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# TESTING FOR MARKET POWER IN THE AUSTRALIAN GRAINS AND OILSEEDS INDUSTRIES<sup>1</sup>

by

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## Abstract

Recent empirical studies have found significant evidence of departures from competition in the input side of the bread, breakfast cereal and margarine end-product markets. In this study we specify a general duality model of profit maximisation that allows for imperfect competition in the input and output markets of the grains and oilseeds industries. The model allows for a variable proportions technology and does not impose restrictions on the relationship between conjectural elasticities in each market. Aggregate Australian data is used to implement the model and draw inferences concerning the presence of market power.

**KEYWORDS:** market power, conjectural elasticities, grains and oilseeds

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## 1. Introduction

Over the last several years there has been a rapidly increasing trend towards consolidation in many sectors of the Australian economy. In recent months, the business media has reported both formal proposals and informal conjectures relating to mergers or takeovers in the airline, health care, banking and whitegoods sectors, as well as in the dairy processing and food retailing sectors. The Australian Competition and Consumer Commission (ACCC) is required to assess the competitive implications of these proposals and conjectures. However, since it is primarily an investigation and enforcement institution, not a research institution, it can only do this well if it has access to independent research (ACCC 1999, p.5). Our investigation of competitive behaviour in the grains and oilseeds industries is motivated in part by this need for independent research.

In a recent empirical study which examined competition across the entire Australian food marketing chain, Griffith (2000) found evidence of statistically significant departures from a competitive market on the input side of the bread, breakfast cereal and margarine end-product markets. That is, he found that firms in (parts of) the processing and marketing sector exerted market power when purchasing grains and oilseeds from farmers. This finding is consistent with the fact that bread manufacturer George Weston was fined twice during 2000 for noncompetitive conduct. The ACCC has also recently pursued cases against Safeway in grains and oilseeds product lines. Our particular interest in the grains and oilseeds industries stems from the Griffith findings as well as the cases coming before the courts.

Griffith obtained his results using highly aggregated data and a relatively simple empirical model. This paper reports progress towards the estimation of a more sophisticated empirical model using a less aggregated grains and oilseeds data set. The empirical model we consider is a generalisation of the new empirical industrial organisation (NEIO) model of Raper *et al* (2000).

NEIO models have a firm foundation in economic theory and have dominated the analysis of industrial organisation for the last fifteen years<sup>2</sup>. A problem with most NEIO models is that they assume imperfectly competitive behaviour by firms on only one side of a transaction, while firms on the other side of the transaction are assumed to be perfectly competitive. The model of Raper *et al* is an exception – these authors consider an upstream firm that produces a single output for sale to a downstream firm, and both parties to the transaction are allowed to exert market power. Unfortunately, the assumption that the upstream firm only produces one output is limiting, particularly in a grains and oilseeds context. Thus, in this paper we extend the Raper *et al* model to the case of an upstream firm that produces multiple outputs.

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<sup>2</sup> Previously, most agricultural economists had analysed firm behaviour in a structure-conduct-performance (SCP) framework. The SCP paradigm asserts that the structural characteristics of an industry (eg. the degree of buyer-seller concentration) determine the conduct of firms in the industry

The structure of the paper is as follows. In Section 2 we identify the major products and agents in the grains and oilseeds marketing chain (using value of output as a metric). Products and agents are aggregated and described in terms of Australian Bureau of Statistics (ABS) four-digit product and industry classifications. In Section 3 we show how the theoretical model of Raper *et al* can be extended to the case of multiple outputs. An empirical model is then obtained under the popular assumption that the cost functions of both the upstream and downstream firms are normalised quadratic. In Section 4 we describe our data. The data consists of annual observations, by state, on the prices and quantities of (most) inputs and outputs used and produced by the most important agents in the grains and oilseeds marketing chain. In Section 5 we estimate part of the model and present some preliminary results. These results suggest, for example, that grains producers may exert market power in the sale of barley to flour mill product manufacturers. Unfortunately, for various methodological reasons our preliminary results are less than robust. In Section 6 we conclude the paper by briefly outlining our plans for further research.

## 2. Supply and Usage of Grains and Oilseeds Products

ABS input-output tables for 1996-97 were used to form a picture of the supply and usage of grains and oilseeds products – see Figure 1. The percentages in Figure 1 are the shares of grains and oilseeds output (by value) directed to various intermediate and final uses. For example, 55% of grains and oilseeds output (by value) was exported, 10% was reused by producers, 10% was used in the flour and cereal food manufacturing industry, and only 2% went directly to households. Arguably the key transactions/interfaces in Figure 1 are those labelled A to N. The agents involved in these transactions are:

- households
- overseas consumers (exports)
- grain producers
- oil and fat manufacturers
- flour and cereal food manufacturers
- bakery product manufacturers
- other food product manufacturers
- beer and malt manufacturers

All other interfaces account for less than 1% of grain/oilseed output by value.

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(eg. pricing behaviour) and ultimately firm performance (eg. profits, margins). SCP models have a much looser foundation in economic theory than NEIO models.

The products/industries in Figure 1 have been identified/labelled using both Input-Output Product Classification (IOPC) codes (eg. "0102 Grains") and Australian and New Zealand Standard Industrial Classification (ANZSIC) codes (eg. "ANZSIC 2161"). Details of selected ANZSIC classifications are provided in Appendix A. A measure of the relative importance of particular products within the IOPC/ANZSIC groupings is provided in Table 1. The four largest grain and oilseed crops (by value) and the twelve largest product items derived from grains and oilseeds are marked with an asterisk. The largest single farm products by value are

- wheat
- barley
- rice
- oilseeds

The largest final products by value are:

- Bread and bread rolls
- Prepared animal and bird feeds
- Beer, ale and stout.
- Cereal foods (incl breakfast foods)
- Wheat and other cereal flours
- Cakes, pastries and crumpets
- Biscuits, biscuit crumbs, rusks etc., unleavened bread
- Refined and processed animal and vegetable oils
- Margarine

In our empirical work we will (eventually) attempt to identify noncompetitive behaviour at points where these farm and final products are exchanged (interfaces A to N in Figure 1)

### 3. The Model

We begin by considering an *upstream firm* (or group of firms) that uses an  $M \times 1$  vector of inputs,  $\mathbf{z}$ , to produce a  $J \times 1$  vector of outputs,  $\mathbf{y}_u$ , for sale to a downstream firm. The profit maximisation problem of this upstream firm is:

$$(1) \quad \max_{\mathbf{y}_u} \mathbf{p}_u' \mathbf{y}_u - C_u(\mathbf{y}_u, \mathbf{w})$$

where  $\mathbf{p}_u$  is a vector of output prices,  $\mathbf{w}$  is a vector of input prices and  $C_u(\mathbf{y}_u, \mathbf{w})$  is the cost function of the upstream firm (specifying the minimum cost of producing output  $\mathbf{y}_u$  at prices  $\mathbf{w}$ ). Following Raper *et al*, we assume

$$(2) \quad \frac{\partial p_{ui}}{\partial y_{ui}} = 0 \quad \text{for all } j \neq i.$$

so that the first-order conditions for profit maximisation become

$$(3) \quad \frac{\partial p_{uj}}{\partial y_{uj}} y_{uj} + p_{uj} - \frac{\partial C_u(\mathbf{y}_u, \mathbf{w})}{\partial y_{uj}} = 0 \quad \text{for } j = 1, \dots, J.$$

If the upstream firm is competitive in all markets then (3) collapses to:

$$(4) \quad p_{uj} - \frac{\partial C_u(\mathbf{y}_u, \mathbf{w})}{\partial y_{uj}} = 0 \quad \text{for } j = 1, \dots, J$$

which, in the case of  $J = 1$  (and if we take the derivative to the right-hand-side) is the firm's inverse output supply equation (see Raper *et al*). A model which includes (3) and (4) as special cases would take the form:

$$(5) \quad \lambda_{mj} \left[ \frac{\partial p_{uj}}{\partial y_{uj}} y_{uj} \right] + p_{uj} - \frac{\partial C_u(\mathbf{y}_u, \mathbf{w})}{\partial y_{uj}} = 0 \quad \text{for } j = 1, \dots, J$$

where  $0 \leq \lambda_{mj} \leq 1$  is a parameter which measures monopolistic market power.

We also consider a *downstream firm* (or group of firms) that produces a  $K \times 1$  vector of outputs,  $\mathbf{y}_d$ , using the intermediate goods produced by the upstream firm as its primary inputs, as well as an  $N \times 1$  vector of other inputs  $\mathbf{x}$ . The profit maximisation problem of this downstream firm is:

$$(6) \quad \max_{\mathbf{y}_u, \mathbf{y}_d} \mathbf{p}_d' \mathbf{y}_d - C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u) - \mathbf{p}_u' \mathbf{y}_u$$

where  $\mathbf{p}_d$  is a vector of output prices,  $\mathbf{v}$  is a vector of input prices and  $C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)$  is the cost function of the downstream firm (specifying the minimum cost of producing output  $\mathbf{y}_d$  given prices  $\mathbf{v}$  and "upstream" inputs  $\mathbf{y}_u$ ). Once again, we follow Raper *et al* and assume

$$(7) \quad \frac{\partial p_{dk}}{\partial y_{di}} = 0 \quad \text{for all } k, i.$$

Then the first-order conditions for profit maximisation include the following:

$$(8) \quad \frac{\partial C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)}{\partial y_{uj}} + \frac{\partial p_{uj}}{\partial y_{uj}} y_{uj} + p_{uj} = 0 \quad \text{for } j = 1, \dots, J$$

If the downstream firm is competitive in all markets then (8) collapses to:

$$(9) \quad \frac{\partial C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)}{\partial y_{uj}} + p_{uj} = 0 \quad \text{for } j = 1, \dots, J$$

Again, a model which includes (8) and (9) as special cases is:

$$(10) \quad \frac{\partial C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)}{\partial y_{uj}} + \lambda_{sj} \left[ \frac{\partial p_{uj}}{\partial y_{uj}} y_{uj} \right] + p_{uj} = 0 \quad \text{for } j = 1, \dots, J$$

where  $0 \leq \lambda_{sj} \leq 1$  is a parameter measuring monopsonistic market power.

In practice, we cannot estimate (5) because we have no expression for the derivative  $\frac{\partial p_{uj}}{\partial y_{uj}}$ . However, if the downstream firm is competitive in all markets, equation (9) implies

$$p_{uj}(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u) = - \frac{\partial C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)}{\partial y_{uj}},$$

so we can write (5) as:

$$(11) \quad \lambda_{mj} \left[ \frac{\partial p_{uj}(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)}{\partial y_{uj}} y_{uj} \right] + p_{uj} - \frac{\partial C_u(\mathbf{y}_u, \mathbf{w})}{\partial y_{uj}} = 0 \quad \text{for } j = 1, \dots, J$$

We can estimate equation (11) as a single equation model. Then tests of hypotheses concerning  $\lambda_{mj}$  are tests for the existence of monopolistic market power under the assumption that the downstream firm is competitive.

A parallel line of reasoning leads us to define  $P_{uj}(\mathbf{y}_u, \mathbf{w}) = \frac{\partial C_u(\mathbf{y}_u, \mathbf{w})}{\partial y_{uj}}$ . Then we can write (10) as

$$(12) \quad \frac{\partial C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)}{\partial y_{uj}} + \lambda_{sj} \left[ \frac{\partial P_{uj}(\mathbf{y}_u, \mathbf{w})}{\partial y_{uj}} y_{uj} \right] + p_{uj} = 0 \quad \text{for } j = 1, \dots, J$$

If we estimate equation (12) as a single equation, tests of hypotheses concerning  $\lambda_{sj}$  become tests for the existence of monopsonistic market power under the assumption that the upstream firm is competitive.

Econometrically, estimation of (11) and (12) as single equations is inefficient. It is more efficient to estimate both equations jointly with the conditional input demand functions implied by Shephard's lemma. If the normalised cost functions are normalised quadratic, ie.,

$$(13) \quad C_u^*(\mathbf{y}_u, \mathbf{w}) = \beta_0 + \sum_{j=1}^J \beta_{uj} y_{uj} + 0.5 \sum_{j=1}^J \sum_{k=1}^J \beta_{ujk} y_{uj} y_{uk} + \sum_{m=1}^{M-1} \beta_m w_m^* \\ + 0.5 \sum_{m=1}^{M-1} \sum_{n=1}^{M-1} \beta_{mn} w_m^* w_n^* + \sum_{j=1}^J \sum_{m=1}^{M-1} \gamma_{ujm} y_{uj} w_m^*$$

and

$$(14) \quad C_d^*(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u) = \alpha_0 + \sum_{j=1}^K \alpha_{dj} y_{dj} + 0.5 \sum_{j=1}^K \sum_{k=1}^K \alpha_{dj k} y_{dj} y_{dk} + \sum_{m=1}^{N-1} \alpha_m v_m^* + 0.5 \sum_{m=1}^{N-1} \sum_{n=1}^{N-1} \alpha_{mn} v_m^* v_n^* + \sum_{j=1}^J \alpha_{uj} y_{uj} \\ + 0.5 \sum_{j=1}^J \sum_{k=1}^J \alpha_{ujk} y_{uj} y_{uk} + \sum_{j=1}^K \sum_{m=1}^{N-1} \phi_{dj m} y_{dj} v_m^* + \sum_{j=1}^K \sum_{m=1}^{N-1} \phi_{uj m} y_{uj} v_m^* + \sum_{j=1}^K \sum_{k=1}^K \phi_{jk} y_{uj} y_{dk}$$

then the conditional input demands are

$$(15) \quad z_m(\mathbf{y}_u, \mathbf{w}) = \frac{\partial C_u(\mathbf{y}_u, \mathbf{w})}{\partial w_m} = \beta_m + \sum_{n=1}^{M-1} \beta_{mn} w_n^* + \sum_{j=1}^J \gamma_{ujm} y_{uj} \quad \text{for } m < M$$

and

$$(16) \quad x_m = \frac{\partial C_d(\mathbf{y}_d, \mathbf{v}; \mathbf{y}_u)}{\partial v_m} = \alpha_m + \sum_{n=1}^{N-1} \alpha_{mn} v_n^* + \sum_{j=1}^K \phi_{dj m} y_{dj} + \sum_{j=1}^K \phi_{uj m} y_{uj} \quad \text{for } m < M$$

where  $w_m^* = w_m/w_M$  and  $v_n^* = v_n/v_N$ . Moreover, (11) and (12) can be written:

$$(17) \quad p_{uj}^* = \lambda_{mj} \alpha_{ujj} (v_N/w_M) y_{uj} + \beta_{uj} + \sum_{k=1}^J \beta_{ujk} y_{uk} + \sum_{m=1}^{M-1} \gamma_{ujm} w_m^*$$

and

$$(18) \quad p_{tj}^* = -\lambda_{sj} \beta_{ujj} (w_M/v_N) y_{uj} - \alpha_{uj} - \sum_{k=1}^J \alpha_{ujk} y_{uk} - \sum_{m=1}^{N-1} \phi_{ujm} v_m^* - \sum_{k=1}^K \phi_{jk} y_{dk}$$

where  $p_{uj}^* = p_{uj}/w_M$  and  $p_{tj}^* = p_{tj}/v_N$ . The form of these equations is (almost) identical to a set of equilibrium tobacco producer and manufacturer equations reported in Raper *et al* (p. 242).

Finally, if any inputs are fixed rather than variable, we simply replace normalised input prices with fixed input quantities on the right-hand-sides of equations (17) and (18).

#### 4. Data

Data on the following variables were collected from various ABS and Australian Bureau of Agricultural and Resource Economics (ABARE) sources:

- production and prices of wheat, barley, rice and canola;
- prices paid by farmers for variable inputs (labour, materials and capital);
- quantities of fixed inputs used by farmers (land);
- production and prices of the outputs of the major grains and oilseeds manufacturing industries (eg. flour mill products, cereal food and baking mixes, oil and fat);
- prices and quantities of labour used in the grains and oilseed manufacturing industries;
- the price of materials used in food product manufacturing industries (as an index);
- retail prices of bread, biscuits, breakfast cereal, flour, margarine and beer;
- average consumer prices; and
- national income.

The data set consists of annual state data covering the period from 1989-1990 to 1999-2000. Interpolation and extrapolation methods were used to estimate some values missing from the ABS and ABARE series. At the time this paper was prepared, the data set was still incomplete.

#### 5. An Empirical Illustration

For illustrative purposes we chose to investigate the existence of noncompetitive behaviour at interface B in Figure 1. Specifically, we chose grains producers (IOPC 0102) as the upstream firm and flour mill product manufacturers (ANZSIC 2151) as the downstream firm. Because the data set was still incomplete, we chose a subset of output and input variables as follows. For grains producers:

$y_{u1}$  = wheat output

$y_{u2}$  = barley output

$p_{u1}$  = wheat price

$p_{u2}$  = barley price

$w_1$  = labour price

$w_2$  = materials price

$w_3$  = capital price (numeraire)

$z_4$  = land quantity (fixed input)

For flour mill product manufacturers:

$y_{d1}$  = flour mill products

$v_1$  = labour price

$v_2$  = price of other inputs (numeraire)

Summary statistics on relevant variables are presented in Table 2. Only 48 observations were available for estimation.

The four equation model represented by equations (17) and (18) was estimated using nonlinear three stage least squares (NL3SLS). The market power parameters were constrained to be nonnegative, in line with the requirements of the theoretical model. Parameter estimates are reported in Table 3.

The zero estimates of  $\lambda_{m1}$  and  $\lambda_{s2}$  reported in Table 3 suggest that grain producers exert no monopoly power in the sale of wheat, and flour mill product manufacturers exert no monopsonistic power in the purchase of barley. The fact that the estimated asymptotic t-ratios are exactly zero simply means that the nonnegativity constraints implied by the theoretical model are binding. Consequently, it is difficult to draw inferences concerning the values of these parameters. To do so effectively, we would probably need to estimate the model in a Bayesian framework.

The non-zero estimates of  $\lambda_{m2}$  and  $\lambda_{s1}$  suggest that grains producers exert monopoly power over flour mill product manufacturers in the sale of barley, and flour mill product manufacturers exert monopsonistic power in the purchase of wheat. Unfortunately, the associated estimated asymptotic standard errors are very high, meaning there is considerable uncertainty about the true values of these parameters. Moreover, the estimates show some sensitivity to the NL3SLS starting values. This suggests that the least squares function may not have a global minimum, and/or not enough information is being incorporated in the estimation process. To overcome these problems, we may want to increase the sample size, incorporate non-sample information into the estimation process (eg. by additional parametric equality and inequality constraints implied by economic theory), and/or estimate (17) and (18) jointly with the conditional input demand equations derived using Shephard's Lemma.

## 6. Conclusion

Most previous attempts at measuring market power in the food chain have been predicated on the assumption that agents on one side of the transaction are perfectly competitive. Raper *et al* relax this assumption in the case of a firm that produces a single output. In this paper we have generalised the Raper *et al* model to the case of firms that produce multiple outputs, and we have used a small grains and oilseeds data set to show how the model can be made empirically operational. Unfortunately, our estimates of important market power parameters are less than robust. Future research will focus on statistical approaches to improving the properties (ie.reducing the standard errors) of our estimators. We will also focus on two important extensions of the Raper *et al* model. First, the model will be extended to account for the fact that the downstream firm only purchases a *proportion* of the outputs of the upstream firm. Second, we will extend the Raper *et al* model to permit the downstream firm to exert market power in the sale of its outputs to firms further downstream. Thus, we will construct a model of the entire grains and oilseeds marketing chain, not just one interface in that chain.

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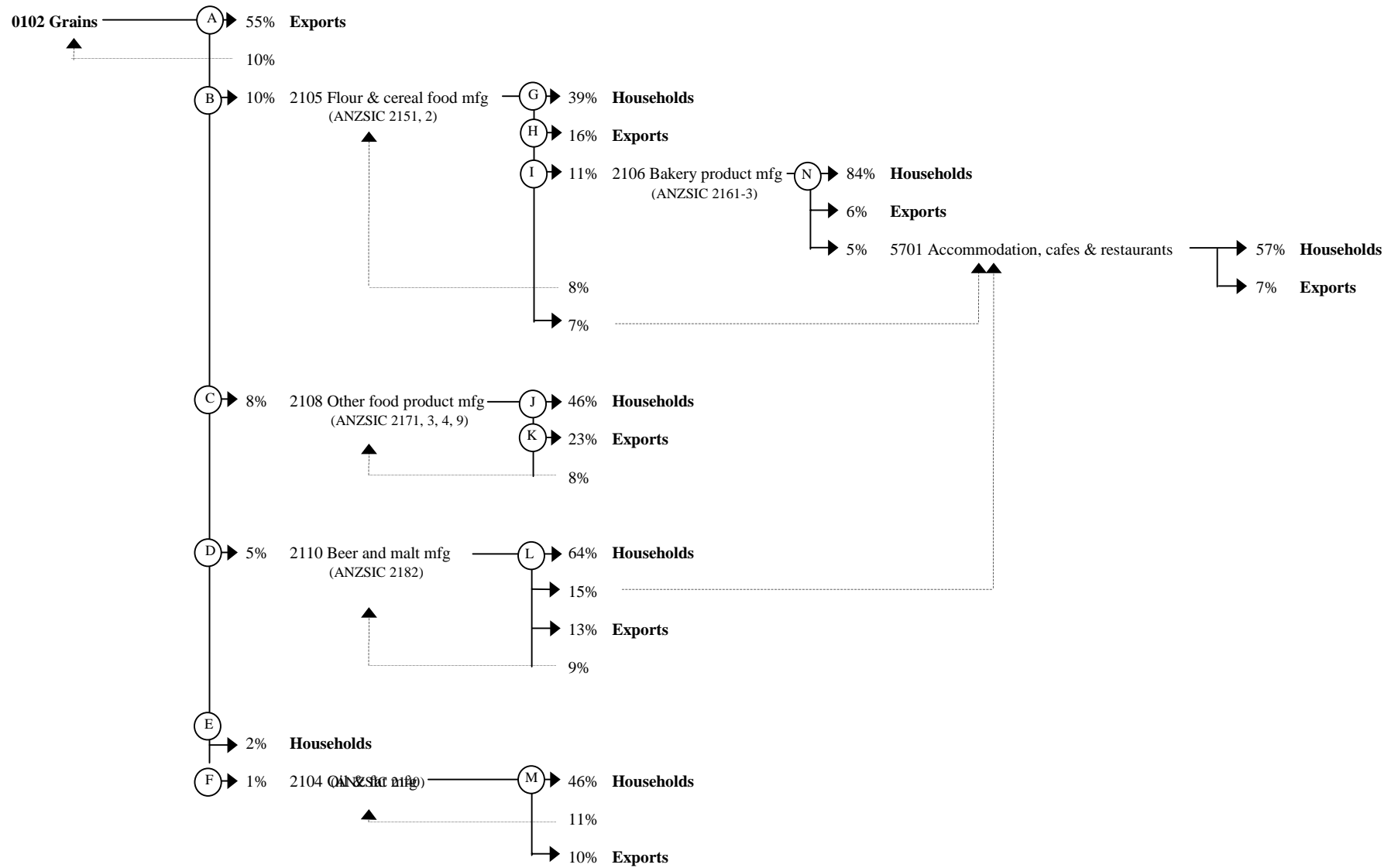


Figure 1. Basic Structure of Grains and Oilseeds Product Supply Chain

**Table 1. Product Supplies and Exports by IOPC Item: 1996-97 (\$million)**

Code	Description	Australian Production (1)	Competing Imports cif (2)	Total (1) + (2)	Exports
<b>0102</b>	<b>Grains</b>				
	*Wheat and meslin, unmilled	4362.2	0.6	4362.8	2,999.5
	*Barley, unmilled	1070.7	-	1070.7	551.9
	Oats, unmilled	193.8	-	193.8	15.3
	*Rice, in the husk	257.3	0.1	257.4	3.5
	Grain sorghum	200.3	-	200.3	34.5
	*Oilseeds	289.3	40.2	329.5	112.8
	Legumes for grain nec.	420.5	0.3	420.7	n.a.
	Cereal grains nec.	<u>207.3</u>	<u>0.4</u>	<u>207.7</u>	<u>n.a.</u>
	<i>Total</i>	<i>7,001.5</i>	<i>41.7</i>	<i>7043.1</i>	<i>3,907.6</i>
<b>2104</b>	<b>Oils and Fats</b>				
	Crude vegetable oils	158.8	114.3	273.0	n.a.
	Oil cake and other solid residues	n.a.	83.0	n.a.	6.5
	*Refined/processed animal/vegetable oils	356.4	184.8	541.3	18.6
	Acid oils from refining animal/vegetable oils	n.a.	13.0	n.a.	n.a.
	*Margarine	<u>260.8</u>	<u>2.9</u>	<u>263.7</u>	<u>69.6</u>
	<i>Total</i>	<i>848.3</i>	<i>398.0</i>	<i>1246.3</i>	<i>119.1</i>
<b>2105</b>	<b>Flour Mill Products and Cereal Foods</b>				
	*Wheat and other cereal flours (excl self raising)	755.0	4.0	759.0	54.8
	Cereal (excl rice) groats etc. for human consumption	12.4	1.2	13.6	5.8
	Wheat bran for humans (excl for breakfast foods)	13.7	1.2	14.9	0.4
	Flour mill products nec, for human consumption	77.5	1.7	79.2	-
	Starch of wheat and corn	153.5	13.8	167.4	20.5
	Glucose, glucose syrup & modified starches	129.7	19.4	149.1	14.8
	Wheat gluten	98.5	2.3	100.8	46.3
	*Cereal foods (incl breakfast foods)	817.5	51.7	869.2	57.3
	Flour (self raising)	20.3	0.2	20.4	0.6
	Prepared baking powders, jelly crystals etc.	n.a.	79.9	n.a.	3.6
	Rice, semi-milled or wholly milled	n.a.	39.0	n.a.	n.a.
	Rice, husked but not further prepared	n.a.	0.1	n.a.	-
	Rice groats; other worked cereal grains etc.	n.a.	27.8	n.a.	n.a.
	Rice bran, sharps and other residues	38.1	-	38.1	0.8
	Pasta	175.8	54.6	230.5	14.8
	Other	12.1	-	12.1	-
	Increase in stocks	<u>0.9</u>	<u>-</u>	<u>0.9</u>	<u>-</u>
	<i>Total</i>	<i>3172.9</i>	<i>269.9</i>	<i>3469.7</i>	<i>542.1</i>
<b>2106</b>	<b>Bakery Products</b>				
	*Bread and bread rolls	1393.0	49.5	1442.4	42.0
	Meat pies	242.5	10.3	252.8	9.3
	*Cakes, pastries and crumpets	725.5	93.6	819.1	37.8
	*Biscuits, biscuit crumbs, rusks etc, unleavened bread	702.5	124.6	827.1	98.6
	Increase in stocks	<u>1.7</u>	<u>-</u>	<u>1.7</u>	<u>-</u>
	<i>Total</i>	<i>3065.2</i>	<i>278.0</i>	<i>3343.2</i>	<i>187.8</i>
<b>2108</b>	<b>Other Food Products</b>				
	Raw Sugar	1876.6	0.7	1877.3	1226.1
	*Prepared animal and bird feeds nec	1332.0	15.8	1347.9	11.9
	Dog and cat food, canned	535.6	31.9	567.5	121.0
	Potato crisps and flakes	603.4	0.1	603.5	0.4
	Other	<u>4774.9</u>	<u>1212.9</u>	<u>5987.8</u>	<u>1175.3</u>
	<i>Total</i>	<i>9122.5</i>	<i>1261.4</i>	<i>10383.9</i>	<i>2424.7</i>
<b>2110</b>	<b>Beer and Malt</b>				
	*Beer, ale and stout, bottled	1157.6	76.0	1233.6	125.8
	*Beer, ale and stout, canned	547.4	46.5	593.9	90.7
	*Beer, ale and stout, bulk	392.4	21.5	413.9	1.8
	Malt (excl malt extract)	250.8	0.6	251.4	108.3
	Other	<u>19.0</u>	<u>-</u>	<u>19.0</u>	<u>12.1</u>
	<i>Total</i>	<i>2367.3</i>	<i>144.6</i>	<i>2511.8</i>	<i>338.8</i>

Source: ABS 5215.0

**Table 2. Descriptive Statistics**

Variable	Mean	Standard Deviation	Variance	Minimum	Maximum
Y <sub>u1</sub>	2534.9	2271.1	0.51578E+07	2.0000	8677.0
Y <sub>u2</sub>	841.25	639.46	0.40891E+06	19.000	2229.0
P <sub>u1</sub>	0.19787	0.38767E-01	0.15029E-02	0.12241	0.27399
P <sub>u2</sub>	0.17193	0.35845E-01	0.12849E-02	0.10789	0.23256
W <sub>1</sub>	131.79	12.580	158.26	112.00	154.60
W <sub>2</sub>	122.43	8.3347	69.467	111.00	136.80
W <sub>3</sub>	123.52	9.4955	90.165	108.00	140.40
Z <sub>4</sub>	2000.3	1488.9	0.22170E+07	9.1000	5394.0
Y <sub>d1</sub>	1.8881	1.9930	3.9720	0.0000	7.8350
V <sub>1</sub>	0.28901E-01	0.12033E-01	0.14480E-03	0.0000	0.54852E-01
V <sub>2</sub>	104.88	4.9878	24.878	98.000	112.00

**Table 3. Parameter Estimates**

Parameter	Estimate	Estimated Asy. St. Error	Estimated Asy. t-ratio
$\lambda_{m1}$	0.14963E-09	0.13891E+11	0.10772E-19
$\alpha_{u11}$	0.19316E-06	0.46670E-06	0.41388
$\beta_{u1}$	0.78957E-03	0.26233E-02	0.30099
$\beta_{u11}$	-0.24249E-06	0.42733E-06	-0.56746
$\beta_{u12}$	-0.23168E-06	0.45566E-06	-0.50846
$\gamma_{u11}$	-0.58153E-03	0.75347E-03	-0.77181
$\gamma_{u12}$	0.14323E-02	0.28008E-02	0.51140
$\gamma_{u14}$	0.40921E-06	0.58817E-06	0.69573
$\lambda_{m2}$	0.57184	6.0387	0.94695E-01
$\alpha_{u22}$	0.37044E-06	0.14213E-05	0.26063
$\beta_{u2}$	0.18458E-02	0.17540E-02	1.0523
$\beta_{u21}$	-0.16429E-06	0.22780E-06	-0.72122
$\beta_{u22}$	-0.20828E-06	0.17572E-05	-0.11853
$\gamma_{u21}$	-0.11868E-02	0.66040E-03	-1.7971
$\gamma_{u22}$	0.75654E-03	0.19315E-02	0.39168
$\gamma_{u24}$	0.28402E-06	0.39336E-06	0.72203
$\lambda_{s1}$	0.88054	1.4253	0.61779
$\alpha_{u1}$	-0.18971E-02	0.14357E-03	-13.214
$\alpha_{u12}$	0.31493E-06	0.31544E-06	0.99838
$\phi_{u11}$	-1.4761	0.98449	-1.4994
$\phi_{11}$	0.12316E-03	0.57169E-04	2.1543
$\lambda_{s2}$	-0.12472E-08	0.25184E+10	-0.49524E-18
$\alpha_{u2}$	-0.15549E-02	0.13652E-03	-11.390
$\alpha_{u21}$	-0.37363E-07	0.53479E-07	-0.69865
$\phi_{u21}$	-1.5167	0.93743	-1.6180
$\phi_{21}$	0.62455E-04	0.53259E-04	1.1727



**APPENDIX A  
SELECTED ANZSIC CLASSIFICATIONS**

**2140 Oil and Fat Manufacturing**

This class consists of units mainly engaged in manufacturing crude vegetable or marine oils, fats, cake or meal, margarine, compound cooking oils or fats, blended table or salad oils, or refined or hydrogenated oils or fats n.e.c.

*Exclusions / References*

Units mainly engaged in

- (a) manufacturing unrefined animal oils or fats (except neatsfoot oil) or in rendering tallow or lard are included in Class 2111 Meat Processing; and
- (b) distilling or refining essential oils are included in Class 2549 Chemical Product Mfg n.e.c.

*Primary Activities*

Animal oils, refined, mfg; Cotton linters mfg; Deodorised vegetable oils mfg; Edible oils or fats, blended mfg; Fish or other marine animal oils or meal mfg; Lard, refined, mfg; Margarine mfg; Tallow, refined, mfg; Vegetable oil, meal or cake mfg

**2151 Flour Mill Product Manufacturing**

This class consists of units mainly engaged in milling flour, (except rice flour) or in manufacturing cereal starch, gluten, starch sugars or arrowroot.

*Exclusions / References*

Units mainly engaged in

- (a) manufacturing milled rice, rice flour, meal or offal, hulled or shelled oats, oatmeal for human consumption, prepared cereal breakfast foods or self-raising flour are included in Class 2152 Cereal Food and Baking Mix Mfg;
- (b) manufacturing prepared animal or bird foods from cereals, or in manufacturing cereal meal, grain offal or crushed grain for use as fodder (from whole grain, except from rice or rye) are included in Class 2174 Prepared Animal and Bird Feed Mfg; and
- (c) repacking flour or cereal foods are included in Class 4719 Grocery Wholesaling n.e.c.

*Primary Activities*

Arrowroot mfg; Atta flour mfg; Barley meal or flour mfg (for human consumption; except prepared breakfast food); Bran, wheaten, mfg (except prepared breakfast food); Cornflour mfg; Dextrin mfg; Dextrose mfg; Flour, wheat, mfg (except self-raising flour); Glucose mfg; Gluten mfg; Pollard mfg (from wheat, barley or rye); Rye flour, meal or offal mfg (except prepared breakfast food); Sausage binder or similar meal mfg (from wheat); Semolina mfg; Starch mfg; Starch sugars mfg; Wheat germ mfg; Wheat meal mfg (for human consumption; except prepared breakfast food)

**2152 Cereal Food and Baking Mix Manufacturing**

This class consists of units mainly engaged in manufacturing prepared cereal breakfast foods, pasta, milled rice, rice flour, meal or offal, hulled or shelled oats, oatmeal for human consumption, self-raising flour, prepared baking mixes, jelly crystals or custard powder.

*Exclusions / References*

Units mainly engaged in

(a) manufacturing prepared animal or bird foods from cereals, or in manufacturing cereal meal, grain offal or crushed grain for use as fodder (from whole grain, except from rice or rye) are included in Class 2174 Prepared Animal and Bird Feed Mfg; and

(b) repacking cereal food products are included in Class 4719 Grocery Wholesaling n.e.c.

*Primary Activities*

Baking mixes, prepared, mfg; Baking powder mfg; Batter mixes mfg; Bread dough, frozen, mfg; Bread mixes, dry, mfg; Cake mixes mfg; Cereal breakfast foods, prepared, mfg; Cereal foods mfg n.e.c.; Crumbs mfg (made from cereal food; except biscuit or bread-crumbs); Custard powder mfg; Desserts, prepared, mfg (in dry form) n.e.c.; Farina mfg; Jelly crystals mfg; Milled rice mfg; Oatmeal mfg (for human consumption); Oats, hulled or shelled, mfg; Oats, kilned or unkilned, mfg; Pasta mfg; Pastry dough, frozen mfg; Pastry mixes mfg; Pizza mix mfg; Rice flour, meal or offal mfg; Rice mfg (except fried); Sago mfg; Scone mixes mfg; Self-raising flour mfg; Tapioca mfg

**2161 Bread Manufacturing**

This class consists of units mainly engaged in manufacturing bread.

*Exclusions / References*

Units mainly engaged in selling to the public bread baked on the same premises are included in Class 5124 Bread and Cake Retailing. Units mainly engaged in manufacturing unleavened bread are included in Class 2163 Biscuit Mfg.

*Primary Activities*

Bread bakery operation; Breadcrumbs mfg; Bread rolls mfg; Fruit loaf mfg; Leavened bread mfg

**2162 Cake and Pastry Manufacturing**

This class consists of units mainly engaged in manufacturing cakes, pastries, pies or similar bakery products (including canned or frozen bakery products).

*Exclusions / References*

Units mainly engaged in selling cakes or pastries, produced on their premises, directly to the general public are included in Class 5124 Bread and Cake Retailing.

*Primary Activities*

Cake icing or decorating; Cakes or pastries mfg; Crumpets mfg; Doughnuts mfg; Fruit or yoghurt slices, mfg; Meat pies mfg; Pastry mfg (except frozen pastry dough); Pies mfg; Plum pudding mfg

**2163 Biscuit Manufacturing**

This class consists of units mainly engaged in manufacturing biscuits (including unleavened bread).

*Exclusions / References*

Units mainly engaged in

(a) manufacturing dog biscuits are included in Class 2174 Prepared Animal and Bird Feed Mfg; and

(b) manufacturing hot bake biscuits or cookies for sale on the same premises to the public are included in Class 5124 Bread and Cake Retailing.

*Primary Activities*

Biscuit crumbs mfg; Biscuits mfg (except dog biscuits); Ice cream cones or wafers mfg; Rusks mfg; Unleavened bread mfg

**2171 Sugar Manufacturing**

**2173 Seafood Processing**

## 2174 Prepared Animal and Bird Feed Manufacturing

This class consists of units mainly engaged in manufacturing prepared animal or bird feed, including cereal meal, grain offal or crushed grain for use as fodder (from whole grain, except from rice or rye).

### *Exclusions / References*

Units mainly engaged in

- (a) slaughtering animals for pet food are included in Class 2111 Meat Processing;
- (b) manufacturing animal feeds prepared from dried skim milk powder are included in Class 2129 Dairy Product Mfg n.e.c.;
- (c) manufacturing crushed rye, or rye flour, meal or offal for use as fodder are included in Class 2151 Flour Mill Product Mfg; and
- (d) manufacturing crushed rice, or rice flour, meal or offal for use as fodder are included in Class 2152 Cereal Food and Baking Mix Mfg.

### *Primary Activities*

Animal feed, prepared, mfg (except uncanned meat or bone meal or protein enriched skim milk powder); Animal food, canned, mfg; Bird feed mfg; Cattle lick mfg; Cereal meal mfg (for fodder; except from rice or rye); Chaff mfg; Crushed grain mfg (incl. mixed; for fodder); Dehydrated lucerne mfg; Dog biscuits mfg; Fodder, prepared, mfg; Grain offal mfg (for fodder; except from rice or rye); Lucerne cubes mfg; Lucerne meal mfg; Pet food, canned, mfg; Poultry feed, prepared, mfg; Sheep lick mfg

## 2179 Food Manufacturing n.e.c.

This class consists of units mainly engaged in manufacturing food products n.e.c. (including snack foods and prepared meals).

### *Exclusions / References*

Units mainly engaged in

- (a) manufacturing sugar are included in Class 2171 Sugar Mfg;
- (b) refining salt for industrial purposes are included in Class 2535 Inorganic Industrial Chemical Mfg n.e.c.;
- (c) egg pulping or drying are included in Class 4719 Grocery Wholesaling n.e.c.; and
- (d) blending or packing tea are included in Class 4719 Grocery Wholesaling n.e.c.

### *Primary Activities*

Coffee mfg; Corn chips mfg; Dessert mixes, liquid, mfg; Flavoured water packs mfg (for freezing into flavoured ice); Flavourings, food, mfg; Food colourings mfg; Food dressings mfg; Food mfg n.e.c.; Ginger product mfg (except confectionery); Herbs, processed, mfg; Honey, blended, mfg; Hop extract, concentrated, mfg; Ice mfg (except dry ice); Meat or ham pastes mfg; Nut foods mfg (except candied); Pearl barley mfg; Potato crisps mfg; Pre-prepared meals mfg n.e.c.; Pretzels mfg; Rice preparations mfg n.e.c.; Salt, cooking or table, mfg; Savoury specialities mfg; Seasonings, food, mfg; Soya bean concentrates, isolates or textured protein mfg; Spices mfg; Taco, tortilla and tostada shells mfg; Tea mfg; Yeast or yeast extract mfg

## 2182 Beer and Malt Manufacturing

This class consists of units mainly engaged in manufacturing, bottling or canning beer, ale, stout or porter, or manufacturing malt.

*Exclusions / References*

Units mainly engaged in manufacturing malt extract or malted milk powder are included in Class 2129 Dairy Product Mfg n.e.c.

*Primary Activities*

Barley malt mfg; Beer mfg (except non-alcoholic beer); Malt mfg (except malt extract); Oaten malt mfg; Porter mfg; Wheaten malt mfg

**5110 Supermarket and Grocery Stores**

This class consists of units mainly engaged in retailing groceries or non-specialised food lines, whether or not the selling is organised on a self-service basis.

*Primary Activities*

Groceries retailing; Grocery supermarket operation

**5124 Bread and Cake Retailing**

This class consists of units mainly engaged in retailing bread, cakes, pastries or biscuits. This class includes units which bake bread, cake, pastries or biscuits on the premises for sale to the final consumer.

*Exclusions / References*

Units mainly engaged in baking bread, cakes, pastries or biscuits are included in Group 216 Bakery Product Mfg.

*Primary Activities*

Biscuits retailing; Bread retailing; Bread vendors; Cakes retailing; Pastries retailing

**5125 Takeaway Food Retailing**

This class consists of units mainly engaged in retailing food ready to be taken away for immediate consumption.

*Exclusions / References*

Units mainly engaged in selling prepared meals for consumption on the premises are included in Group 573 Cafes and Restaurants.

*Primary Activities*

Chicken, take away, retailing (cooked, ready to eat); Cut lunches retailing; Fish and chips, take away, retailing (cooked, ready to eat); Hamburgers, retailing (cooked, ready to eat); Ice cream retailing (for immediate consumption); Milk drinks retailing (for immediate consumption); Pizza, take away, retailing (cooked, ready to eat); Soft drinks retailing (for immediate consumption); Take away foods retailing (cooked ready to eat)

**5720 Pubs, Taverns and Bars**

This class consists of hotels, bars or similar units (except licensed clubs) mainly engaged in selling alcoholic beverages for consumption on the premises, or in selling alcoholic beverages both for consumption on and off the premises (e.g. from bottle shops located at such premises).

*Exclusions / References*

Units mainly engaged in

(a) retailing alcoholic beverages for consumption off the premises are included in Class 5123 Liquor Retailing; and

(b) operating licensed clubs are included in Class 5740 Clubs (Hospitality).

*Primary Activities*

Bar operation (mainly drinking place); Hotel operation (mainly drinking place); Night club operation (mainly drinking place); Pub operation (mainly drinking place); Tavern operation (mainly drinking place); Wine bar operation (mainly drinking place)

**5730 Cafes and Restaurants**

This class consists of units mainly engaged in providing meals for consumption on the premises.

*Exclusions / References*

Units which are mainly engaged in

- (a) retailing ready to eat food in take away containers are included in Class 5125 Takeaway Food Retailing;
- (b) selling alcoholic beverages for consumption on the premises (except clubs) are included in Class 5720 Pubs, Taverns and Bars; and
- (c) operating hospitality clubs are included in Group 574 Clubs (Hospitality).

*Primary Activities*

Cafe operation; Catering service operation; Restaurant operation

**5740 Clubs (Hospitality)**

This class consists of associations mainly engaged in providing hospitality services to members. These units also may provide gambling, sporting or other social or entertainment facilities.

*Primary Activities*

Club operation (hospitality); Licensed club operation