AN INQUIRY INTO THE CURRENT STATUS AND FUTURE OF THE TASMANIAN ABALONE PROCESSING INDUSTRY

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Overview

Aims and Approach

The aims of this study are as follows:

- To identify appropriate measures of the industry's performance as a basis for its reform.
- To obtain the industry's perspective on its current structure and performance from processors' financial data and to reassess its contribution to the Tasmanian economy.
- To derive benchmarks for the performance of the Tasmanian post harvesting abalone industry.
- To derive the conditions necessary for putting the processing sector on a sound financial footing in the future.
- To recommend to the industry and relevant government agencies the way ahead, given that a major concern of stakeholders is to guarantee that the industry operates on a viable basis particularly through current economic conditions.

The approach involved the following issues:

- An updated assessment of the status of the industry (Chapter 1);
- The impact of the GFC on the industry (Chapter 2);
- Show that the processing industry continues to be a self-reliant contributor to the Tasmanian economy using the RIOM I/O model (Chapter 3);
- Analyse the causes of the industry's current problems in a multiple regression (Chapter 4);
- Determine if the current industry is operating efficiently in an economic context (Chapter 5);
- Test the data to see if there are too many processors (Chapter 5);
- Identify the relevant market structures into the future: the Price Leadership model and a model open to additional competition, with foreign competitors being the major candidates (Chapter 6).

Results

- Since the GFC hit the industry in 2006/07 processor returns fell by 26-35% in unadjusted terms. This fall in processor returns and unit prices is far worse in

real (inflation adjusted) terms. Unit prices have fallen in real value by 63% and returns to processors by 55%.

- Since 2005/06 the Total Allowable Catch (TAC) imposed on processors has fallen from 2509 tonnes to 2140 tonnes in 2013.
- The 2014 quota has fallen to 1930 tonnes.
- The processing sector is still a vibrant one for the state economy. Application of the RIOM model suggests the industry contributes:
    - $178 million to the output of all Tasmania;
    - $83.62 million in value added (GSP);
    - Full time employment of 568 FTEs and over $30 million to wages.
- The processing sector has not required government subsidisation to this point.
- Regression modelling shows that 3 factors help drive processors' returns: the beach price; the high value of the Australian dollar and the past history of returns to processors.
- The stubbornly high value of the AUD has had the same effects on export volumes and values of exported abalone as it has on other exporters.
- We also discover some mediating relationship between the effects of the beach price on processors revenues: some 25% of this effect is caused by the mutual correlation of beach prices and Australian GDP. Thus, returns are affected by the cycle in economic activity.
- In the earlier report (2005), we found that there were 20 factories processing abalone. The recommendation made at the time was to reduce the number of active processors to 12 through-putting 215 tonnes of abalone per season. The research conducted for this report shows that 8 processing units had either switched production to other fish species or voluntarily left the industry altogether. Thus there are currently 12 active processors in operation.
- With the TAC for abalone continuing to fall each year, there are still too many processors.
- As the TAC has now fallen to 1930 tonnes for the 2014 season. The research that we have done shows that the appropriate number of processors for this reduced throughput is 9.
- From the sample of 4 producers, we find that the processing sector operates as an economically efficient sector of the Tasmanian economy.

- The current industry operates on Price Leadership principles with two dominant firms, one in live exports of Abalone and one in canned abalone. There are also about 10 medium to small processors.
- We could not isolate any insurmountable barriers to new entrants, making the market open to new competition. Even if not realized, the threat of foreign competition is enough to make the abalone market contestable. The market for fresh abalone in particular has advanced to the point where it is a contestable market, allowing access for overseas entrants.

Recommendations

Recommendations and Conclusions

1. Market Structure

   One of the major findings of the study is that the Tasmanian abalone industry operates increasingly as a price leadership structure. One large producer influences prices while the remaining firms are influenced by the leader's decisions. The risk associated with this form of market operation is that competitive forms of pricing can emerge and these are not always beneficial to the industry. **The processing sector should recognise these risks and their potential effects**.

2. Local Control

   The Tasmanian live abalone trade is presently privately owned and controlled. Recent market behaviour includes a proposed merger involving foreign interests and local processors. The present laissez-faire approach to the industry structure means that no consideration has been given to whether foreign competition is good, bad or indifferent. **The industry should be aware of the risks involved in foreign ownership and act to alleviate these if appropriate.**

3. Threats to the Resource

   Our research shows that bio-security requirements have reduced the TAC from 2509 tonnes in 2005 to 1930 tonnes presently. **There are threats to the industry**

in relation to resource security. In relation to modes of production the moratorium on the issue of abalone aquaculture licences must remain for the foreseeable future.

4. The Number of Processors and Supply Constraints

The decline in the TAC exposes the supply constraints confronting this resource industry. Our research on this issue shows that eight processors have opted out of the industry since 2005, leaving 12 operating at the present time. The industry is not in a growth phase and cannot be given the low value of the beach price, diminished returns to processors and TAC restrictions. There is no space for new licences in the current situation. **As a result, no more processor licences should be issued in the short term.**

5. The Industry Attitude to a Restructured Industry

Discussions with the major players in the processing sector reveal general acceptance of a future processing sector compromised of a dozen processors and built largely around the current structure. Twelve processors appears from our research to be the optimal number of licences to furnish the output processed abalone. **The preservation of the status quo should be the guiding principle in relation to the future structure of the processing industry and competitive pressures should be allowed to restructure the industry**.

6. Cooperation in the Processing Sector

The single desk for the marketing of live abalone in particular is discussed in previous studies of abalone processing. A single desk for the sale of a resource is usually associated with the Australian Wheat board, which introduced the single desk in 1933. A single desk enables the Tasmanian processing industry to exercise some monopoly power in the determination of the mark up in live abalone. The counter argument against the idea of the single desk is the argument that in the age of competition policy there is no need for the single desk. Here we note a concern expressed by processors to preserve competitive

elements within the industry; processors should have the right to export abalone wherever they want and choose who sells abalone on their behalf. **The Tasmanian Abalone Council should seek the opinions of the individual processors about which approach to marketing abalone is best and to consider the risks and benefits of a single desk.**

7. Cooperation between Industry Segments

The sustainability of the revised processing sector will depend as much on cooperation between divers, quota holders and processors as it will on cooperation within each industry segment. An example of inter-sectoral cooperation is the $1 million investment made by the market leading firm in a vessel designed to encourage the industry more generally. The segmentation of the industry was completed when divers' licences were separated from quotas, leading to a fall in the TAC and the lower incomes earned by non-quota holders. This is the point at which the findings from this study of processing will crossover with a separate study of diver's licencing. **The Tasmanian Abalone Council should identify the points of common interest between the divers, quota holders and processors and encourage individuals to act in the industry's interest.**

8. Free Trade Agreements

New Zealand has almost finalised a FTA with the USA, with the US fully participating in the Trans Pacific Partnership. Australia provides 50% of the demand for premium quality abalone. Tasmanian sources supply 25% of the world demand. Australia's view of the US-NZ FTA is to count the cost of the US-NZ agreement. However, the NZ product is not of a quality or quantity to seriously discommode the local industry. **The local industry should continue to express support for the vaunted US-Australia FTA and for the abolition of the tariff on Chinese exports of Tasmanian abalone.**

9. Fees Charges and Taxes

The level playing field for old and new holders has been much debated over time. The processing industry has more than a passing interest in this debate, because the royalty levied on the beach price impacts negatively on all three sectors of the industry as a consequence. In approaches to the State government by the TasAb council, care has been taken to distinguish the "royalty" basis of current payments to government from the "rent resources tax" basis. Under a rent resources tax, the tax is levied on rents in the market and not on output as is the case with a royalty basis. There may be some confusion about the intention of the Department (DIPWE) in this case. **We recommend that in discussions with the relevant Minister in a new State government that the basics (royalty or RRT) be clarified. It will be necessary to calculate the tax if the RRT is deemed to be the preferred basis, and it is preferred by most micro economists because the RRT is more efficient than royalty taxes.**

10. AQIS charges

In conversations with sampled processors about AQIS charges, there was significant hostility towards them. Levies of this kind act as a tax on exports. **We recommend that processors lobby government to review this mode of taxing wealth creating activities**.

11. Disease Control

Abalone production in Tasmania is a highly risky business. There is the ever present threat of disease in the fish stock. While Deeds of Agreement ameliorate some of this risk, concern still exists with regard to the degree of protection they actually offer in the event of large scale disease problems. Given the important role of diver surveillance in efforts to control harmful viruses such as the AVG virus, this tension needs to be addressed. **TasAb could consider the alternatives for further encouraging diver surveillance and reporting and providing more certainty about risk allocation within the industry.**

12. Currency Risk

The GFC has made processors aware of a further financial risk, namely currency risk, where the value of the Australian dollar becomes stationary at very high levels against other major currencies, particularly the US greenback. The upside risk is evident when the AUD rises against the USD. **Individual processors can hedge contracts for the sale of abalone if such contracts exist. This is reliable in Australia for hedging against the rise of our dollar against the greenback.** The simplest hedge is to write contracts in the foreign currency. Tasmania's export industry operating subject to currency risk can pool risk through the use of a sovereign fund designed to stabilise returns. **Consideration of options for hedging against currency risk is a worthy approach to the issue. A futures fund should extend to all primary industries and the fish processing sector should be pro-active in this debate.**

13. A New Industry Structure?

There is no urgency about creating a new industry structure. From the research conducted in this report, the current industry with twelve processors can continue with minimal change. If there are to be changes in structure, then they should emerge as a market response. **We recommend that the basic structure of the industry remain unchanged and that any changes that occur be market driven.**

14. Product and Market Diversification

Recent research efforts geared to identifying new products (eg modified atmosphere packaging) and markets (eg the emerging affluent Chinese middle class offer opportunities to address recent falls in beach price and return to all sectors of the industry, particularly for wild caught abalone. **We recommend that the industry support attempts to diversify the wild abalone product and development of new markets to address recent price falls.**

CHAPTER 1 AIMS, METHODS AND LITERATURE

There are several aspects of central importance to the viability of Tasmania's abalone processing industry which are reflected in the following goals of the study:

1.1 THE AIMS OF THIS STUDY:

This report analyses the current status of the abalone processing industry following the impact of controllable and uncontrollable shocks hitting the industry since the last review in 2004. These include the effects of the Global Financial Crisis (GFC), the unacceptably high value of the Australian dollar on trade, contestability of the markets for Tasmanian abalone and other external factors such as the NSW moratorium imposed on abalone imported from Tasmania. The agreed Terms of Reference (TOR) for the report follow:

- To identify appropriate measures of the industry's performance as a basis for its future.
- To obtain the industry's perspective on its current structure and performance from processors' financial data and to reassess its contribution to the Tasmanian economy.
- To derive benchmarks for assessing the efficiency of the post harvesting abalone industry in Tasmania.
- To derive the conditions necessary for putting the processing sector on a sound financial footing in the future.
- To recommend to the industry and relevant government agencies the way ahead, given that a major concern of stakeholders is to guarantee that the industry operates on a viable basis particularly through current economic conditions.

1.2 APPROACH

Here we describe the appropriate method for achieving each of the aims described above.

In relation to the first aim of defining the current status of the industry's performance, the report entitled *Analysis of the Abalone and Rock lobster post harvesting industry in Felmingham (2005)* is updated and the *Strategic Plan 2008-2013* reviewed. On this occasion, the study is confined to the abalone processing sector as the profile of processing for the two commodities rock lobster and abalone has changed in recent times. There is much less common ground between abalone and rock lobster

processing in 2014, so a separate analysis of abalone processing is appropriate. Chapters 2 and 3 of the report are dedicated to determining the current status of the industry. In chapter 2 we analyse the decline in the processing sector and in particular the effects of the GFC on returns to processors. Data for this purpose is largely drawn from published sources such as the Australian Bureau of Statistics (ABS) series on fisheries, from industry sources maintained within the Tasmanian Abalone Council and from relevant Tasmanian Government agencies. In chapter 3 we use the RIOM I/O model to reassess the flow on economic impact of the processing sector on the Tasmanian economy as a whole.

The second and third TORs are related: seeking industry feedback and perspective to inform the development of suitable performance measures for the processing sector. A review of the literature on industry benchmarking confirms that that the appropriate benchmark is based on the economic efficiency of individual processors in addition to alternatives like profits, value added and output.

A survey of processors was conducted to obtain data for efficiency bench marking. This included face to face interviews with 10 processors and telephone or email interviews with 8 additional processors still operating in the abalone processing business. We also requested key financial data from the population of processors, including the value of processors' sales of abalone and the processors' total cost of processing abalone. Total processing cost comprises the following costs in dollars: wages costs; depreciation; and other processor's costs. It was hoped to use these data to conduct a Date Envelopment Analysis (DEA) to identify the relative efficiency of the processing sector and how close it is to full efficiency. Unfortunately complete data sets were received from only 4 processors. While this sample is too small for DEA, the processors sampled account for 45% of the value of industry sales of fresh abalone and as such form a representative sample for the assessment of the Overall Technical Efficiency (OTE) of processors as outlined in Chapter 5.

Chapter 4 of this report is dedicated to an analysis of the factors which impact on the earnings of processors. Included here are beach prices, Australia's GDP and the USD/AUD exchange rate.

The fourth TOR comprises discussion of the conditions necessary for putting the processing sector on a sound financial footing in the future. In Chapter 5, the efficiency ratios are calculated and individual sampled processors are assessed according to their efficiency. These ratios, plus the minimum throughput of 215 tonnes per season required for full efficiency identified in Felmingham (2005) are used to quantify the number of processors required for an industry within in the state.

Restructuring is not necessarily a black or white issue. It is certainly not the case that efficient producers are the only ones who should remain in the industry while the less efficient ones are reformed. There will be processors achieving efficiency scores like 85% of full efficiency and they can easily get to full efficiency with modest changes to the way in which they operate.

The final TOR involves advice to industry and government based on the findings of the study. The final chapter (Chapter 6) is dedicated to the current economic structure of the industry and the identification of issues for policy debate about the structure of the industry in future.

1.3 RECENT LITERATURE

There are certain findings from the 2005 report which also appear to apply in 2014 with equal force. First Individual processors have some influence on export prices and in this respect (Appendix 3A of Felmingham: causality tests) show that beach and export prices are jointly determined. Beach prices do not cause export prices exclusively and vice versa. The arguments surrounding the wisdom or otherwise of the processing industry's reliance predominantly on a single market for abalone remain as they were in 2005. No further analysis of the direction of causation involving beach and export prices is required in this update.

1.4 MATTERS OF HEIGHTENED INTEREST IN THIS UPDATE OF THE 2005 REPORT

The changing circumstances confronting Tasmanian abalone processors since 2005 bring to light certain key issues warranting a new analysis. The following issues are included in this group:

- A changing pattern in the demand for Tasmanian abalone;
- Changes in the beach price and its impact on the processing sector;
- The approach to new markets for abalone;

- The effectiveness of attempts to get round bottlenecks preventing the processing industry from growing and diversifying the industry into new markets;
- The industry's attempts to manage the effects of the GFC, in particular in relation to the high level of the USD/AUD exchange rate;
- The changing role of government in managing the effects of the GFC on abalone processing; and
- The need for a more efficient industry.

CHAPTER 2 THE PROCESSING INDUSTRY IN ABALONE PRODUCTION AND IN THE TASMANIAN ECONOMY.

2.1 MARKETS FOR ABALONE

The processing sector of the Tasmanian abalone industry is part of a vertically integrated fishing industry in which the post harvesting (fishing) sector supplies predominantly live, fresh abalone to a global export market. The Tasmanian industry supplies 25% of the market for wild catch abalone to these markets[1]. Figure 2.1 below shows the market distribution of live fresh abalone and the expanding market share which is sold into the Chinese market with smaller proportions shipped to Japan and Taiwan.

[1] The Tasmanian Abalone Industry Profile, May 2009, Department of Primary Industries and Water (now Primary Industries, Parks, Water and Environment)

Figure 2.1 Live Abalone Export market share and distribution 1995

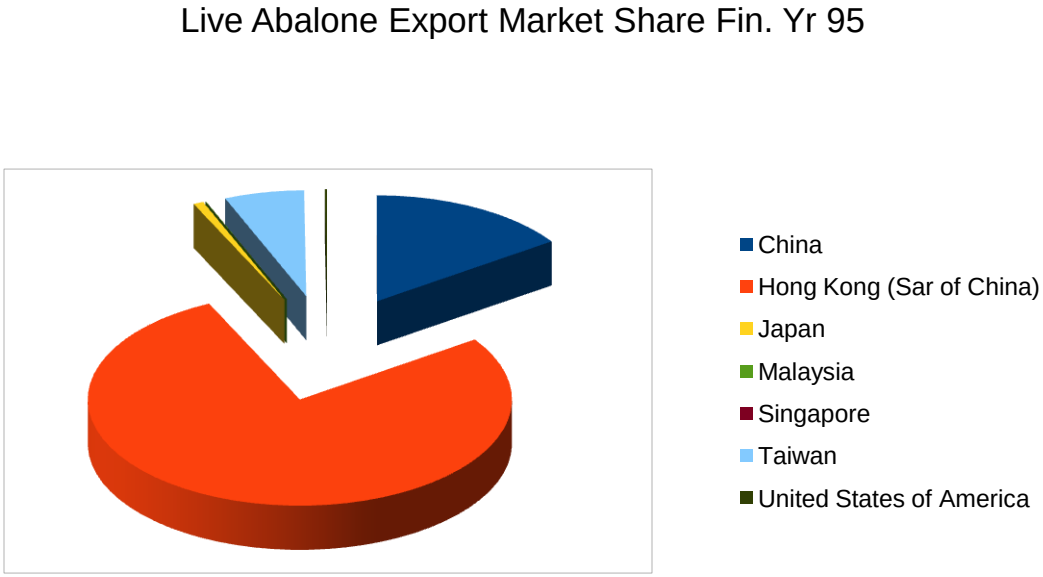
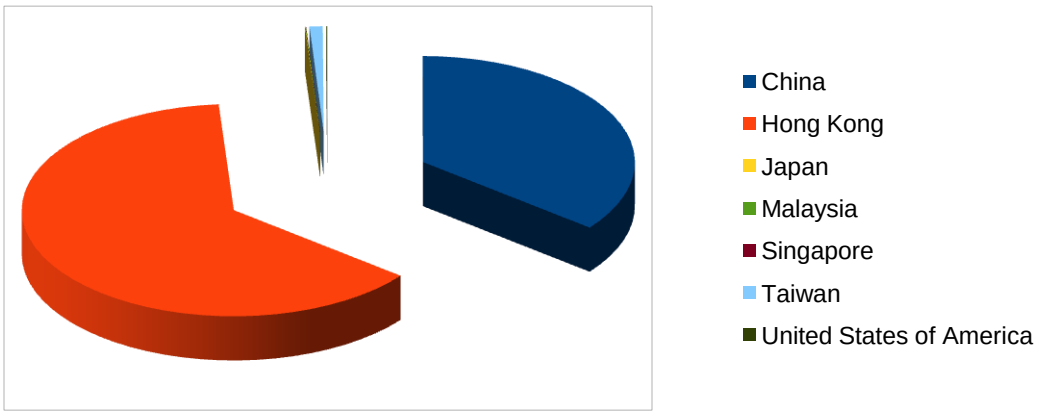
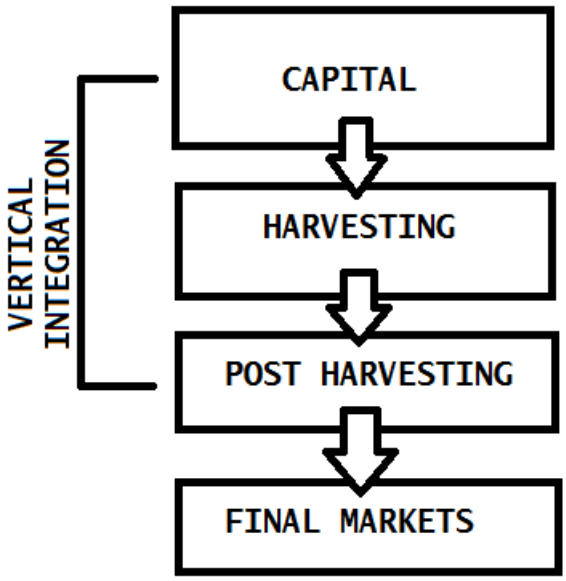


Figure 2.2 Live Abalone Export market share and distribution 2013



The place of the abalone processing sector in the Tasmanian abalone fishery is portrayed on figure 2.3 below. Figure 2.3 captures the vertically integrated nature of the abalone fishery where the fishers for abalone supply the processors, who in turn hold predominantly a stock of live abalone in tanks prior to shipment overseas. These sales of live abalone account for about 70 % of export sales with the balance sold in prepared forms such as canned, chilled, frozen or dried. There is a small domestic market for Tasmanian abalone.

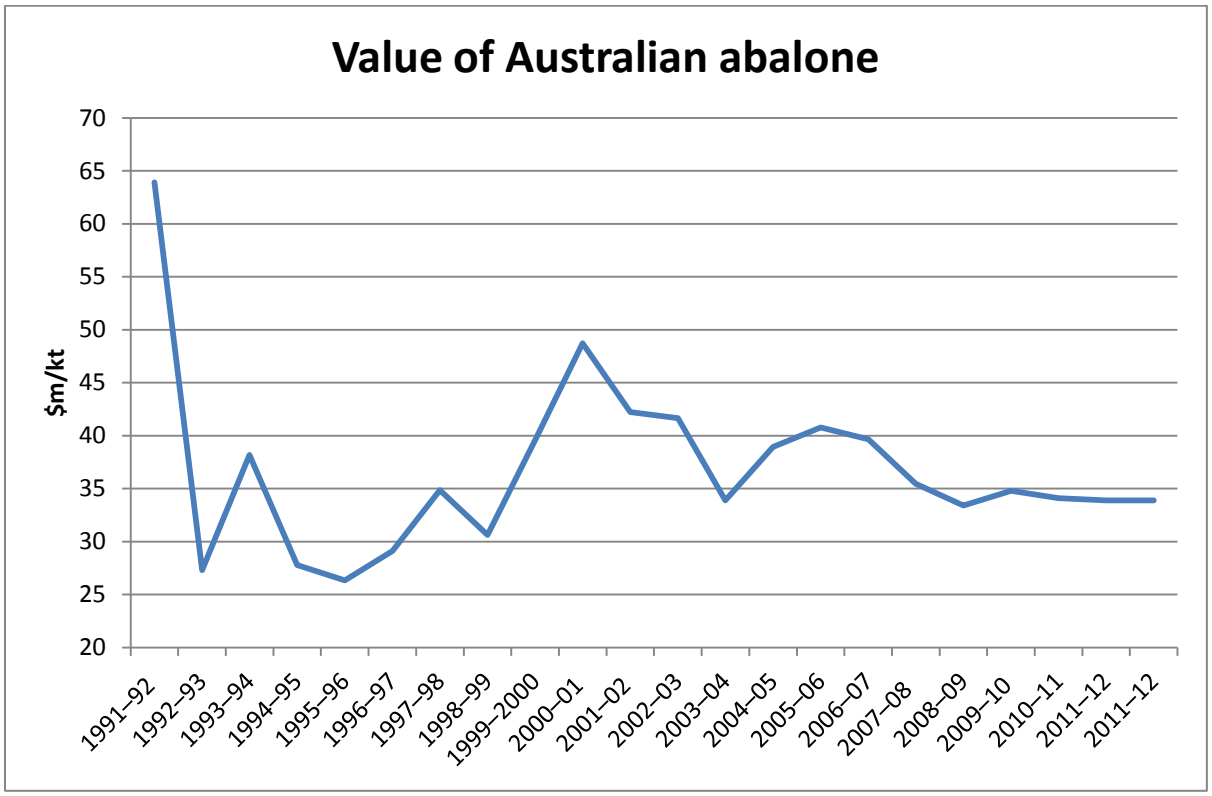
Figure 2.3 Structure of the Tasmanian Abalone industry



2.2 BEACH AND EXPORT PRICES

The structure of the Tasmanian abalone industry shown on figure 2.3 is secured through its pricing arrangements. The beach price is the price paid by processors for the fishers catch. Thus the beach price is the fishers' income but represents a cost to processors. The price charged by processors for abalone includes a margin or mark up on the beach price usually by negotiation and it is the price secured by processors for their product. The behavior of the beach price is pivotal to the performance of the industry determining both the returns to fishers and the costs of processing abalone. The behavior of beach prices over time is shown on figure 2.4 below.

Figure 2.4 Beach price of Australian abalone 1991-2 to 2011-12[2]



The salient features of the behavior of beach prices from the beginnings of the industry include the peak in beach prices occurring in 1993 coinciding with the emergence of the world economy from the worst recession since the great depression. The beach price peaks again in 2000, another period of strong growth and it falls again over the period 2007-2008 potentially as a consequence of the global financial crisis at the beginning of that period. One compensation for a sharp decline in beach prices in 2003 is that the volatility of the beach price settles down providing traders in the abalone market with reduced market risks. The beach price displays less volatility from 2006/07 and beyond, but remains at very low levels during the period around $30 per kilo. It does seem as if beach prices are influenced by global market conditions, an issue addressed further in chapter 4.

Returns per kilo from the export of abalone also emphasize the effects of global market conditions. This is evident in the table 2.1 below where the peak export price is almost

[2] Source: ABARES 2012

$41 at the beginning of the sample period in F/Y 2005 – 2006 but it falls to $34 per kilo at the end of the sample period in F/Y 2012-13.

Table 2.1 Value of Australian production ($m/kt)[3]

Financial Year	Value of Australian Production $m/kt
2005–06	40. 8
2006–07	39. 7
2007–08	35. 5
2008–09	33. 4
2009–10	34. 8
2010–11	34. 1
2011–12	33. 9

2.3 EARNINGS FROM ABALONE EXPORTS

The impact of the GFC on Australia's abalone export earnings is not confined to a fall in prices per kilo it is also reflected by a fall in the quantity of abalone exported otherwise known as the demand for Australian abalone. Export revenue from abalone is shown for each year of the eight year period 2005-06 to 2011-2012 and for each state of the Commonwealth and for all types of abalone namely canned, chilled, live and dried abalone. These total industry revenues are shown on table 2.2.

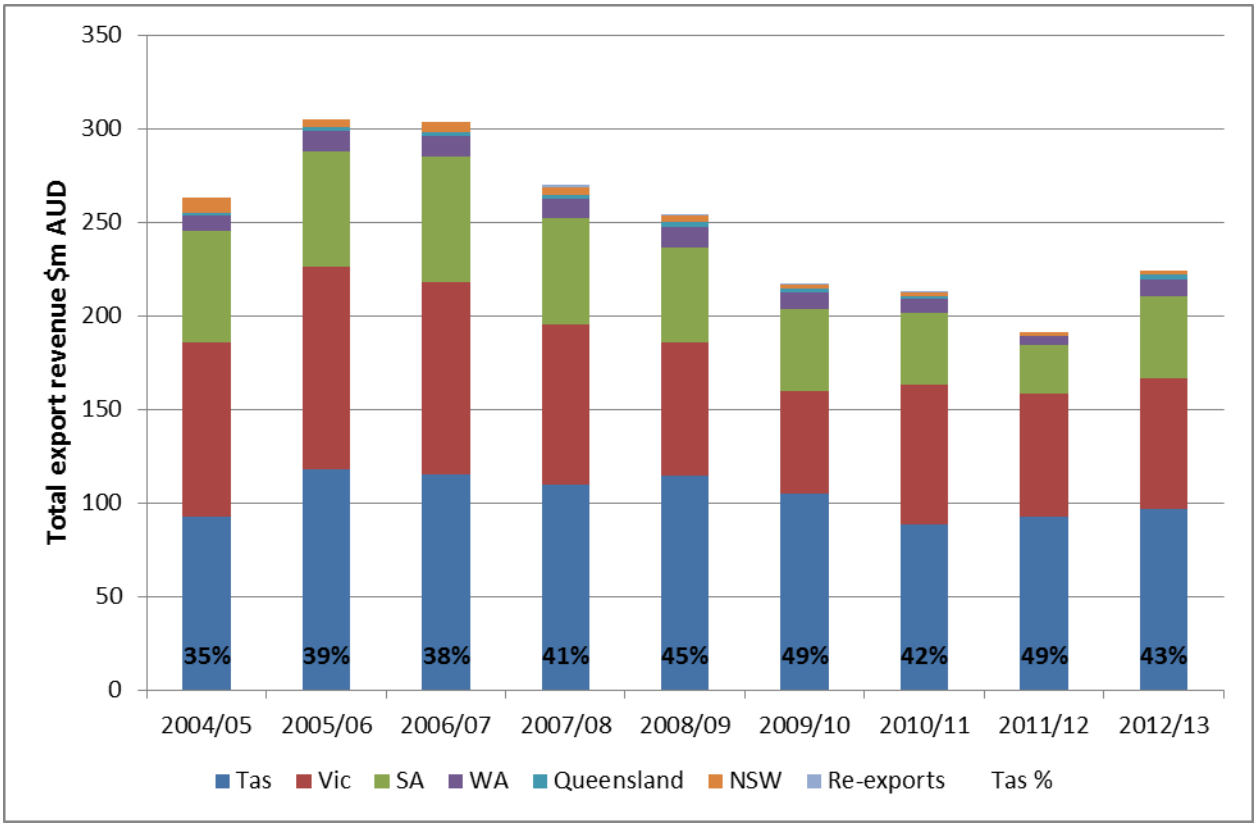
Table 2.2 Total abalone export revenue ($m) by state 2004/05 – 2012/13

State of Origin	2004/05	2005/06	2006/07	2007/08	2008/09	2009/10	2010/11	2011/12	2012/13
Tas	92.80	117.78	115.49	109.46	114.65	105.04	88.43	92.93	96.75
Vic	93.01	108.16	102.44	85.81	71.00	54.63	74.54	65.77	69.82
SA	59.25	61.80	66.81	57.16	50.52	43.86	38.62	25.82	44.05
WA	8.48	11.08	11.47	10.30	11.03	9.18	7.77	4.56	8.89
QLD	1.41	1.71	1.96	1.85	3.12	1.80	1.12	0.41	2.26
NSW	8.05	4.48	5.18	4.08	3.19	1.98	1.80	1.66	2.07
Re-exports				1.12	1.01	0.04	0.02	0.00	0.00
Grand Total	**263.00**	**305.00**	**303.34**	**269.78**	**254.52**	**216.52**	**212.29**	**191.16**	**223.84**
Tas %	35%	39%	38%	41%	45%	49%	42%	49%	43%

[3] ABARES 2012

In the years leading up to the GFC the total Australian export income from abalone sales exceeded $300 million but revenues have declined by 26% plus since the GFC impacted throwing the export abalone industry into a challenging period. Tasmania supplies about 40% of the total Australian export business and a much higher percentage of the live abalone trade and has not been able to avoid the current problems. The data in table 2.2 are shown graphically in figure 2.5 below. This figure demonstrates both the decline in total Australian export revenue since 2006/07 and the increase in Tasmania's share of the total over the same period.

Figure 2.5 Total abalone export revenue ($m) by state 2004/05 – 2012/13



The decline in returns to processors and investors looks far worse when adjusted for inflation. The effects in constant (inflation adjusted) prices and current (unadjusted for inflation) prices are shown on table.

Table 2.3 Declines in processor returns and unit prices: Dec 2000- Dec 2012: Current and Constant prices[4]

	Returns $/kt		Value of Units $000s	
	Current Prices	Constant Prices	Current Prices	Constant Prices
Dec 2000	46.30	66.37	310	444
Dec 2013	29.75	29.75	160	160
% Change	-36%	-55%	-48%	-63%

From table 2.3 returns to processors fell by 36% (in inflation unadjusted terms), but the fall is far worse at 55% in real terms (inflation adjusted). The drop in the real (inflation adjusted) values of unit prices is **alarming and cannot be glossed over**. The capital asset backing for the industry is rapidly eroding and raises the question about the industry's stability.

2.4 MANAGEMENT OF THE RESOURCE

The Tasmanian abalone processing industry is managed under the legislative provisions of the Living Marine Resources act (1995) and the Fishery (abalone) rules. The jurisdiction of the Act extends to State Waters which are congruous with Tasmania's coastal zone and do not include inland waters. The abalone resource is publicly owned which provides justification for the Tasmanian government's levy or royalty imposed on the industry. The fallacy of this argument is that abalone is not a pure public good in that it is not an infinitely renewable resource and the case against the payment of a royalty is weaker as a consequence. Public ownership of the resource is enough to justify strict government control of it. Control is secured by practices applied under the legislation cited above. At the centre of the control system is the annual allocation of fishing quotas to and within 5 fishing zones. The annual allowable catch in each zone requires relevant ministerial approval. Quotas allocated are subject to minimum size requirements and individual quotas are transferable. The Tasmanian abalone industry fishes two types of abalone blacklip and greenlip, blacklip being more common than greenlip. As a consequence, greenlip abalone is subject to a separate catch limit in the

[4] Sources: CPI data from ATO Collection. Returns and unit prices from TasAb Council.

Total Allowable Catch (TAC) approved by the relevant minister, reflecting its relative scarcity. Presently, the NSW government has placed an embargo on the importation of Tasmanian abalone from the Tasmanian fishery due to the algae threat in Bass Strait. Fishers and processors are subject to considerable risks, in particular, sovereign risk like the one evident in this algae bloom scare or more generally the threat of disease in the fish stock. Sovereign risk is ameliorated by the presence of contracts known as Deeds of Agreement which provide some guarantees for risk takers in the industry. However tension remains in the industry about the protection afforded in countering risks.

CHAPTER 3 ECONOMIC IMPACTS OF THE LIVE ABALONE TRADE IN TASMANIA

Input/Output methodology (I/O) is used to examine the effects of the live abalone trade on the Tasmanian economy. These effects are considered in terms of the industry's impacts on six key measures: the output of Tasmanian industries, their contribution to Gross State Product, employment numbers, wages income, taxes generated and imports. The model used in this report is the Regional Input/Output Model (RIOM). A more detailed account of the RIOM model and the principles of Input/Output modelling are provided in Appendix B.

3.1 STATEWIDE IMPACTS

The overall impacts of the live abalone export trade in Tasmania are shown in Table 3.1 below.

Table 3.1 Statewide impacts – all industries combined

Sector	Output Impact ($MM)	GSP Impact ($MM)	Total Emp Impact	FT Emp Impact	Wages Impact ($MM)	Imports Impact ($MM)	Taxes Impact ($MM)
Fishing and Aquaculture	$178. 42	$83. 62	799	568	$30. 20	$47. 46	$15. 52

These impacts represent an ongoing gain for the Tasmanian economy. The output of all industries increases by $178.42 million and GSP by $83.62 million. 799 additional jobs are created, 568 of them full-time, representing $30.20 million of wage income for Tasmanian workers.

The spread of the impacts across different industry groups provides additional information, as seen in table 3.2 below.

Table 3.2 Statewide impacts by industry sector

	Output	GSP (GVA)	Total Employment	FT Employment	Wages
Agriculture, Forestry & fishing	$114.99	$55.59	508.13	364.88	$16.33
Mining	$0.72	$0.37	1.11	1.05	$0.16
Manufacturing	$22.42	$7.25	63.87	54.16	$4.14
Electricity, Gas & Water Supply	$1.40	$0.69	2.84	2.50	$0.20
Construction	$0.63	$0.20	4.89	4.08	$0.10
Wholesale	$9.24	$3.45	40.27	30.99	$1.74
Retail	$3.38	$1.85	45.60	25.36	$1.16
Accommodation & food services	$1.67	$0.56	16.93	7.25	$0.35
Transport & Storage	$5.03	$2.42	21.19	15.45	$0.97
Communication services	$1.59	$0.78	5.20	3.86	$0.27
Banking, finance & insurance	$6.05	$3.96	21.26	15.56	$1.79
Professional, technical, property & business services	$4.52	$1.59	24.83	17.46	$0.79
Government administration & defence	$0.50	$0.28	3.81	2.88	$0.25
Education	$0.68	$0.52	9.84	5.82	$0.49
Health & Community Services	$1.07	$0.90	10.81	5.54	$0.78
Cultural & recreational services	$0.93	$0.39	5.73	3.13	$0.21
Other personal services	$0.85	$0.54	11.64	7.64	$0.47
Ownership of dwellings	$2.75	$2.28	0.61	0.00	$0.00

By far the greatest impact on output and value adding is seen in the Agriculture, Forestry and Fishing Industry sector (A) to which the live abalone trade belongs. Other major increases on Output and Gross Value Added are seen in the Wholesale (F); Banking, finance & insurance (K); Transport & Storage (I); and Professional, technical, property & business services (L) industry groups. Examining these results at a more detailed industry level, we see that the manufacturing impacts on output and GVA are largely in the food processing industry (C1), which includes chilling and other processing of live abalone for export. Similarly, the transport impacts are mostly in the road transport industry (I1), as shipping is conducted by non-Tasmanian based businesses.

In order to produce these increases in output and GSP, workers are needed. Thus, we see impacts in employment and wages for Tasmanians, across a range of industries. Because different industries are more or less labour intensive, and more or less well

paid, the pattern of these impacts does not necessarily follow that of the Output/GVA impacts. Once again, by far the greatest impact is seen in the Agriculture, Forestry and Fishing industry sector (A) to which the live abalone trade belongs. As for Output/GVA, we also see major employment impacts in the Manufacturing (C) and Wholesale (F) industry sectors. While the majority of employment generated in manufacturing is in the Food Processing Industry (C1), there are contributions from the Fabricated Metal Product Manufacturing (C13) and Machinery and Equipment Manufacturing (C15) industries. Additionally, we see increased employment and wages in the Retail sector. Since domestic sales of live abalone are low, this represents mainly an induced effect created by increased employment across all sectors. The increase seen in the Banking, Finance and Insurance sector (K) has also produced a smaller increase in wages and employment. However a greater increase in this measure is seen in the Professional, technical, property & business services (L) sector.

CHAPTER 4 FACTORS EXPLAINING THE INDUSTRY'S CURRENT STATUS.

4.1 FACTORS THAT MAY EXPLAIN THE DOWNTURN AND DATA

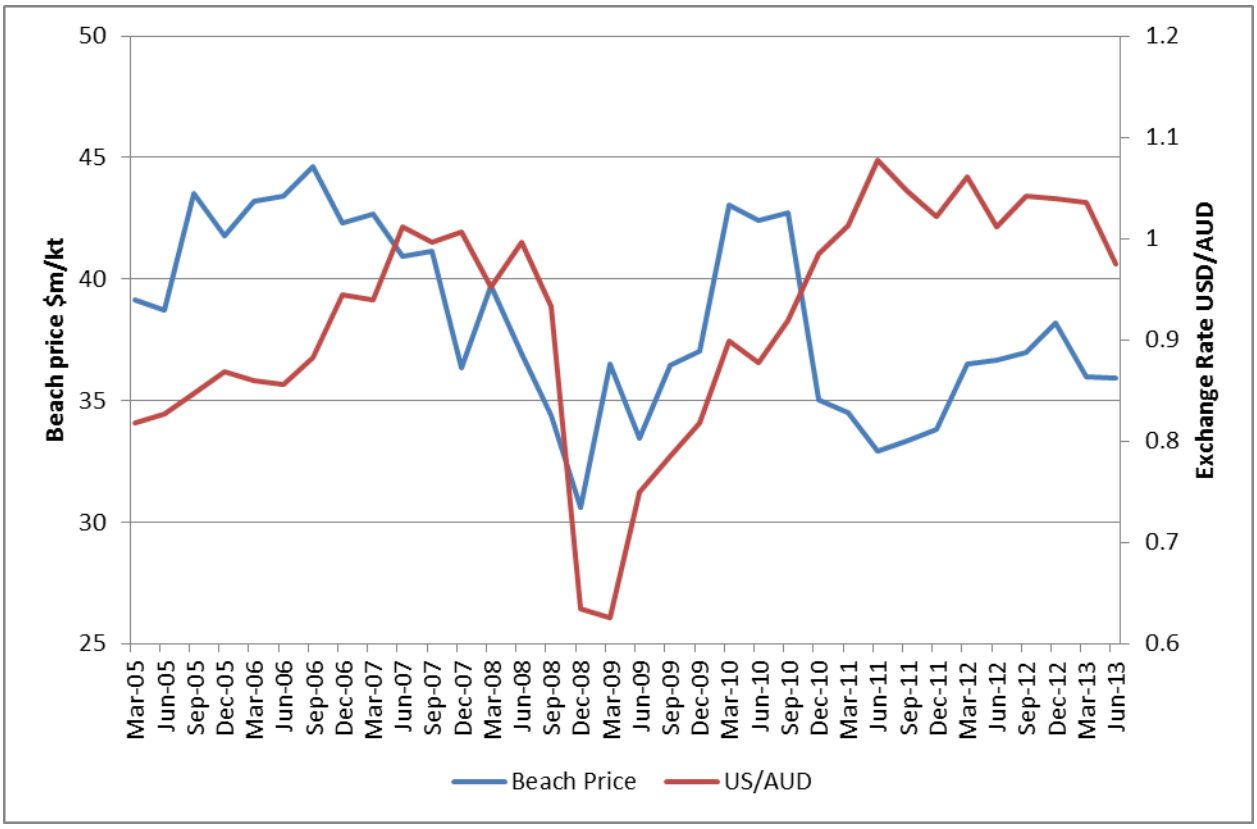
The focus of the analysis in chapter 2 was to identify the extent to which the abalone industry had been affected by the GFC and we find that processor earnings fell by 25%-36% between 2008 and 2013. In spite of this calamitous downturn in earnings the abalone processing industry remained a significant contributing industry to the Tasmanian economy, one that has the capacity to recover its original status through this downturn and beyond.

This result is evidenced by the I/O analysis in chapter 3. In order to find a solution to the processing industry's current decline, its causes must be clearly understood. A guide to identifying the influences which matter and those that do not is given by the regression models applied in *Felmingham (2005)* where we identified the following potential factors affecting processors earnings: beach prices, Australian GDP and the exchange rate of the USD against the Australian dollar. Each of these factors appears to have a significant impact on earnings of abalone processors. Several other factors were trialled but failed. US GDP and Chinese GDP were trialled as proxies for foreign income but neither turned out to be significant influences on earnings in the abalone processing sector. The variables selected as independent predictors of earnings in the following

paragraphs are those which influenced the value of processor earnings in the 2005 study, namely: beach prices (labeled PB); Australian Gross Domestic Product (GDP); and the USD/AUD exchange rate (ER). There is an additional independent predictor variable, namely the lagged one period value of processor earnings (R1). This predictor recognizes that the current level of processor earnings may well depend on the past level of earnings.

The data for the dependent variable, processors' earnings, are drawn from the Tasmanian Abalone Council quarterly time series over the period 2005/06 to 2012/2013. Thus, the time series on earnings contains 32 data points. There were some missing observations in the Tasmanian Abalone Council data set once it was compiled. These observations were estimated by the well known statistical technique labelled extrapolation. The time series for quarterly values of Australia's GDP are sourced from the Australian Bureau of Statistics (ABS 2013) and quarterly observations of the USD/AUD exchange rate is taken from RBA Monthly reports of the bank initially (RBA 2013). A quarterly time series for the exchange rate is the average of the three monthly rates reported in each quarter.

Figure 4.1 US/AUD Exchange rate and Abalone Beach price



4.2 CORRELATION ANALYSIS

Correlation analysis is not concerned with causation but it clearly indicates the existence or otherwise of a co-movement in pairs of variables. This is important information for researchers because the success of the associated regression which explains causality will depend on the absence of correlation between the predictor or independent variables. Statisticians describe correlation between the independent variables as multi-collinearity, a problem which renders regression tests unreliable. It is wise therefore to conduct a preliminary correlation analysis testing for correlation of each independent variable with the dependent variable and with the remaining independent variables. The results from the pairwise correlation of the variables in this analysis are shown on the following table 4.1.

Table 4.1 Pairwise correlation results

	PB	ER	GDP	R1
PB Pearson Correlation	1	0. 21	-. 504**	0. 186
Significance (2-tailed)		0. 248	0. 003	0. 284
N	36	32	32	35
ER Pearson Correlation	0. 21	1	0. 185	0. 166
Significance (2-tailed)	0. 248		0. 31	0. 363
N	32	32	32	32
GDP Pearson Correlation	-. 504**	0. 185	1	0. 06
Significance (2-tailed)	0. 003	0. 31		0. 746
N	32	32	32	32
R1 Pearson Correlation	0. 186	0. 166	0. 06	1
Significance (2-tailed)	0. 284	0. 363	0. 746	
N	35	32	32	35

** Correlation is significant at the 0. 01 level (2-tailed)

Table 4.1 shows the pairwise correlations of each predictor of processor earnings with all other predictor values. For example, in the first row of table 4.1 the correlation of the beach price (PB) with itself is equal to one. Perfect positive correlation applies in this case. The correlation of the exchange rate ER with the beach price PB is +0.160, which is not significant at any of the accepted values for acceptance like the 95% or 99% levels of significance. In fact there are two situations in which there is a significant correlation between the predictor variables. Firstly, a negative correlation exists between the beach price and Australia's GDP. The correlation coefficient is -0.504, which is significant at the 99% level of significance. The other situation arises in the co-movement of the exchange rate ER and GDP which displays some much weaker evidence of positive correlation. On balance, this correlation analysis reveals that multi-collinearity of the predictor variables is not a serious problem. However the correlation of the level of GDP and the beach price indicates that the GDP may be mediating or moderating the influence of the beach price on processors' earnings. We put this proposition to the test in section 4.4 of this report.

4.3 SIGNIFICANT PREDICTORS OF PROCESSOR EARNINGS

In order to separate the significant from the insignificant determinants of processor earnings a multivariate regression analysis is conducted. In essence, we take the view that there are four influences (factors, variables or predictors) which explain the Tasmanian abalone processing industry. These include the exchange rate ER, the level of Australia's GDP, the beach price PB and the past history of industry returns R-1. The regression analysis is conducted by applying the Ordinary Least Squares estimator contained in the SPSS software package. The results of this procedure are shown on table 4.2:

Table 4.2 Correlation co-efficients

Coefficients[a]

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-15053.219	11661.393		-1.291	.208
	PB	307.432	146.906	.451	2.093	.046
	ER	-1656.697	4639.246	-.073	-.357	.724
	GDP	.047	.029	.384	1.624	.116
	R1	.365	.163	.360	2.230	.034

a. Dependent Variable: R

In reading table 4.2, the focus of attention is the t-statistics in the last 2 columns of the table. The penultimate column contains t ratios from which we make inferences about the factors that are significant predictors of processors' earnings. The t ratio itself is found by dividing the unstandardized coefficients in column B by its standard error in the third column. For example, the t-ratio for the beach price is calculated by dividing 280.008 by 134.848 to get the value of t which is 2.093. The same calculation is applied to ER, GDP and the lagged value of processor earnings R-1. The decision about which of the predictors of earnings is exerting an influence on earnings is made on the basis of the t score shown in the last column of table 4. 2. Generally, a predictor has a significant impact on the dependent variable if its t-score is less than 2.0. From table 4.2 the predictors which have a significant impact on processor earnings using this criterion are the beach price, PB, where the t-score is 0.47 and the lagged (historical) value of earnings where the t-ratio stands at 0.034. Both are significant predictors of processors' earnings. The exchange rate is not a significant predictor of earnings. This is not a surprising result for primary industries are generally dependent on the price of commodities and less so on the price of the currency. A potentially more important

influence on the earnings of processors is GDP which is significant at the respectable 10.2% level. The role of GDP and the ER needs further analysis.

4.4 MEDIATING INFLUENCES

The failure of the exchange rate to influence processor earnings is due to the fact that the exchange rate does not vary much over the nine year period 1995 to 2013. Instead, the ER displays sharp, sudden changes in value such as the swift depreciation of the Aussie dollar in response to the GFC in 2009 and an even sharper appreciation of the Aussie dollar in 2011 when currency markets came to acknowledge the weakness of the American economy vis-a-vis the Australian economy. In fact, the Aussie exceeded parity with the USD from November 2011 until July 2013, clearly overstating its true value according to market fundamentals for the entire period. The Aussie still trades above its true value buying 78 US cents. The miscreant overvalued behavior of the Aussie and its stubborn nature in not falling has led many small to medium manufacturing concerns to close their doors because their management could not settle on a viable business plan with the Aussie varying on a tiny range of values like parity against the USD to 110 US cents for each 100 Aussie cents. Tasmania's abalone processing industry is not exempt from these ER pressures and three of those who have stopped processing abalone or severely curtailed abalone processing nominate the high value of the dollar as a primary reason for their departure from the industry. It follows that once the ER depreciates the viability of the sector will improve.

The regression modeling indicates that the beach price and the lagged one period value of earnings are significant causes of the value of processor earnings and there is some role for Australia's GDP in determining the returns to abalone processors. Could it be that GDP affects earnings indirectly through its impact on one or other of the predictors namely, the beach price or the exchange rate? Statisticians test for indirect effects by conducting a mediation analysis which tests for effects felt through the interaction of GDP with the ER or beach prices. The outstanding feature of the correlation analysis on table 4.1 is the negative association of the beach price and GDP with a correlation coefficient of -0.54. In order to further investigate the relationships, we have run mediation analyses. The results of this further analysis show that the ER does not mediate the relationship between beach prices and returns to the industry. This is not to deny the true role of the ER in determining processor's returns which is the rigid nature of the ER and its failure to depreciate when such stimulus is most needed, as discussed previously. We do find that Australia's GDP does mediate the relationship

between beach prices and processor's returns. In other words, abalone processor's returns are influenced indirectly by the level of GDP so the wealth they glean from processing abalone is influenced by where we are at on the Australian business cycle. Returns will be less when the economy is in recession and they will rise when the economy is in a boom phase.

CHAPTER 5 TOO MANY PROCESSORS?

There can be no doubt that the Tasmanian abalone processing industry is at a financial crossroads. That is the only inference one can make about the evidence presented in chapters 2 and 4 of this report where the focus is on the external influences on the industry's markets. So we know that, like other manufacturing sectors, the stubbornness of the USD/AUD in maintaining levels at or above parity makes a mess of business plans for many agricultural and primary industries. Some have gone to the wall while others struggle along with the help of government and elsewhere. Some comfort may be drawn from the fact that the beach price remains as the dominating influence on the behavior of returns and the dollar value of returns to processors. At least the destiny of the industry still remains in the hands of its own price which is a slightly better situation than many facets of agricultural production where the destiny of fairness is determined in pure price taking mode. None the less, processors' returns have fallen by 36% (55% in real terms) since the GFC dumped on our economic well-being. It is also clear that returns to processors are influenced by the position of the economy on the business cycle, otherwise known as the fluctuation of GDP, but this works through the beach price.

In spite of all these negative influences, the industry remains as an important contributor to Tasmania's economy, still making a valued contribution to job creation and the state's total income (GSP). That much follows from chapter 3. Now in this section, the focus shifts to the industry itself where the market behaviour of the processors is analysed. This should give decision makers the chance to formulate strategies which secure the industry's future. The analysis which appears here is largely the result of discussions with individual processors as to how the industry currently operates and at another level how it should behave. The survey of processors was comprehensive including face to face interviews with 10 processors and telephone or

email interviews with 8 additional processors still operating in the abalone processing business[5].

The contents of the survey differed from processor to processor, allowing for the variation in the structure of each processor's business it was simply inappropriate to use a standard questionnaire as a basis for interviewing processors. We also requested key financial data from the population of processors but only four provided the complete data set, raising the issue of the adequacy of a sample of only 4 processors. This sample of 4 processors is quite adequate for the purposes to which the data is applied and is a representative sample in the following sense. The four processors account for 45% of the value of industry sales of live abalone.

The aims of this chapter include an analysis of the economic efficiency of the industry which will lend credibility to its value from a Tasmanian perspective. They also include an answer to the question about the number of processors: Are there too many?

5.1 ECONOMIC EFFICIENCY

An industry that is economically efficient makes best use of the resources available to it. There is no better solution to the age old economic problem of allocating scarce resources to competing uses. The broadest measure of economic efficiency is the ratio of the output of input(s) although if the data were available we might have sought the optimal level of efficiency which arises when the price of abalone is equal to the marginal cost of producing it. The difficulty in this study and others is that marginal cost is difficult to measure. The requisite data for calculating marginal cost is simply not available. The approach adopted here is to use the broadest definition of economic efficiency defined as the ratio of inputs/outputs. We label this overall technical efficiency and make the point that OTE is composed of management efficiency (PTE) and scale economies (SE).

$$OTE = PTE \times SE$$

We identified two inputs involved in determining the OTE for each of the sampled processors, namely, labour and abalone purchased for processing and resale while there is a single identifiable output, namely, the output of abalone measured in dollars .The ratio of output to inputs is a pure number which is shown for each of our processors on table 5.1. Efficient producers will register OTE scores exceeding one in value so it can be

[5] 6 of the processors who participated in the research are not currently active in the industry.

said that for financial year 2013/2012 all four processors recorded efficiency scores which suggest that for the latest financial period they were efficient. An individual processor is efficient if his OTE score exceed one in value. From table 5.1 we observe that Processor I has an OTE score of 1.313 while the three remaining processors have OTE scores above on in value, suggesting that all four are operating efficiently. A further piece of evidence is that P2, P3 and P$ scored OTE scores which are only marginally less than the benchmark score of P1, namely 1.313, indicating that all three remaining processors are operating closely to the benchmark.

Table 5.1 OTE for sampled processors[6]

	2012-13			2011-12		
	OTE	**Relative OTE %**	**Labour ratio**	**OTE**	**Relative OTE %**	**Labour ratio**
P1	**1.313***	-	0.054	1.311	+2.8%	0.065
P2	1.258	+ 2.0%	0.052	**1.348**	-	0.043
P3	1.304	+ 0.6%	0.055	1.315	+ 2.5%	0.085
P4	1.274	+ 1.47%	0.039	1.308	+3.06%	0.072

Efficiency as it is defined also applies in the second financial period 2011/2012 where all OTE scores exceed one. The most efficient processor in F/Y 2013 is P1 registering a score of 1.313. In 2011/2012 the most efficient processor (P2) scores 1.348 in 2011/2012. We can use the OTE scores to obtain some idea about relative efficiency. We use the best scores in each year as benchmarks for the other processors. For example, the ratio of the best score in 2012/2013 to P2 (1.288) is 1.0194 suggesting that the most efficient processor has a 2% margin over P1, a margin of 0.6% over P3 and 1.5% over P4. The relative efficiencies in 2011/2012 are calculated in the same way and are shown in column 5 of table 5.1.

The general conclusion drawn from this analysis is that the Tasmanian abalone industry operates in an efficient manner using the broadest definition of efficiency. All four processors are efficient users of labour, returning OTE scores in labour which are low. The lower they are, the more efficient they are.

[6] * = Benchmark for relative OTE
OTE = Overall Technical efficiency (Output/Input)
Relative OTE = OTE P_i/OTE P_j
Labour ration = Labour input/Output

5.2 NUMBER OF PROCESSORS

In an earlier study, Felmingham (2005 table 3.9) the efficient operator required a throughput of 215 tonnes per season to be operating at full efficiency. This figure is not sensitive to price effects and there is therefore no reason to alter this estimate. Thus, the optimal number of processors producing at an efficient level is determined by the TAC annual allocation. In 2006 when the TAC was 2509 tonnes the optimal number of processors stood at 12. **In 2014 when the TAC has fallen to 1930 tonnes the optimal number of processors would be 9**.

CHAPTER 6 STRUCTURE AND CONDUCT OF THE MARKET FOR PROCESSED ABALONE IN TASMANIA

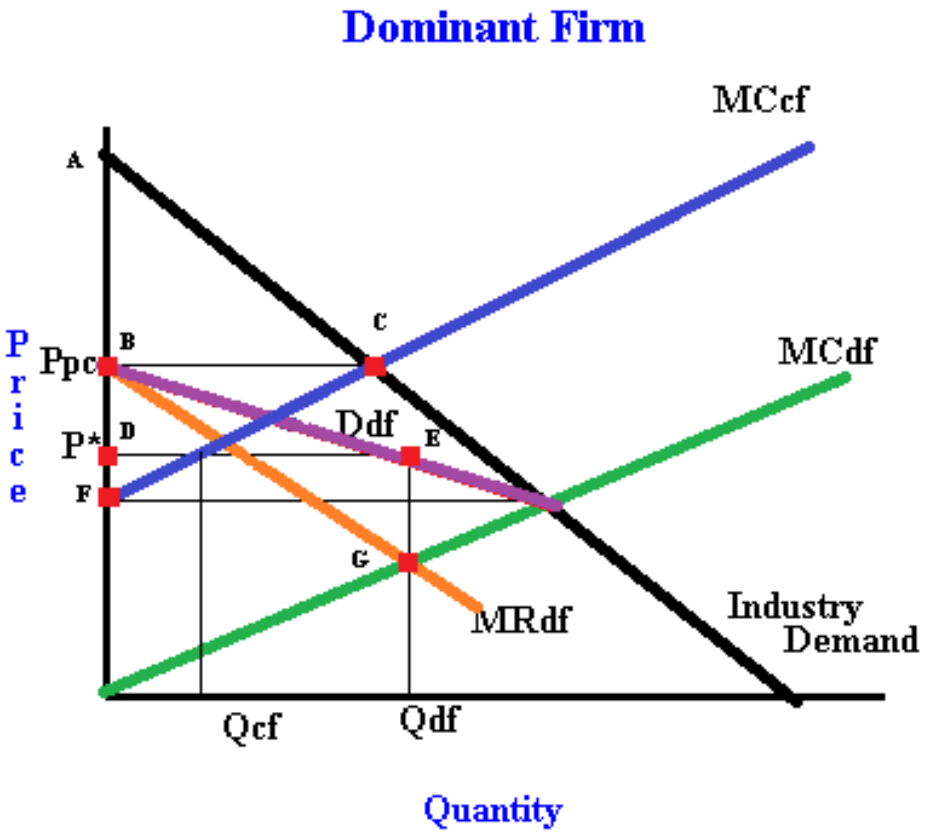
6.1 PRICE LEADERSHIP APPLIES TO THE ABALONE MARKET

There is a piece of microeconomic analysis which makes a good fit with the structure of the market for Tasmania's output of processed abalone: the Price Leadership model. Price Leadership models relate to industries in which there are small numbers of firms but one or two which dominate the industry in terms of their size and market power.

The Tasmanian industry consists of two larger enterprises and a dozen smaller ones. As seen in the Price Leaders Model, the larger firms bargain with the final buyers of abalone for a margin over and above the prevailing beach price and in this sense have some price setting capacity. These firms therefore act as price leaders for the smaller processors. The remaining smaller firms in the industry follow the prices partially set by the leaders and in this respect are price followers.

The model is illustrated on the diagram below.

Figure 6.1 The Price Leadership Model



The diagram shows how price leaders, or dominant firms (df), and price followers, referred to as the competitive fringe (cf) interact to supply the total industry demand shown by the black line on the graph.

The guiding principles from a processor's perspective are profit maximization and the retention or expansion of market share. These operational aims apply equally to price leaders and price followers. The leaders set the output they will sell which is given as the output level coinciding with the equality between Marginal Cost (MC_{df} shown in green) and Marginal Revenue (MR_{df} shown in orange). The remaining dozen or so price followers share the residual demand for their product as shown in Figure 6.1, their shares being determined by their relative marginal cost (MC_{cf} shown in blue). The smaller processors are vulnerable particularly when markets are depressed or production costs are rising and beach prices declining. The combination of these three market parameters will force some processors to the wall. This diminution of the industry goes on not always caused by these market pressures; sometimes they are caused by natural disasters and processors reckoning that reinvestment in the

processing sector is not warranted by the current depressed conditions of beach prices and profits.

In the 2005 version of this report, the optimal number of Tasmania processors of abalone was estimated to be 12. See Felmingham (2005 p. 46) and the industry then was composed of 32 processors. During the GFC, the number of processors has more than halved. This was a very unstable period for the industry which continues at present. An important aspect of vulnerability is the effects of over spending on the purchase of abalone by local processors generally around the New Year period in any season. The international (Chinese) market for abalone is seasonal having its best period in the months of December and January, so high and profitable returns can be earned in that peak period. At other periods when the market is oversupplied with abalone then any tendency towards over purchasing puts the industry under stress. In face of an excess supply of abalone tanks fill, live abalone are held for longer, quality declines and the death rate rises. Small operators are not willing or are unable to absorb these operational risks hastening their departure from the industry. An important aspect in all of this is the effects of scale which featured prominently in the preceding chapter as a source of instability. More often than not the price followers in the industry cannot operate at a large enough scale for efficiency as beach prices fall. Recall from the regression modeling in chapter 4 that the beach price remains the pivotal variable in the processing industry and the fishery as well. This view of the operation of the processing industry follows face to face interviews with 10 processors.

Price leadership models of markets are often influenced by barriers to entry and exit. The attraction of these markets to potential entrants is the lure of short run profits. In the long run, any super normal profit earned by firms in the industry are bid away by new entrants. The following questions apply: Are there substantial barriers to entry or exit which discourage new entrants? The industry's perspective on this question is about the effectiveness of any barriers to entry which preserves well-being of the current industry and of the participants in it. To analyse this argument we first define these barriers. Barriers to entry deter potential new entrants by imposing costs on them. These costs do not afflict the incumbent firms. There are six sources of such barriers as follows: the presence of economies of scale; product differentiation; capital requirements; access to distribution channels; government; and the length of the learning curve. In relation to scale economies we find from the analysis conducted that there are few scale effects not exploited. These will not act as a deterrent to entry.

Given the homogenous nature of live abalone there is little if any opportunity for product differentiation and no amount of advertising will convince consumers that one form of abalone is clearly superior. Capital requirements could be a substantial barrier to entry especially if the entrant is to match the portfolio of investments undertaken by the leading firm in expanded tank capacity and investment in another ship to encourage the fishing effort. Such costs can be avoided by an entrant who could run his investment plans under a business plan dissimilar to the current market leader. The most significant source of entry barrier is the government's moratorium on the issue of new processing licences which expires soon. **There is a strong argument for preserving this arrangement as the industry passes through its current financial woes.** The structure of the industry will adjust to current market conditions and should be allowed to do so unencumbered by the effects of a new entrant. **The future of Tasmania's abalone industry is at stake in the current market environment.**

6.2 A CHANGED STRUCTURE

An alternative approach to the industry's structure is something that some in the industry might see as a workable alternative to the current price leadership model and that is opening up the Tasmanian processing industry to further competition. This could be achieved by taking down any further barriers to the entry of new firms but this would put at risk the local control of the industry. This will undoubtedly be the outcome if mergers initiated by international competitors eventuate.

6.3 MARKET AND PRODUCT DIVERSIFICATION

The substantial declines in the market returns are on wild caught abalone in particular, suggesting that the governing bodies of the industry continue to seek product variations which are quality based and preserve the market status of Tasmanian abalone and of wild abalone in particular. The China project seeks to determine whether there is demand for Australian wild caught abalone amongst the emerging sector of affluent Chinese, to evaluate the potential for new product formats and to find new markets for the product. Initiatives include the application of modified atmosphere packaging with less emphasis on canned or frozen product. The China project mentioned above should inform the industry about the business case for a collaborative market development effort, depending on the support of the industry.

Appendix A References

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Appendix B Input/Output Modelling

B1 OVERVIEW OF I/O MODELLING

Industry Linkages

Analysis of the total impact of economic activity of one sector of the economy is based on an understanding that industries, and individual companies within these industries, do not exist in a vacuum, but use each others' products to produce their own. Thus, an increase in demand for one industry's products (the motivating change) leads to increases in the demand of other 'linked' industries. An I/O model of the economy is comprised of a set of industries which are linked by these I/O or intermediate relationships and by the final demand for each industry's output. For this report, the model used is the Regional Input Output Matrix (RIOM) model.

Broadly, I/O modelling examines how different industries interact to produce final demand. For example, a dairy farmer (as part of the Agriculture industry) may sell some of his or her milk to a Milk Processing company (part of the Food Product Manufacturing industry), which uses it as an ingredient in their chocolate milk. This company in turn sells some of its output to a food wholesaler (part of the Wholesale Trade industry), who sells some of it to a local supermarket (part of the Retail Trade industry), who sells it to a thirsty customer. The same 500 ml of milk has been sold several times, but only the last transaction represents part of the state's final demand. Thus, it can clearly be seen that the inputs required by one industry form part of the demand for the products of another. By quantifying these linkages, I/O models measure the impacts of a change in the final demand for the products of one industry (the motivating change) on the demand for other industries, the cascading effects of which represent the total impacts across the entire economy.

There are two major types of Input-Output models: open and closed models. In open models, the labour and wages of employees and the gross operating surplus of companies are treated as primary inputs in the production of goods and services; if you want to produce more widgets, you must employ more widget makers. This type of model captures the direct and indirect effects of changes in demand in one industry on the other industries in the economy. By contrast, RIOM is a closed model that includes the household sector as a separate industry. This enables the consideration of induced

effects of changes in demand. Induced impacts reflect the changes in consumer spending resulting from changes in economic activity and therefore in employment. The household sector is considered as an "industry' whose outputs are labour, and whose inputs consist of consumer spending; if you create more employment, you also create an increase in demand from the household sector for consumer goods like food, accommodation, entertainment and so on.

B2 The Mathematics of I/O Modelling

To model the industry linkages described above, an I/O table or matrix is used. The essential feature of an I/O Table is its backward and forward linkage structure, which defines its set of inter-industry relationships. The development of an I/O model applied in this analysis is based on a transaction Table developed by the ABS which has the following structure.

Each row shows the distribution of one industry to other industries and to final demand while each column records the acquisition of inputs by the industry in question from other industries and together comprise an economy. The acquisition of inputs are referred to as "intermediate purchases", to distinguish them from final purchases/sales. Only final goods and services contribute to Gross Domestic (or State) Product (GDP/GSP) using the production measure.

The Table at Figure 1 contains 4 Quadrants. The processing Sector is shown as Quadrant 1 and records the flow of goods and services between individual industries during a year. The second quadrant (2) records the consumption expenditures of final buyers and the other industry Sectors from which they are made. Quadrants 3 and 4 record payments for the use of primary inputs in particular to labour, to corporations as profits or rents and to governments in various tiers as indirect taxes and charges and to importers.

Figure B1 Quadrants of the Transactions Table

STRUCTURE OF AUSTRALIAN INPUT-OUTPUT TABLES

Direct allocation of imports, Basic prices, Recording of intra-industry flows

	To / From	Row prefix	Intermediate Uses: Agriculture, etc	Intermediate Uses: Mining	Intermediate Uses: Manufacturing, etc	Intermediate Uses: Construction	Intermediate Uses: Services	Intermediate uses (sub-total)	Final Uses: Final consumption expenditure — household	Final Uses: Final consumption expenditure — government	Final Uses: Gross fixed capital formation — private	Final Uses: Gross fixed capital formation — public enterprises	Final Uses: Gross fixed capital formation — general government	Final Uses: Changes in inventories	Final Uses: Exports of goods and services	Final Uses (sub-total)	Total supply (grand total)
	Column prefix		0101-0400	1100-1500	2101-3701	4101-4102	4501-9601		Q1	Q2	Q3	Q4	Q5	Q 6	Q 7		
Intermediate uses	Agriculture	0101-0400	QUADRANT 1 INTERMEDIATE USE						QUADRANT 2 FINAL USE								
	Mining	1100-1500															
	Manufacturing, etc.	2101-3701															
	Construction	4101-4102															
	Services	4501-9601															
	Intermediate uses (sub-total)																
Primary inputs	Compensation of employees	P1	QUADRANT 3 PRIMARY INPUTS TO PRODUCTION						QUADRANT 4 PRIMARY INPUTS TO FINAL USE								
	Gross operating surplus and mixed income	P2															
	Taxes on products (net)	P3															
	Other taxes on production (net)	P4															
	Imports	P5															
	Australian production																

The shaded areas correspond to aggregates shown in the Gross Domestic Product Account.

corresponds to aggregates shown as the components of gross domestic product, income approach.

corresponds to aggregates shown as the components of gross domestic product, expenditure approach.

A particular feature of Quadrant 2 is the presence of capital items which are included as part of the total expenditure of the individual industries, however, these capital goods are not consumed in production in the current period and so they are shown for the production Sector only.

Quadrant 3 records payments for the use of primary inputs in particular to labour (wages, recorded as Compensation of Employees), to corporations as profits or rents (Gross Operating Surplus), to governments in various tiers as indirect taxes and charges and to importers. The value added by each industry contributes to total national income, GDP or GSP measured at factor (input) cost is the combination of some of these payments as follows:

$$Value\ Added_i = WSS_i + GOS_i + Indirect\ taxes_i - subsidies_i$$

So the value added by industry i is the sum of wages, salaries and supplements or compensation of employees (COE_i) paid to labour, the gross operating surplus (GOS_i) plus indirect taxes and charges net of subsidies paid by government to industry i. The sum of all the value added by the i industries constituting the economy is the value of Australia's national income, namely GDP by the income method. One of the objectives of the modelling is to determine how much GDP increases in response to the activity of the industry or enterprise under examination and by people employed within it.

In the development of the Regional Input-Output Matrix (RIOM) model an estimate has been derived of the proportion of each state's supply which is met by imports from interstate and overseas. Where demand results in output of a particular Sector being imported from overseas this represents a leakage from the system, resulting in lower impact on production and employment. In many respects the leakage associated with imports is a major driver of the differences in economic impact between different projects and industries.

The Transaction Table above is defined by dividing the elements of the matrix above by the current value of industry i's output. By this definition:

$$a_{ij} = \frac{x_{ij}}{x_j} \qquad (1)$$

These a_{ij} are the technical coefficients of production and they represent the amount of industry i's output required to produce a unit of output in industry j.

From (1) we can write:

$$x_{ij} = a_{ij} X_j \tag{2}$$

and the output for industry i is the sum of intermediate sales and purchases plus the final demand for i's output (D_i) as follows:

$$X = AX + D \tag{3}$$

Where X is a vector of industry outputs, D is a vector of final demands and A is an i_{xj} matrix of technical coefficients.

The expression (3) can be solved for X as a function of D:

$$X - AX = D \tag{4}$$

$$X(1 - A) = D \tag{5}$$

$$X = (1 - A)^{-1} D \tag{6}$$

$$X = BD \tag{7}$$

The solution vector represents the output of industries as some multiple of final demand (D) the multiple is the matrix (I-A)-1=B. This is known as the Leontieff inverse after its creator. Now B is structured in the following manner:

$$B = \begin{bmatrix} b_{11} & b_{12} \cdots \cdots b_{ij} \cdots \cdots b_{1n} \\ \vdots & \vdots \\ b_{21} & b_{22} \cdots \cdots b_{2j} \cdots \cdots b_{2n} \\ \vdots & \vdots \\ b_{i1} & b_{i2} \cdots \cdots b_{ij} \cdots \cdots b_{in} \\ \vdots & \vdots \\ b_{n1} & b_{n2} \cdots \cdots b_{nj} \cdots \cdots b_{un} \end{bmatrix} \tag{8}$$

This is referred to as the Table of interdependence co-efficients and measures the direct, induced and indirect effects of a change in final demand for one of the industry outputs. The columns of this interdependence co-efficient Table are the output multipliers.

What do I/O output multipliers tell us? I/O output multipliers measure the changes in all industry outputs generated by a change in the final demand for any one output. For example, if the demand for agricultural output in Tasmania increased by 10 percent, then I/O output multipliers measure the impact on all industry output including agriculture.

Employment multipliers describe the impact of a change in the final demand for a specific industry's output on employment in the same and all other industries. These I/O employment multipliers are derived from employment equations, which are derived in turn by simply multiplying the output equations for each industry by the employment (E_i)/Output (X1) ratio for the industry in question. So the employment equation for industry 1 is found by multiplying (1) though by E_i/X1. Then I/O employment multipliers are found in the same way by inverting the set of employment equations solving for employment in industry i.

Wage multipliers are found in an identical fashion, but on this occasion wage equations are employed to derive these. The wage multiplier measures the change in all industry wage incomes flowing from a change in any of the final demands.

However there is also a wage-multiplier effect which effectively 'closes' the model with respect to the household Sector. The wage-multiplier identifies the extent to which increased household income from wages raises expenditure in the community, thereby generating additional economic activity and employment. To incorporate the impact of increased wages on household final consumption expenditure (a component of final demand D) we derive a matrix C which is parallel to the matrix A. The elements of matrix C, c_{ij} relate the expected increase in household final consumption expenditure associated with a unit increase in output by industry j. Therefore final demand D contains a dependent component based on wages and an independent component that with identify as FD. We describe this relationship in equation (9).

$$FD = D - CX \qquad (9)$$

The expression (9) can be substituted into (8) while maintaining the equality as follows:

$$Y = AX + CX + FD \quad (10)$$

The expression (10) can then be solved for equilibrium X = Y as a function of FD:

$$Y - AY - CY = FD \quad (11)$$

$$Y(1 - A - C) = FD \quad (12)$$

$$Y = (1 - A - C)^{-1} FD \quad (13)$$

$$Y = (1 - A - C)^{-1} FD \quad (14)$$

$$Y = X = L \times FD \quad (15)$$

The solution vector B represent the output of industries as some multiple of final demand (FD) the multiple is the matrix $(1\text{-}A\text{-}C)^{-1}$ = L. The structure of L is a Table of interdependence coefficients and measures the direct, indirect and induced (where the model is closed) effects of a change in final demand for one of the industry outputs. The columns of this inter-dependence Table are the output multipliers.

Output I/O multipliers measure the change in all industry outputs generated by a change in the final demand for any one output. Wage, Value-added and employment multipliers are calculated based on the output multipliers. It is assumed that the relationship between output of a given Sector and its wage, value-added and employment are constant (effectively determined by technology and structural parameters in the industry) so that if output in a Sector increases by a given amount, then the value-added, wage and employment impacts can be calculated using a constant ratio for each industry.

GSP multipliers measure the contribution of a final demand change to each industry's value added or its individual contribution to GSP. GSP multipliers are derived from total income equations which are output equations converted to total income relationships by applying value added/output ratios to each industry's outputs.

All four sets of multipliers are applied to the task of identifying employment, GSP, wage and output effects of a particular change in final demand (the motivating change).

Here, a distinction should be made between Type I and Type II multipliers. Type I income or output multipliers are the ratio of the direct plus indirect income or output change of demand to the direct income change resulting from a dollar increase in final demand for any given industry.

Type II multipliers are those derived mathematically above and can be read off the column of the B matrix in (7). In either case, type I or II, the I/O model is closed with respect to households which is the case here.

The practicality of I/O models depends on certain properties and assumptions. First, a workable I/O model will be mathematically stable which happens if the following holds:

- The table of technical coefficients must have at least one column which sums to a number less than one.
- No column in the table can exceed one in the aggregate (no industry can pay more for its inputs than it receives from the sale of its output).

The following assumptions underpin all practical I/O models:

- A single production function exists for all firms in an industry.
- This production function must be linear and be homogeneous of degree I (Constant Returns to scale applies).
- There is no substitutability between factions of production (labour and capital).

The RIOM Model

The RIOM model was developed in 2009 and includes 57 industry Sectors plus ownership of dwellings. The model can be used to model economic effects in any of states and territories of Australia.

The basic model is developed from the Australian Bureau of Statistics 2005-06 Supply and Use Tables by apportioning employment statistics for each state based on the 2006 census[7]. Demand and calibration factors are then determined using the State National Accounts data to ensure alignment with each state's reported GSP and Final

[7] Because the model uses the 2005-06 ABS Supply and Use tables, the 2006 census employment by industry by state. Is more appropriate than the 2011 data.

Consumption Expenditure. The differences between demand and output are used to estimate inter-state trade based on residuals.

The RIOM model has been used to study Tasmanian economic impacts across a range of different industries and research projects since its development.

B3 MODELLING THE IMPACT OF TASMANIAN LIVE ABALONE EXPORTS

THE MOTIVATING CHANGE

The total value of final (exported) sales of live abalone from Tasmania in 2012-13 was $97 million. The total allowable catch (TAC) of Tasmanian abalone is controlled by the Quota Management System (QMS) and has remained relatively stable since 1985. Changes in the value of live abalone sales over time therefore depend on two main factors:

- Proportion of the catch sold live; and
- Price fluctuations on the global market.

Historically, the price of abalone is subject to considerable fluctuation, as seen in chapter 2. The RIOM model is based on 2005-06 ABS Supply and Use tables, used to show how much of one industry (industry j)'s product is used to make 1 unit of the product of another industry (industry i).

These ratios are called the co-efficients of production (a_{ij}). The model relies on considering the inputs required and outputs produced in terms of dollar value rather than production tonnes or other volume measures. Thus, the ABS tables are based on the value of inputs required to produce $1 million worth of abalone (or any other product or service) at 2005-06 prices. As we have seen, the nominal value per tonne of abalone has been falling since 2005-06.

While the final sale price of a tonne of abalone may be lower, the amount of work, equipment and other inputs required to harvest, prepare and ship it has not decreased. Using 2011-12 prices in the model would imply that, for example, only 83% as many workers were required to produce a tonne of abalone as would have been needed in 2005-06. To control for this variation, the motivating change in expenditure used to calculate impacts is inflated from the actual sale price, to represent the price the same

tonnage of abalone would have attained if sold at 2005-06 prices. Thus, the $97 million final demand is converted to $116.7 million in 2002-06 dollars.

THE EXTRACTION METHOD

To estimate the indirect and induced impacts of the live abalone trade on the state's economy, the extraction method is used. This approach is a standard one in the literature about I/O models. The final demand before and after the withdrawal of the industry or expenditure in question is estimated first and then multiplied by a series of multiplier relationships. This procedure forms the basis of our evaluation of Tasmania-wide effects.

The live abalone trade is a component of the Tasmanian Aquaculture and Fishing industry. In fact, in 2006-07, abalone sales accounted for 22% of total Tasmanian seafood sales[8]. Thus, if live abalone sales had totally ceased without being replaced (eg by an increase in the sale of frozen or otherwise processed product), the final demand for the Tasmanian industry as a whole would have fallen by that proportion, with consequences right across the economy.

The live abalone trade's contribution to the output of the Tasmanian economy is thus the difference between output across all industries prior to withdrawal of this demand and after its withdrawal. The effect on the other economic indicators is found by repeating this exercise using RIOM multipliers for each measure. The approach adopted here is based on the output, employment, wages income and total income (GSP) multipliers contained in the RIOM model.

[8] DPIPWE 2009