is the share of industry j capital stock in the total capital stock available to Group A industries. The variables and parameters of equation (A.4) are similarly defined, and are not described here.

The process of determining the equilibrium distribution of capital between Group A and between Group B industries relies upon the price paid to each unit of capital (P_i^K). It is assumed that at equilibrium the price paid to capital in each industry is the same, i.e. for Group A industries.

(A.5) $P_1^K = P_2^K = P_3^K = P_4^K$.

Similarly, for Group B industries

(A.6) $P_8^K = P_9^K = P_{10}^K$.

Converting equations (A.5) and (A.6) into percentage changes, we have for Group A industries

(A.7) $p_1^K = p_2^K = p_3^K = p_4^K$,

and for Group B industries

(A.8) $p_8^K = p_9^K = p_{10}^K$.

An alternative approach to determining the equilibrium price relationship is to calculate the rate of return on capital in each industry. Following Dixon *et al*. (1982), the net rate of return to fixed capital (R_j) is given by

(A.9) $$R_j = \frac{P_j^K}{\Pi_j} - d_j,$$

where P_j^K is the user's price of capital to industry j, Π_j is the cost of capital to industry j, and d_j is the rate of physical depreciation of the capital stock in industry j. Assuming that the depreciation rate is constant, this equation is given in percentage change terms by

(A.10) $r_j = Q_j (p_j^K - \pi_j)$,

where $Q_j = (R_j + d_j)/R_j$ is the ratio of the gross rate of return to capital to the net rate of return.

In the short-run, where capital stocks are fixed, so is the cost of capital to industry j (where the cost represents the price paid in the production of the existing units of capital). Therefore, the change in the cost of these existing units of capital, δ_j, is equal to zero.

Equation (A.10) then simplifies to $r_j = Q_j\, p_j^K$.

If it is assumed that R_j and d_j are the same for each industry in Group A, and for each industry in Group B, then it follows that at equilibrium the return to capital in each group will equalise, and, therefore, the price paid to capital in each industry will also equalise. Thus, in the short-run, equilibrium for Group A industries is represented by,

(A.11) $p_1^K = p_2^K = p_3^K = p_4^K$,

while for Group B industries,

(A.12) $p_8^K = p_9^K = p_{10}^K$.

These are equivalent to the results obtained earlier.

APPENDIX 3.

CALCULATING THE SHOCKS USED IN THE WAM SIMULATIONS AND ADJUSTING THE SIMULATION RESULTS

Section 4 contains the results of the eight simulations conducted using WAM. To perform these simulations it is necessary to 'shock' the model with percentage changes in the output of the expanding agricultural processing industries. The calculation of these shocks is presented in this appendix.

The regional shocks are calculated by dividing the $1m increase in the output of the agricultural processing industry by the industry's total output. The values for total industry output - shown in column 3 of Table A3.1 - are for the year 1994-95 (the base year of the WAM database). Therefore, if we assume that the $1 million pertains to the 2001/02 financial year, then it is first necessary to adjust the $1 million by the change in the price level between 1994/95 and 2001/02. Based on ABS data (ABS, 2002), prices have risen by 19 percent over this period. Thus, $1 million in 2001/02 would have been worth $1 m / 1.19 = $840,000 in 1994/95. Dividing this value by the 1994/95 value of agricultural processing industry output (column 3 of Table A3.1) allows the required shocks to be calculated (see column 4 of Table A3.1).

Once these shocks have been applied to the model, WAM provides results showing the percentage change in a wide range of economic variables for Western Australia. To convert the model results to 1994/95 values, the percentage change results are multiplied by the corresponding values from the model's database. Results not expressed in dollar terms – for example employment growth and change in the CPI – need no further adjustment; however, those expressed in dollar values – such as GSP and output – are adjusted to 2001/02 values by the application of the price level increase between 1994/95 and 2001/02 (i.e. the results are multiplied by 1.19).

Table A3.1. Shocks used in the WAM simulations

Ind No.	Processing industry	Total production 1994-95 ($m)[1]	Output shock (percent)
(1)	(2)	(3)	(4)
20	Meat and meat products	932.5	0.0901
21	Dairy products	309.9	0.2711
22	Fruit and vegetable products	165.8	0.5066
23	Oils and fats	44.1	1.9048
24	Flour mill products and cereal foods	100.8	0.8333
29	Beer and malt	288.3	0.2914
30	Wine and spirits	76.8	1.0938
31	Textile fibres, yarns, fabrics etc.	140.7	0.5970

Notes:

1. Total production values are taken from the WAM database.

APPENDIX 4.

ADDITIONAL SIMULATION RESULTS

The simulation results presented in Section 4 of this report relate to a $1 million increase in the output of the agricultural processing industries. In this appendix, we present a different approach to the expansion of the agricultural processing industries. Here, we consider a 10 percent increase in the value of output of each of these industries. (Where the 10 percent change is relative to the size of the industry in 1994/95, the base year of the database.)

Table A4.1 presents the results of the simulations conducted to determine the economic impact of a 10 percent expansion in the output of agricultural processing industries. Clearly, the most economic benefit is derived from the expansion of the Meat and meat products industry, with real GSP expanding by 0.12 percent. This is substantially more than the meagre 0.007 percent increase in real GSP associated with a 10 percent expansion of the Oils and fats industry. However, in interpreting these results it must be remembered that the Meat and meat products industry - with output valued at $930m in 1994-95 (see column 3 of Table A3.1) - is more than 20 times larger than the Oils and fats industry - which had output valued at only $44m in 1994-95. As such, the results in Table A4.1 are to interpreted cautiously, as much of the difference between industry impacts is due to the relative sizes of the expanding industries.

However, relative industry sizes are clearly not the only factors of importance. Consider the results for the Dairy products and Fruit and vegetable products industries in Table A4.1. Even though the Dairy products industry is nearly twice the size of the Fruit and vegetable products industry (see column 3 of Table A3.1), the economic impacts from a 10 percent increase in the output of each are quite similar, with the real GSP of each rising by 0.031 percent. As was shown in Table 4.1 in Section 4 - where a $1 million increase in output was considered - expansion in the Dairy products industry has considerably less flow on benefits to the WA economy than does expansion in the Fruit and vegetable products sector. This is reflected in the results presented in Table A4.1.

Table A4.1. Macroeconomic impact of a 10 percent expansion in agricultural processing industries (percentage change)

Agricultural processing industries	Real GSP	CPI	Employment	Imports	Exports
(1)	(2)	(3)	(4)	(5)	(6)
Meat and meat products	0.120	0.104	0.187	0.057	0.125
Dairy products	0.031	0.029	0.050	0.018	0.033
Fruit and vegetable products	0.031	0.026	0.048	0.023	0.035
Oils and fats	0.007	0.006	0.011	0.008	0.010
Flour mill products and cereal foods	0.016	0.014	0.026	0.009	0.016
Beer and malt	0.058	0.050	0.084	0.035	0.060
Wine and spirits	0.020	0.016	0.025	0.009	0.010
Textile fibres, yarns, fabrics etc.	0.013	0.009	0.022	0.004	0.008

APPENDIX 5.

SECTORAL DEFINITIONS

In Section 4, the results from the WAM modelling are presented for eight broad sectoral categories:

- Agriculture
- Forestry, logging and fishing
- Mining
- Manufacturing
- Construction
- Trade and transportation
- Services
- Government administration and defence.

Table A5.1 demonstrates the individual WAM industries that constitute the components of these aggregated sectors.

Table A5.1. List of industries in the eight aggregated industry groups

Groups	108-sector industries	Groups	108-sector industries
1. Agriculture	Sheep meat	4. Manufacturing (cont'd)	Oils and fats
	Sheep wool		Flour mill products and cereal foods
	Cereals		Bakery products
	Pulses and oilseeds		Confectionary
	Beef cattle		Other food products
	Pigs		Soft drinks, cordial and syrups
	Poultry		Beer and malt
	Horticulture		Wine and spirits
	New industries and other agriculture		Textile fibres, yarns, fabrics etc.
	Dairy cattle		Textile products
			Knitting mill products
2. Forestry, logging and fishing	Forestry and logging		Clothing
	Commercial fishing		Footwear
			Leather and leather products
3. Mining	Coal		Sawmill products
	Oil and gas		Other wood products
	Iron ores		Pulp, paper and paperboard
	Non-ferrous metal ores		Paper containers and products
	Other mining		Printing and servies to printing
			Publishing: recorded media and publishing
4. Manufacturing	Meat and meat products		Petroleum and coal productsi
	Dairy products		Basic chemicals
	Fruit and vegetable products		Paints

Table A5.1 continued …

Groups	108-sector industries	Groups	108-sector industries
4. Manufacturing (cont'd)	Medicinal and pharmaceutical products; pesticides	4. Manufacturing (cont'd)	Photographic and scientific equipment
	Soap and other detergents		Electronic equipment
	Cosmetics and toiletry preparations		Household appliances
	Other chemical products		Other electrical equipment
	Rubber products		Agricultural, mining and construction machinery
	Plastic products		Other machinery and equipment
	Glass and glass products		Prefabricated buildings
	Ceramic products		Furniture
	Cement, lime and concrete slurry		
	Plaster and other concrete products	5. Construction	Other manufacturing
	Other non-metallic mineral products		Residential building
	Iron and steel		
	Basic non-gerrous metal and products	6. Trade and transportation	Other construction
	Structural metal products		Wholesale trade and repairs
	Sheet metal products		Retail trade and repairs
	Fabricated metal products		Road transport
	Motor vehicles and parts; other transport equipment		Rail, pipeline and other transport
	Ships and boats		Water transport
	Railway equipment		Air and space transport
	Aircraft		

Table A5.1 continued …

Groups	108-sector industries	Groups	108-sector industries
7. Services	Services to agriculture; hunting and trapping	7. Services (cont'd)	Scientific research, technical and computer services
	Services to mining		Legal, accounting, marketing and business management services
	Electrical supply		Other business services
	Gas supply		Education
	Water supply' sewerage and drainage services		Health services
	Accommodation, cafes and restaurants		Community services
	Services to transport; storage		Motion picture, radio and television services
	Communication services		Libraries, museums and the arts
	Banking		Sport, gambling and recreational services
	Non-bank finance		Personal services
	Financial asset investors		Other services
	Insurance		
	Services to finance, investment and insurance	8. Public administration and defence	Government administration
	Ownership of dwellings		Defence
	Other property services		