# Another Look at Market Power in the Australian Fresh Meat Industries[1]

**Kit C. Chung**
Postgraduate Student, School of Business, Economics and Public Policy, University of New England, Armidale.

**Garry R. Griffith**
Principal Research Scientist, Industry and Investment NSW, University of New England, Armidale, and Adjunct Professor, School of Business, Economics and Public Policy, University of New England, Armidale.

## Abstract

The issue of market power in the Australian food marketing chain is of continuing and growing concern. Contributing factors include sharply rising retail food prices in recent years together with relatively stable farm prices, and thus increasing marketing margins; high and increasing concentration in the retail food sector, where the two largest supermarket chains account for a large percentage of total national grocery sales; and the legacy of past deregulation of agricultural marketing institutions and trade liberalisation. In this paper an updated quantitative analysis of the competitive behaviour of the marketing chains for beef, lamb, pork and chicken, from farm gate to retail, is reported. A New Empirical Industrial Organisation model is used. Both linear and nonlinear, and single equation and SUR, regression analyses are estimated. As with previous studies, no evidence is found that the marketing chains for the Australian fresh meat industries are non-competitive.

## 1. Introduction

Competition in the Australian food marketing chain is of continuing and growing public concern, in particular to consumers, primary producers and policy-makers. Many commentators simply focus on nominal retail and farm gate prices. Figures 1 to 4 show nominal and real marketing margins for beef (mmbf), lamb (mmlb), pork (mmpk) and chicken (mmck) respectively, over the period 1970-2007[2]. The real margins have the suffix "r". These data certainly indicate that nominal retail prices have risen faster than nominal farm gate prices in the last three decades, and thus the nominal marketing margins have increased. For example, the nominal beef marketing margin has risen from 121 c/kg in 1970 to 1246 c/kg in 2007. Similarly, lamb, pork and chicken margins have all risen substantially over this 38 year period. Hyde and Perloff (1998) confirm that livestock prices and retail meat prices in Australia were strongly correlated during 1970-1990.

However, a better measure is real marketing margins, which account for the real cost of supplying the marketing services that go along with the cost of the live animal in producing a retail meat product. Real marketing margins are calculated by dividing the nominal margin by an index of the changing value of money over time. Here the CPI for food (base=1990) has been used as a proxy. Real marketing margins have either been fairly stable or have actually fallen during most of the last three decades.

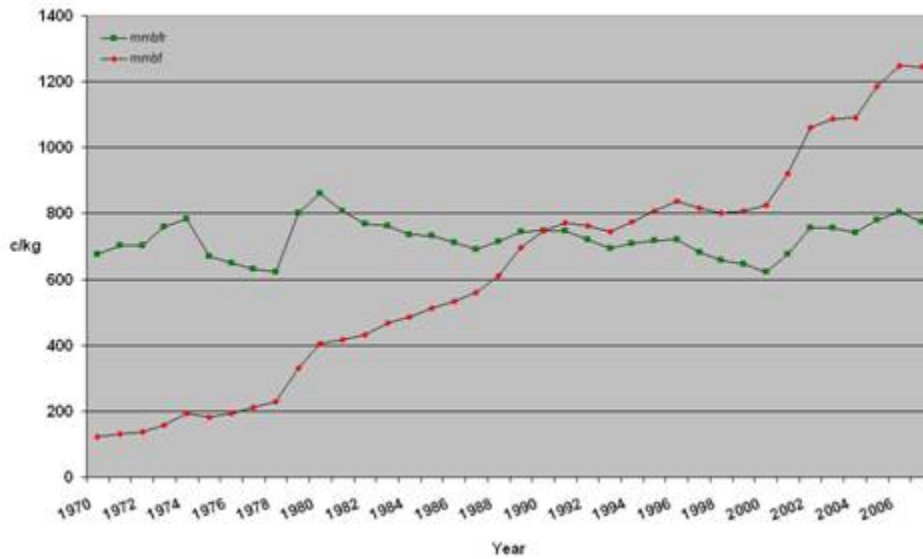**Figure 1.  Real and Nominal Beef Marketing Margins, 1970–2007**



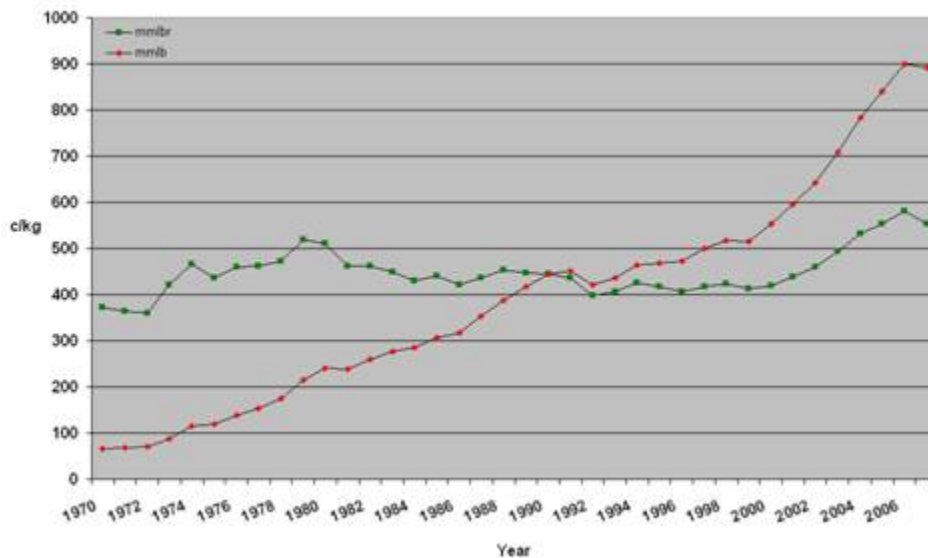**Figure 2.  Real and Nominal Lamb Marketing Margins, 1970–2007**

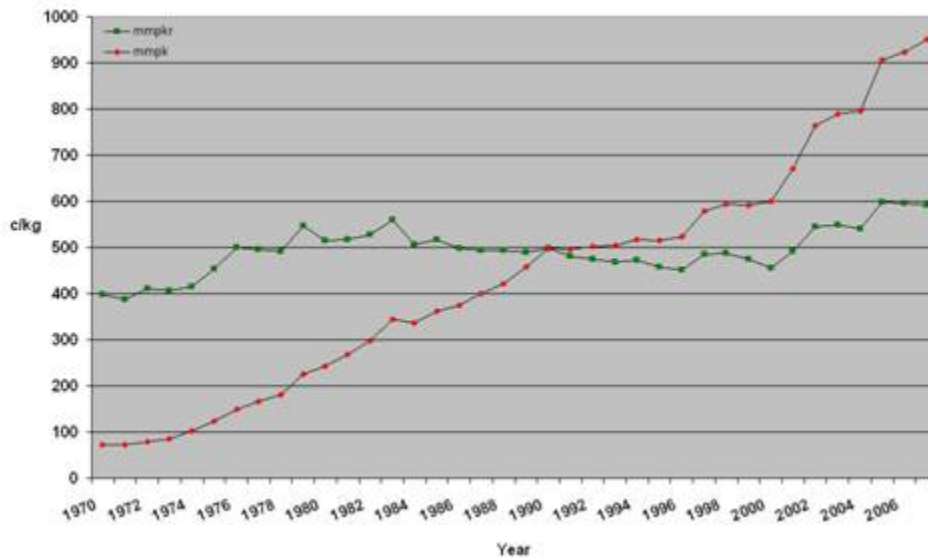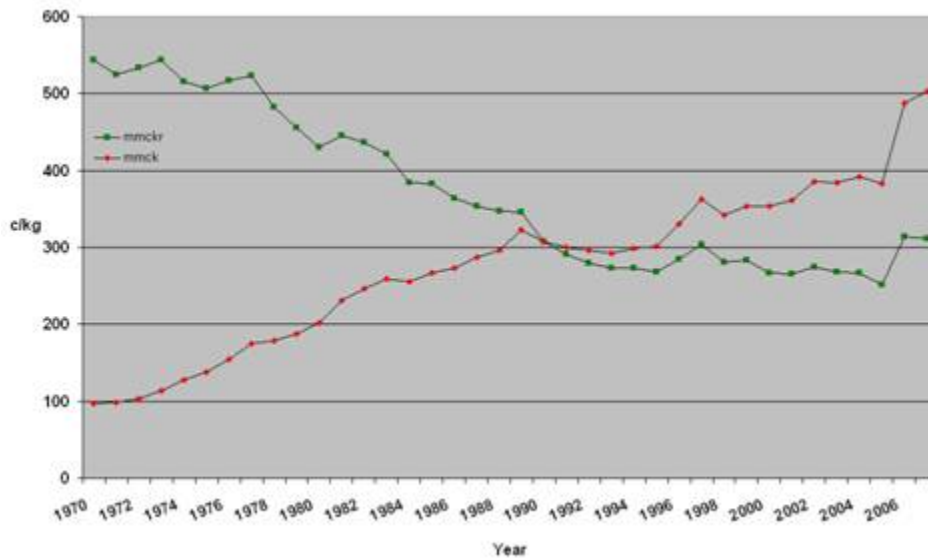**Figure 3. Real and Nominal Pork Marketing Margins, 1970–2007**



**Figure 4. Real and Nominal Chicken Marketing Margins, 1970–2007**



For example, the real marketing margin for chicken has fallen steadily from its high of 543 c/kg in 1970 to its current value of 312 c/kg. The real margins for beef, lamb and pork have all fallen from historic highs in the early 1980s until about the year 2000. Since then, the real marketing margins for beef, lamb and pork have shown consistent increases, and the fall in the real marketing margin for chicken has been arrested. The real margins for lamb and pork were at historic highs in 2007 and the real margin for beef was approaching its historic high of 860 c/kg in 1980. These recent changes may imply non-competitive behaviour in the meat processing and/or retailing sectors.

Concentration of ownership in the retail sector is a current feature of the Australian food marketing chain. The Australian food retail sector comprises five major supermarket chains (Coles, Woolworths, Foodland, IGA and ALDI) and a large number of small

independent retailers. The largest two major chains (Coles and Woolworths) account for around 62 per cent of total grocery sales (Delforce, Dickson and Hogan 2005). This oligopolistic market structure at the retail (and wholesale) level of the food industry generates backward pressure on the agricultural and processing sectors. The Australian food industry has changed from agricultural producers 'pushing' products into the supply chains to retailers 'pulling' products from the suppliers in response to consumer preferences (Griffith 2004). Most of the policy concern focuses on the supplier side, rather than the consumer side of the market, as the findings of Australian Parliament (1999) suggested a competitive environment on the consumer side at the food retail level.

A more general concern for producers, in particular, is the substantial deregulation of agricultural product marketing that has occurred over time due to the implementation of National Competition Policy guidelines. The marketing board arrangements common in many industries have been dismantled with the abolition of most guaranteed farm prices, production quotas and single desk marketing arrangements. In the past, producers were protected by these measures from much of the uncertainty inherent in global food markets as well as from the actions of non-competitive participants in domestic food markets. There is also the argument that deregulation is a concern for many producers because they are now forced to make more marketing decisions themselves.

Evidence of this ongoing concern is demonstrated by the large number of investigations and inquiries into competition and market conduct in the grocery industry recently undertaken by the Australian Competition and Consumer Commission (ACCC), such as ACCC (2002, 2004, 2007, 2008).

Given this context, the objective of this paper is to investigate the competitive structure within the fresh meat marketing chain in Australia, as a follow up to a previous study of competitive behaviour within the broader Australian food marketing chain (Griffith 2000).

## 2. Previous Studies

There have been several previous studies that have examined various aspects of the competitive structure of the Australian food marketing chain. Zhao, Griffith and Mullen (1998) modified the model developed by Holloway (1991) and applied it to the Australian beef market. The traded status of this particular market was a major focus. When the domestic and export markets were separated, there was no evidence of imperfect competition in the domestic beef market..

Hyde and Perloff (1998) found that the domestic meat market was competitive for beef, lamb and pork and that market power had not increased over time. They employed a structural method in which they simultaneously estimated a demand system, a market-power parameter, and the marginal cost function for each meat product.

Conversely, Griffith, Green and Duff (1991) found that short-run price levelling was a persistent characteristic of the Australian meat market. This behaviour reflects market inefficiency and is inconsistent with competitive market behaviour. Chang and Griffith (1998) applied co-integration and impulse response analysis to study the short-run and long-run price dynamics of the Australian beef market, They found that the farm,

wholesale and retail prices for beef were co-integrated and moved together over time, all responding to exogenous shifts in demand and supply curves that is evidence of competitive price determination. However, wholesale prices were found to be weakly exogenous which is an indication of market inefficiency, which may be due to the common practice of price levelling in the beef marketing system. Hyde and Perloff (1998) also noted the conflict between a competitive retail meat market and the practice of price levelling in Australia.

Griffith (2000) used highly aggregated data and a relatively simple empirical model for estimating market power across different food chains. He found that the null hypothesis of competitive behaviour in both the output and input markets could not be rejected for groups of meat products, fresh fruits or fresh vegetable. Some evidence of non-competitive behaviour was found for the grains and oilseeds sector.

Following up on these results, O'Donnell *et al*. (2004) specified a general duality model of profit maximisation that allows for imperfect competitive behaviour in both the input and output markets of the Australian grains and oilseeds industry. They also allowed for variable-proportions technologies in the estimation, and for market power to be a potential outcome at every stage along the marketing chain. O'Donnell *et al*. (2004) found some evidence of a non-competitive buying behaviour in the processed grains (eg. flour and cereal food product manufacturers) and oilseed sector.

Very few empirical studies of market power using formal theoretical frameworks have been done in the Australian food marketing chain. Adequate data has always been a significant limiting factor. Several studies of the meat industry have suggested competitive conduct (although inconsistent with price levelling). However the recent evidence of increasing real marketing margins and the ongoing policy relevance suggest that these marketing chains should be looked at again.

# 3. The New Empirical Industrial Organisation (NEIO) Framework

A real marketing margins model is used, based on the structural NEIO framework applied by O'Donnell (1999). The fundamental basis of this model is that the real marketing margin for a food product potentially contains three components. The first component is marketing service costs which refer to the costs of transforming the agricultural raw products into the final food product. The second component is any economic rent that is earnt from non-competitive purchasing behaviour in the relevant input market, the difference between input price and marginal factor cost. The third component is any economic rent that is earnt from non-competitive behaviour in the relevant output market, the difference between price and marginal revenue. The second and third components, if positive and significant, imply non-competitive behaviour in the market. Put differently, in a competitive market, the second and third components would not be significantly different from zero and the real marketing margin would be equal to the real cost of supplying marketing services (Griffith 2000).

This version of the structural NEIO framework (O'Donnell 1999) is as follows:

$$m_j = a_j + \sum_{k=1} c_{jk}z_k + \beta_j q_j + \sum_{m=1} \gamma_{jm}x_m/w_m \qquad \text{(Equation 1)}$$

Where, for any product j;

$m_j$ = Industry marketing margin, $p_j - w_j$;

$p_j$ = Price of the food output j;

$w_j$ = Price of the agricultural input j;

$c_{jk}$ = Price of the marketing service k that contributes to food output j;

$z_k$ = Non-agricultural inputs k and trend and seasonal variables where required;

$q_j$ = Quantity of the food output j;

$\beta_j$ = Output conjectural coefficient;

$\gamma_{jm}$ = Input conjectural coefficient.

$q_m$ is the aggregate quantity of output m and $x_m$ is the aggregate quantity of input m.

On the demand side, an inverse demand function exists in the output market with a form $p_m = f(q_m)$. On the supply side, the agricultural inputs have input supply functions of the form $x_m = f(w_m)$, where agricultural marketing firms combine agricultural inputs $x_m$ and non-agricultural inputs z to produce $q_m$ (Griffith 2000).

The conjectural coefficients are important parameters in the NEIO model. Conjectural variation elasticities measure the extent to which individual firms choose to modify their output supply or input demand decisions on the basis of their expectations or conjectures about how other firms will react in determining the level and price of aggregate industry supply or demand.

In equation 1, $\beta_j = -\theta_{qjj}/\eta_j$, where $-\theta_{qjj}$ is the average conjectural elasticity of the industry in the output market in relation to the aggregate output, and $\eta_j$ is the slope of the market demand function for product j. If the values of $-\theta_{qjj} = 0$ or $-\theta_{qjj} = 1$, the output market behaviour is either perfectly competitive or a monopoly, respectively. In the input market, $\gamma_{jm} = \theta_{xmj}/\varepsilon_{jm}$, where $\theta_{xmj}$ is the average conjectural elasticity of the industry in the input market in relation to aggregate input, and $\varepsilon_{jm}$ is the slope of the input supply function for agricultural input j. It has the same interpretation of the value of the conjectural elasticity as the output market. The input market is perfectly competitive or a monopsony, if the values of $-\theta_{xmj}$ are equal to zero or one, respectively. However, this model does not contain direct estimates of the conjectural elasticities (Griffith 2000; O'Donnell 1999).

So, the industry marketing margin for a food product, $m_j$, can be explained by the prices of marketing inputs, and two variables relating to the quantity of the agricultural input

and output that are attached to the conjectural coefficients. If the input and output markets are competitive, the conjectural coefficients are zero and the equilibrium price of marketing services reflects the competitive outcome of price equal to marginal cost (Griffith 2000).

Thus, the two coefficients $\gamma_{jm}$ and $\beta_j$ represent market power in the input and output market, respectively. The test of competitive behaviour in a specific input and output market of a food product is simply testing whether the coefficients $\beta_j$ and $\gamma_{jm}$ are significantly different from zero. According to the theory and the assumptions, the coefficients $\beta_j$, $\gamma_{jm}$ and $c_{jk}$ must be non-negative (Griffith 2000).

While widely used, this econometric model relies on several major assumptions. First, fixed proportions are assumed which implies that agricultural and non-agricultural inputs are non-substitutable in the production process between the farmgate and retail level. That is, the elasticity of substitution between the inputs is zero. Food processing technology is a key factor that influences price transmission. Tomek and Robinson (2003) believe that the zero substitution assumption is fairly realistic, although other researchers have found quite high values for particular products (Griffith, Nightingale and Piggott 1999; O'Donnell 1999, 2004).

Other assumptions made which are also common in the agricultural economics literature, are constant returns to scale, satisfaction of the first order condition of profit maximisation, marginal cost is equal to the marginal revenue, and that there are specific functional forms for the demand, supply and cost functions that aggregate every firm in the industry (Griffith 2000).

# 4. Data Definitions and Descriptions

For any meat product, the only data required are farm and retail prices, the quantity demanded (since interest is only in the proportion of total output sold in the domestic market), the costs of marketing services and the consumer price index for food (CPI) as an appropriate indicator of the changing relative value of all goods and services over time.

Annual data were collected and the sample period was from 1970-2007, where possible (some chicken data were only available from 1978 onwards). All the data were sourced from publicity accessible government websites. The data were highly aggregated at the national level, rather than at state or firm level. All the data were converted to real terms that eliminated the influence of inflation. Regarding the individual marketing service cost data, all the data were converted to indexes. All the meat models were estimated on a calendar year basis, so in some cases where the raw data were available on a financial year basis, they had to be converted to a calendar year basis. The data sources and descriptions are as follows:

*General Data*

- Consumer Price Index for Food, Australia, base 1990, ABS.
- Wage rate index, compensation of employees, Australia, base 2001, ABS 1350.0.
- Electricity cost index, Australia, base 2001, ABS 6427.0.

- Interest rate, 90 day bank bills, Australia, base 2001, ABARE ACS 2008.
- Marketing cost index, calculated as (0.75*Wage) + (0.1*Electricity) + (0.15*Interest), base 2001 (see below for source).

## *Meat Products Data*

- Retail prices for meat, c/kg, ABARE ACS 2008.
- Farm prices for livestock, excluding chicken, c/kg, ABARE ACS 2008 and MLA.
- Farm price for chicken, average unit gross value of poultry slaughtering, dollar per bird, converted to c/kg by average carcase weight, ABS 7503.0.
- Aggregate domestic consumption, kt carcase weight, ABARE ACS 2008 and MLA.

## 5. Results

This section presents the results of estimating the marketing margin models for the four meat products (beef, lamb, pork and chicken) that were specified above. The models were estimated using the TSP/GiveWin econometric package (version 4.5, July 2003). Definitions of the variables used in the estimation and the summary statistics of the main variables are presented in Appendix 1 and 2 respectively.

Initially, the three major types of costs involved in transforming live animals into retail products (wages, electricity and interest rate) were treated as separate variables. However this approach resulted in poor individual levels of significance, usually evidence of multi-collinearity. It was found that there were very high correlations between the three individual cost variables (Table 1). Consequently, the three individual costs were replaced by an aggregate cost index. The ratios of this aggregate cost index were suggested by Zhao, Griffith, and Mullen (1998), which reflected a relatively high ratio of labour cost (75 per cent) in the Australian food retailing and processing sector. All subsequent estimations showed that the aggregate cost index had better t-statistics and contributed to higher overall levels of explanation.

### Table 1. Correlation Matrix of the Marketing Service Cost Indexes

|  | Wage rate | Electricity | Interest rate | Cost index |
|---|---|---|---|---|
| **Wage rate** | 1.00 |  |  |  |
| **Electricity** | 0.88 | 1.00 |  |  |
| **Interest rate** | -0.54 | -0.30 | 1.00 |  |
| **Cost index** | 0.89 | 0.90 | -0.09 | 1.00 |

A trend variable was also introduced to capture any informally specified structural change in relation to the pricing of market services generally over the whole 38 year period of the data. Possible gradual structural change would be change in consumer

demand for market services and change in the whole industry or sector such as labour and financial deregulation and takeover and merger activity (Griffith 2000).

The equations were also estimated with two different dummy variables (1987 onwards = 1 and 2000 onwards = 1) to test whether behaviour had changed at these points in time. The 1987 dummy variable was aimed to pick up any separate effect of the implementation of agricultural deregulation since the mid 1980s (Kenwood 1995), while the 2000 dummy variable was aimed to pick up any separate effect of changes in market structure or behaviour from 2000. Using a dummy variable for these purposes is not ideal, but there are no easily measurable continuous variables for either the degree of regulation/deregulation or the degree of market concentration. However in no case were either of the dummy variables significant, and they are excluded from the following discussion.

The equations were estimated in a number of ways – simple linear equations vs non-linear equations, single equations vs a seemingly unrelated set of equations, and with and without autocorrelation correction. Hyde and Perloff (1998) suggested that the retail market structure for all three meats they studied was identical, where all meats are sold in almost every supermarket or butcher shop. Therefore, it is also presumed that the retail prices of the four different meat products used in this study will influence the retail prices of the other meats, and thus an appropriate estimation technique is as a seemingly unrelated regression (SUR) group instead of individually.

For each equation, R-squared ($R^2$), t-statistics and Durbin Watson (DW) statistics are reported. All t-statistics were tested at the five per cent significance level, so any variable with a t-statistic greater than approximately 2.03 (two tailed test, n=37 for beef, lamb and pork, n=30 for chicken) is a significant independent variable for explaining real marketing margins.

The results are reported in Tables 2 to 5 for beef, lamb, pork and chicken, respectively. In relation to the model specified in equation 1, costind and time are two $z_k$ variables, dmbf etc are the $q_j$ variables and dmbfi etc are the $x_m/w_m$ variables.

**Table 2. Regression Estimates of Real Beef Marketing Margin Equations,
1970-2007**

| constant | costind | dmbf | dmbfi | time | RHO | $R^2$ | DW | Single Eqn/SUR | Restriction |
|---|---|---|---|---|---|---|---|---|---|
| 493.8 | 1.51 | 0.113 | -27.95 | 4.63 | - | 0.46 | 0.92 | S | U |
| (5.36) | (2.59) | (0.69) | -(2.73) | (2.72) | - | | | | |
| 606.6 | 3.83 | -0.717 | 21.78 | 7.39 | - | 0.22 | 0.82 | SUR | U |
| (5.01) | (4.60) | -(4.87) | (2.75) | (3.50) | - | | | | |
| 502.8 | 1.36 | 0.000 | 0.000 | 3.87 | - | 0.12 | 0.72 | S | R |
| (4.76) | (2.10) | na | na | (1.99) | - | | | | |
| 430.1 | 2.16 | 0.000 | 0.000 | 4.06 | - | 0.25 | 0.86 | SUR | R |
| (3.95) | (3.02) | na | na | (2.13) | - | | | | |
| 611.8 | 1.63 | -0.187 | -10.19 | 5.48 | 0.652 | 0.63 | 1.54 | S | U |
| (5.69) | (2.84) | -(1.002) | -(0.99) | (2.72) | (4.48) | | | | |
| 515.8 | 1.30 | 0.000 | 0.000 | 3.64 | 0.638 | 0.48 | 1.40 | S | R |
| (4.16) | (1.80) | na | na | (1.36) | (4.44) | | | | |
| 470.1 | 2.22 | 0.000 | 0.000 | 2.54 | 0.442 | 0.49 | 0.88 | SUR | R |
| (3.89) | (2.84) | na | na | (1.14) | (4.71) | | | | |

1) All t-statistics are tested at the 5% level of significance    2) Values in brackets are t-statistics   3) U: Unrestricted estimation, R: Restricted estimation   4) SUR estimates are 1978-2007

**Table 3. Regression Estimates of Real Lamb Marketing Margin Equations,
1970-2007**

| constant | costind | dmlb | dmlbi | time | RHO | $R^2$ | DW | Single Eqn/SUR | Restriction |
|---|---|---|---|---|---|---|---|---|---|
| 187.4 | 1.83 | -0.130 | -25.62 | 6.59 | - | 0.57 | 0.65 | S | U |
| (2.03) | (3.67) | -(0.35) | -(1.07) | (4.94) | - | | | | |
| 69.56 | 3.67 | -0.917 | 75.24 | 9.18 | - | 0.62 | 1.12 | SUR | U |
| (0.94) | (6.27) | -(2.51) | (1.50) | (6.67) | - | | | | |
| 73.04 | 2.14 | 0.000 | 0.000 | 7.52 | - | 0.52 | 0.57 | S | R |
| (1.04) | (5.00) | na | na | (5.84) | - | | | | |
| -3.73 | 2.88 | 0.000 | 0.000 | 8.00 | - | 0.58 | 0.86 | SUR | R |
| -(0.05) | (6.05) | na | na | (6.31) | - | | | | |
| 298.8 | 0.953 | -0.272 | 4.88 | 5.48 | 0.847 | 0.82 | 1.70 | S | U |
| (3.18) | (2.74) | -(0.81) | (0.25) | (3.26) | (9.38) | | | | |
| 276.8 | 1.015 | 0.000 | 0.000 | 4.10 | 0.817 | 0.81 | 1.58 | S | R |
| (3.43) | (2.73) | na | na | (1.87) | (7.87) | | | | |
| 37.8 | 2.53 | 0.000 | 0.000 | 7.59 | 0.363 | 0.72 | 1.09 | SUR | R |
| (0.46) | (4.67) | na | na | (5.20) | (3.49) | | | | |

1) All t-statistics are tested at the 5% level of significance    2) Values in brackets are t-statistics  3) U: Unrestricted estimation, R: Restricted estimation   4) SUR estimates are 1978-2007

## Table 4. Regression Estimates of Real Pork Marketing Margin Equations, 1970-2007

| constant | costind | dmpg | dmpgi | time | RHO | $R^2$ | DW | Single Eqn/ SUR | Restriction |
|---|---|---|---|---|---|---|---|---|---|
| 279.3 | 1.08 | -0.048 | -0.905 | 5.75 | - | 0.38 | 0.56 | S | U |
| (2.80) | (2.03) | -(0.83) | -(0.01) | (1.63) | - | | | | |
| 159.6 | 2.39 | -0.188 | 30.49 | 5.71 | - | 0.62 | 1.45 | SUR | U |
| (2.56) | (5.90) | -(0.67) | (1.29) | (2.66) | - | | | | |
| 277.1 | 1.05 | 0.000 | 0.000 | 5.32 | - | 0.38 | 0.56 | S | R |
| (3.49) | (2.16) | na | na | (3.63) | - | | | | |
| 124.6 | 2.42 | 0.000 | 0.000 | 6.60 | - | 0.58 | 1.40 | SUR | R |
| (2.06) | (6.11) | na | na | (6.24) | - | | | | |
| 496.1 | -0.272 | -0.373 | 37.21 | 4.29 | 0.872 | 0.78 | 2.07 | S | U |
| (6.54) | -(0.72) | -(1.16) | (1.35) | (1.47) | (11.03) | | | | |
| 530.9 | -0.335 | 0.000 | 0.000 | 1.10 | 0.833 | 0.75 | 2.04 | S | R |
| (5.76) | -(0.83) | na | na | (0.42) | (8.47) | | | | |
| 132.3 | 2.38 | 0.000 | 0.000 | 6.44 | 0.135 | 0.61 | 1.35 | SUR | R |
| (2.06) | (5.64) | na | na | (5.63) | (1.05) | | | | |

**1) All t-statistics are tested at the 5% level of significance   2) Values in brackets are t-statistics**
**3) U: Unrestricted estimation, R: Restricted estimation   4) SUR estimates are 1978-2007**

## Table 5. Regression Estimates of Real Chicken Marketing Margin Equations, 1978-2007

| constant | costind | dmck | dmcki | time | RHO | $R^2$ | DW | Single Eqn/ SUR | Restriction |
|---|---|---|---|---|---|---|---|---|---|
| -107.8 | 2.08 | 0.065 | -74.2 | 16.40 | - | 0.25 | 0.69 | S | U |
| -(0.40) | (1.62) | (0.07) | -(1.25) | (1.50) | - | | | | |
| -100.5 | 2.04 | 0.064 | -72.9 | 16.08 | - | 0.25 | 0.68 | SUR | U |
| -(0.41) | (1.77) | (0.08) | -(1.40) | (1.68) | - | | | | |
| 333.3 | -0.165 | 0.000 | 0.000 | -2.34 | - | 0.09 | 0.63 | S | R |
| (2.36) | -(0.17) | na | na | -(0.94) | - | | | | |
| 333.3 | -0.164 | 0.000 | 0.000 | -2.33 | - | 0.09 | 0.63 | SUR | R |
| (2.59) | -(0.20) | na | na | -(1.04) | - | | | | |
| -178.3 | 2.42 | 0.581 | -72.3 | 6.90 | 0.717 | 0.60 | 1.98 | S | U |
| -(0.88) | (2.32) | (1.04) | -(1.41) | (0.82) | (4.87) | | | | |
| 84.0 | 2.55 | 0.000 | 0.000 | -1.60 | 0.837 | 0.60 | 2.22 | S | R |
| (0.33) | (2.16) | na | na | -(0.25) | (6.49) | | | | |
| 93.64 | 2.57 | 0.000 | 0.000 | -1.93 | 0.846 | 0.60 | 2.24 | SUR | R |
| (0.39) | (2.48) | na | na | -(0.28) | (7.60) | | | | |

**1) All t-statistics are tested at the 5% level of significance   2) Values in brackets are t-statistics   3) U:**
**Unrestricted estimation, R: Restricted estimation**

In all cases the simple linear regression models exhibited positive and significant values for the cost and trend variables, but low t-statistics for the market power variables and other evidence of model mis-specification including substantial positive autocorrelation problems. A correction for autocorrelation was deemed to be necessary (confirmed by the generally significant t-values of the rho coefficients).

Importantly, it was found that at least one of the quantity-related coefficients (input or output conjectural coefficient) was estimated to be negative and significantly different from zero. Consequently, the margin equations suggest a negative relationship between margins and throughput. A declining average cost curve for the processing, distribution and retail sectors for the meat products is implied. Therefore, greater attention is required for the theoretical assumption of constant returns to scale. These findings were consistent with the suggestion by Paul (1999a, 1999b) in which a sound knowledge of the cost structure is claimed to be important when examining the competitive nature of the food marketing chain (Griffith 2000). Since the values of the input and output conjectural coefficients did not fulfil the theoretical restrictions, the hypothesis tests were not able to be implemented for any of the four different meat products.

As a result of these values for the conjecture coefficients, it was decided to impose a theoretical restriction of non-negativity on the conjecture coefficients.

The restricted SUR estimates of the four margin equations with autocorrelation corrections imposed are reported in the last row of each table and then summarised in Table 6. When the non-negativity restrictions were imposed, all the meat margins equations had significantly different results from the unrestricted estimations. All the values of the input and output conjectural coefficients across each meat industry were exactly equal to zero. That is, these are corner solutions. For each meat industry, the null hypothesis of a competitive behaviour in either input or output markets could not be rejected. These high proportions of corner solutions are consistent with the results of Griffith (2000).

The $R^2$ were relatively modest (the beef equation at 49 per cent up to the lamb equation at 72 per cent). All of the cost index coefficients were positive and significant as expected, while the lamb and pork equations had significant trend coefficients. Regarding the autocorrelation test, even after a formal correction, autocorrelation might be still a problem with all except the chicken equation.

The trend coefficients were a mix of positive and negative values across the various industries - positive for beef, lamb and pork and negative for the chicken industry. This finding suggests that knowledge of structural changes across the different meat industries is important for modelling the industry marketing margin.

**Table 6. Restricted SUR Estimates of Real Meat Marketing Margin Equations with Autocorrelation Correction, 1978-2007**

| Real Marketing Margins | Cost Index Coefficient | Output Conjecture Coefficient | Input Conjecture Coefficient | Trend Coefficient | $R^2$ | DW |
|---|---|---|---|---|---|---|
| **Beef** | 2.22 | 0.000 | 0.000 | 2.54 | 0.49 | 0.88 |
| | (2.84) | na | na | (1.14) | | |
| **Lamb** | 2.53 | 0.000 | 0.000 | 7.59 | 0.72 | 1.09 |
| | (4.67) | na | na | (5.20) | | |
| **Pork** | 2.38 | 0.000 | 0.000 | 6.44 | 0.61 | 1.35 |
| | (5.64) | na | na | (5.63) | | |
| **Chicken** | 2.57 | 0.000 | 0.000 | -1.93 | 0.60 | 2.34 |
| | (2.48) | na | na | (-0.28) | | |

**1) All t-statistics are tested at the 5% level of significance   2) Values in brackets are t-statistics   3) Two-tail test for the coefficients**

The hypothesis test results were consistent with previous Australian meat industry studies by Zhao, Griffith and Mullen (1998), Hyde and Perloff (1998) and Chang and Griffith (1998). The results were also consistent with the findings in Griffith (2000), even though the sample period in the current study was extended by over a decade (from 1997-2007).

One reason for this lack of evidence of non-competitive behaviour may be that independent butcher shops still account for a relatively important proportion of meat sales (around 31 per cent) in Australia (ACCC 2007). Therefore, the meat retailing market still contains of a fair degree of competition between the major supermarket chains and butcher shops across Australia, although the market concentration of the major supermarket chains is relatively high. Further, the two major supermarket chains (Coles and Woolworths) have strong competition among themselves, and strategic decisions are likely to be adopted in this zero-sum game. Therefore, if one of the major chains raises their meat retail prices above their rivals, the major chain will lose market share immediately. As a result, it can be argued that the major winners from the increased concentration and oligopolistic structure of the major chains are consumers, in terms of lower prices, a greater product choice, deregulated trading hours and the convenience of one-stop shopping. As a result, competition in the meat retail sector appears to be healthy on the consumer side (Griffith 2000).

Another reason for the lack of evidence of non-competitive behaviour is that Australia is a relatively small country which exports a significant share of agricultural products and imports a smaller but important share of food requirements. This is particularly so for the beef and lamb industries, but also the pork industry since the trade agreement in 1990s. Thus the domestic marketing chain has to operate in the context of the influence of trade or potential trade. Additionally, domestic food prices are significantly impacted by world demand and supply conditions, and thus the world price (Griffith, Nightingale and Piggott 1999). With adequate data, a model specified to examine market power in the domestic market should also consider the trade status of the industries being examined.

# 6. Conclusions

The aim of this study was to re-examine the competitive behaviour of both selling and purchasing along the Australian meat marketing chain from the farm-gate to the retail level, given empirical evidence of increasing real marketing margins in recent years and a continuing interest in the topic by the ACCC. The null hypotheses of perfect competition in both the input and output markets for each meat industry at the retail level could not be rejected, using the models, techniques and data described above. Although the food marketing chain had seen the emergence of several potential causes of non-competitive behaviour in the last decade, the empirical results were consistent with the Griffith (2000) results even with ten years added to the sample period.

It is important to note that this study is based on average representation of market behaviour with highly aggregated data at the national level. Also, the results reported in this study are within a long historical period, from 1970-2007.

It is also important to consider these results in the context of what the regulatory authorities mean by market power. One recent definition that has been used by the ACCC (1999, p.26) is "…the ability of a firm to behave persistently in a manner different from the behaviour that a competitive market would enforce on a corporation facing otherwise similar cost and demand conditions."

This would include the ability to raise selling prices and depress input prices, to deter entry, to re-distribute profits to oneself from other firms and, importantly, to be able to sustain these benefits over time. This last point is critically important. If a firm takes advantage of a temporary situation of power, it will have less effect on the well-being of other buyers and/or sellers than would a permanent advantage. It could be said that firm decisions are a continual effort to make the best of the present situation. Only if the advantage stays with one firm, or set of firms, is the market frustrated in allocating resources efficiently.

So models such as those used in this study are useful for searching for persistent market power, but may not very useful for investigating market power in a specific period, such as when anecdotal evidence arises about some perceived short term abuse by one or more of the major players. Further, a simple linear marketing margin model with a number of quite stringent theoretical restrictions may not be able to accurately explain and model the long and complex meat marketing chain. A more advanced model with variable market power indexes would be preferred, such as those developed by Paul (1999a, Paul 1999b) and Muth and Wohlgenant (1999a, 1999b).

However, data availability and quality is a significant limitation for studies such as this, including the estimation of more complex models. Due to the nature of publicly available data, product-level data are deficient, in terms of short sample periods, absence of wholesale prices, absence of farm prices from direct sales, and the use of fixed proportions assumptions in calculating prices and quantities at each stage along the marketing chain. Moreover, sector-level data and firm-level data are also deficient. Given the oligopolistic structure of the major supermarket chains, retail level data is often seriously restricted based on confidentiality considerations. A review of data availability would seem to be long overdue.

As mentioned previously, the influence of trade is important in specifying empirical models regarding the measurement of market power in the Australian meat industry, except the chicken industry to some extent. However, most of the formal theoretical models were constructed in the context of the US and Europe where world prices and trade are not important in those markets. More work needs to be done in this area.

Finally, a declining long run average cost curve is implied from the negative value of the input and/or output conjectural coefficients in the estimation, which runs counter to the theoretical assumption of constant returns to scale. Increasing returns to scale and non-optimal plant sizes may occur in many industries in a small country like Australia. Especially, the oligopolistic structure of the major supermarket chains are likely to generate cost economies, so the shape of industry cost curves should be examined in detail during modelling the Australian food industry.

# 7. References

Australian Competition and Consumer Commission 2002, *Report to the Senate by the ACCC on Prices Paid to Suppliers by Retailers in the Australian Grocery Industry,* ACCC, Canberra.

Australian Competition and Consumer Commission 2004, *Assessing Shopper Docket Petrol Discounts and Acquisitions in the Petrol and Grocery Sectors*, ACCC, Canberra.

Australian Competition and Consumer Commission 2007, *Examination of the Prices Paid to Farmers for Livestock and the Prices Paid by Australian Consumers for Red Meat*, ACCC, Canberra.

Australian Competition and Consumer Commission 2008, *ACCC Inquiry into the Competitiveness of Retail Prices for Standard Groceries*, Issues paper, ACCC, Canberra.

Australian Parliament 1999, *Report of the Joint Select Committee on the Retailing Sector*, Senate, Canberra.

Chang, H-S., and Griffith, G.R. 1998, 'Examining long-run relationships between Australian beef prices', *Australian Journal of Agricultural and Resource Economics*, vol. 42, no. 4, pp. 369-388.

Delforce, R., Dickson, A. and Hogan, J. 2005, 'Australia's Food Industry – recent changes and challenges', *Australian Commodities*, vol. 12, no. 2, pp. 379-390.

Griffith, G.R., Green W. and G.L. Duff 1991, 'Another look at price levelling and price averaging in the Sydney meat market', *Review of Marketing and Agricultural Economics*, vol. 59, no. 2, pp. 97-109.

Griffith, G., Nightingale, J. and Piggott, R. 1999, 'Market power in the Australian food chain: Towards a research agenda', Paper presented to an Industry Workshop, NSW Farmers Association, Sydney.

Griffith, G.R. 2000, 'Competition in the food marketing chain', *Australian Journal of Agricultural and Resource Economics*, vol. 44, no. 3, pp. 333-367.

Griffith, G.R. 2004, 'Policy forum: Competition issues in the Australian grocery industry – The impact of supermarkets on farm suppliers', *The Australian Economic Review*, vol. 37, no. 3, pp. 329-336.

Holloway, G.J. 1991, 'The farm-retail price spread in an imperfectly competitive food industry', *American Journal of Agricultural Economics,* vol. 73, no. 4, pp. 979-989.

Hyde, C.E. and Perloff, J.M. 1998, 'Multimarket market power estimation: the Australian retail meat sector', *Applied Economics,* vol. 30, pp. 1169-1176.

Kenwood, G. 1995, *Australian Economic Institutions since Federation*, Oxford University Press, Melbourne, Ch. 3.

Muth, M.K. and Wohlgenant, M.K. 1999a, 'Measuring the degree of oligopoly power in the beef packing industry in the absence of marketing input quantity data*', Journal of Agricultural and Resources Economics*, vol. 24, no. 2, pp. 299-312.

Muth, M.K. and Wohlgenant, M.K. 1999b, 'A test for market power using marginal input and output prices with application to the US beef processing industry', *American Journal of Agricultural Economics*, vol. 81, no. 3, pp. 361-383.

O'Donnell, C.J. 1999, 'Marketing margins and market power in the Australian dairy processing and retailing sectors', paper presented to the 43$^{rd}$ Annual Conference of the Australian and Resource Economics Society, Christchurch, January.

O'Donnell, C.J., Griffith, G.R., Nightingale, J.J. and Piggott, R.R. 2004, *Testing for Market Power in Multiple-Input, Multiple-Output Industries: The Australian Grains and Oilseeds Industries*, Technical Report for the Rural Industries Research and Development Corporation on Project UNE-79A, Economic Research Report No.16, NSW Agriculture, Armidale.

Paul, C.J.M. 1999a, 'Market power measures and their uses: where's the cost?' Paper presented at the 1999 Industry Economics Conference, Melbourne.

Paul, C.J.M. 1999b, 'Aggregation and the measurement of technological and market structure: the case of the US meat packing industry', *American Journal of Agricultural Economics*, vol. 81, no.3, pp. 624-629.

Tomek, W.G. and Robinson, K.L. 2003, *Agricultural Product Prices*, 4$^{th}$ Edition, Cornell University Press, Ithaca, NY.

Zhao, X., Griffith, G.R. and Mullen, J.D. 1998, *The Competitive Structure of the Australian Beef Industry: Accounting for Trade*, Working Papers in Econometrics and Applied Statistics, No. 101, Department of Econometrics, University of New England, Armidale.

# Appendix 1. Variable Definitions

|  | DEFINITION |
|---|---|
| **WAGE** | Wage rate index in Australia |
| **ELECT** | Electricity cost index in Australia |
| **INT** | Interest rate in Australia, 90 days bank bills |
| **COSTIND** | Marketing cost index = (0.75*WAGE) + (0.1*ELECT) + (0.15*INT) |
| **TIME** | Trend variable |
| **BF** | Beef |
| **LB** | Lamb |
| **PK** | Pork |
| **CK** | Chicken |
| **FCPI** | Consumer price index for food in Australia |
| **PRBF** | Retail prices for beef in Australia |
| **PFBF** | Saleyard prices for beef in Australia |
| **PRLB** | Retail prices for lamb in Australia |
| **PFLB** | Saleyard prices for lamb in Australia |
| **PRPK** | Retail prices for pork in Australia |
| **PFPK** | Saleyard prices for pork in Australia |
| **PRCK** | Retail prices for chicken in Australia |
| **PFCK** | Farm gate prices for chicken in Australia |
| **MMBF** | Nominal marketing margin for beef = (PRBF-PFBF) |
| **MMLB** | Nominal marketing margin for lamb = (PRLB-PFLB) |
| **MMPK** | Nominal marketing margin for pork = (PRPK-PFPK) |
| **MMCK** | Nominal marketing margin for chicken = (PRCK-PFCK) |
| **MMBFR** | Real marketing margin for beef = (MMBF/FCPI) |
| **MMLBR** | Real marketing margin for lamb = (MMLB/FCPI) |
| **MMPKR** | Real marketing margin for pork = (MMPK/FCPI) |
| **MMCKR** | Real marketing margin for beef = (MMCK/FCPI) |
| **DMBF** | Total domestic demand for beef in Australia |
| **DMLB** | Total domestic demand for lamb in Australia |
| **DMPK** | Total domestic demand for pork in Australia |
| **DMCK** | Total domestic demand for chicken in Australia |
| **DMBFI** | DMBF/PFBF |
| **DMLBI** | DMLB/PFLB |
| **DMPKI** | DMPK/PFPK |
| **DMCKI** | DMCK/PFCK |

**Appendix 2. Summary Statistics of the Main Variables, 1978-2007**

| Main Variables | | Mean | Standard Deviation | Minimum | Maximum | Coefficient of Variation |
|---|---|---|---|---|---|---|
| Marketing Service Cost | WAGE | 51.23 | 34.96 | 6.11 | 125.59 | 0.68 |
| | ELECT | 75.66 | 33.92 | 21.93 | 113.95 | 0.45 |
| | INT | 204.22 | 85.20 | 102.17 | 354.35 | 0.42 |
| | COSTIND | 76.62 | 25.17 | 25.45 | 123.77 | 0.33 |
| Beef | PRBF | 750.48 | 388.73 | 181.18 | 1506.40 | 0.52 |
| | PFBF | 165.75 | 80.41 | 30.40 | 320.70 | 0.49 |
| | MMBF | 584.73 | 312.14 | 121.48 | 1185.70 | 0.53 |
| | MMBFR | 719.78 | 54.36 | 621.52 | 860.21 | 0.08 |
| Lamb | PRLB | 515.53 | 294.80 | 103.71 | 1189.00 | 0.57 |
| | PFLB | 150.54 | 91.77 | 35.93 | 387.00 | 0.61 |
| | MMLB | 364.99 | 207.62 | 66.69 | 847.80 | 0.57 |
| | MMLBR | 443.18 | 43.37 | 358.85 | 558.87 | 0.10 |
| Pork | PRPK | 581.56 | 285.16 | 129.78 | 1140.49 | 0.49 |
| | PFPK | 175.85 | 60.35 | 57.90 | 276.20 | 0.34 |
| | MMPK | 405.72 | 229.45 | 71.36 | 906.99 | 0.57 |
| | MMPKR | 487.63 | 47.01 | 387.15 | 597.89 | 0.10 |
| Chicken | PRCK | 301.09 | 59.22 | 179.81 | 394.30 | 0.20 |
| | PFCKC | 157.73 | 27.62 | 90.77 | 190.22 | 0.18 |
| | MMCK | 143.36 | 37.58 | 89.05 | 224.33 | 0.26 |
| | MMCKR | 159.38 | 36.16 | 108.26 | 240.66 | 0.23 |
| Other | TIME | 18.00 | 10.25 | 1.00 | 35.00 | 0.57 |

---

[1] This paper is an updated version of Chung's Bachelor of Agribusiness (Honours) dissertation submitted to the University of New England and supervised by Griffith. The authors thank an anonymous referee for constructive comments on an earlier draft.

[2] These marketing margins are calculated as the weighted average retail price for a small number of cuts of meat, minus the farmgate price of the appropriate livestock type on a carcase weight basis. They are not properly constructed price spreads as described for example in Griffith, Green and Duff (1991).