

Oligopoly Behaviour, Pricing and Imports in Australian Consumer Non-durable Goods Manufacturing

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Abstract

Oligopoly behaviour by domestic firms faced with foreign competition in a small open economy is examined in the context of a market for differentiated products. Market power is measured using conjectural variations, distinguishing two models of oligopoly based alternatively on Cournot and Bertrand behaviour. This leads to the econometric specification of price-cost margin, import share and budget share equations consistent with an oligopoly equilibrium that encompasses both models. The resulting regression model is applied to quarterly data covering the period from 1984 to 2000 for each of the two-digit Australian manufacturing industries producing primarily consumer non-durable goods.

1. Introduction

Over the past three decades, the theory of international trade has been revolutionized as the traditional assumption of universal perfect competition has been replaced by imperfect competition, at least in product markets (see Helpmann and Krugman, 1985; Krugman, 1994). Yet, empirical studies of trade flows still explicitly or implicitly assume perfect competition in product markets. We address this disjuncture using an econometric specification of import flows into a small open economy that explicitly incorporates imperfect competition by domestic producers of import-competing products. This specification leads to a system of equations including a price-cost margin equation, a domestic producer-share equation and an industry budget-share equation. We then apply the econometric specification to estimate the demand for imports of consumer non-durable goods into Australia, along with the pricing behaviour of domestic producers.

We develop our approach from the large body of econometric models of pricing by domestic producers faced with import competition (see Caves 1989). Particularly relevant are models of pricing in small open economies that treat import prices as exogenously determined, but where domestic products are imperfect substitutes for imports and where domestic producers are modelled as a non-cooperative oligopoly. In this literature, there are a number of studies that assume domestic producers have conjectures about the quantity reactions of rivals (Cournot conjectures), such as Lyons (1981) and Stålhammer (1991). Other studies assume that domestic producers have conjectures about the price reactions of rivals (Bertrand conjectures), such as Bloch (1992), Allen (1998) and Olive (2002). We use an econometric specification that encompasses both Cournot and Bertrand conjectures.

We follow Kohli (1982 and 1983), and many subsequent studies of demand for imports as intermediate products, by using an econometric specification derived from assuming maximizing behaviour by both consumers and producers. However, we focus on differentiated finished goods and use a CES utility function with composite goods and nested preferences. The utility function is of the form introduced by Spence (1976) and Dixit and Stiglitz (1977). We employ the simplest possible assumption regarding production technology by treating domestic producer as facing constant marginal costs.

Our assumptions are quite restrictive, but nonetheless the results illustrate the potential gains from empirical work employing econometric specifications with a coherent theoretical basis.

Our econometric specification for each industry contains three equations, a price-cost margin equation for domestic producers, an equation for the domestic producer share of industry sales and an equation for sales of the industry product as a share of total sales for domestic manufacturing. Estimation over the three equations is carried out alternatively using seemingly unrelated regression (SUR) and three-stage least squares (3SLS), with the latter method allowing for the possibility of endogenous explanatory variables. Estimation is carried out with quarterly data covering the period from 1986 to 2000 for the three manufacturing industries at the two-digit level in the Australian New Zealand Industrial Classification (ANZIC) system that produce primarily consumer non-durable goods. These are ‘Food, Beverages and Tobacco’, ‘Textiles, Clothing, Footwear and Leather’ and ‘Printing, Publishing and Recorded Media’.

Section 2 below presents our model of consumer and producer behaviour. Section 3 outlines the econometric specification, while Section 4 describes the data and Section 5 contains the estimation results. We conclude with some comments on the findings and on the implications of our approach for further research on estimating pricing and trade flows under conditions of imperfect competition.

2. Modelling Consumer and Producer Behaviour

2.1 Consumers

The consumer demand function is derived from a CES (constant elasticity of substitution) utility function, with consumers assumed to have nested preferences over composite goods. The convexity of indifference surfaces of a conventional utility function defined over the quantities of all potential commodities embodies the desirability of variety in the choice of differentiated goods.¹

At the top level, consumer demand is derived from a general type of CES utility function over m composite consumption goods:

¹ See Spence (1976) and Dixit and Stiglitz (1977).

$$c = \left[\sum_{i=1}^m \alpha_i \frac{1}{\sigma} c_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} \quad (1)$$

In (1), α_i is the weight of consumption good i consumed, which over all i add up to unity. σ is the substitution elasticity between the m consumption goods.

Using an ‘‘Armington’’-type assumption, the second level of the nesting assumes that the composite good c_i can be sourced locally ($c_{d,i}$) or from the rest of the world ($c_{f,i}$):

$$c_i \equiv \left[\beta_i \frac{1}{\sigma_{df,i}} c_{d,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} + (1 - \beta_i) \frac{1}{\sigma_{df,i}} c_{f,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} \right]^{\frac{\sigma_{df,i}}{\sigma_{df,i}-1}} \quad (2)$$

In (2) β_i gives the weight of domestic goods in determining the ‘quantity’ of composite good, where $0 \leq \beta_i \leq 1$. At the two extreme points, $\beta_i = 0$ specifies that good i is a pure import good, while $\beta_i = 1$ specifies good i is only sourced domestically. In the intermediate case, where $0 < \beta_i < 1$, good i is both imported and domestically produced. The elasticity of substitution between domestically produced and imported composite goods is denoted by $\sigma_{df,i}$.

Finally, at the third level of the nesting, the composite domestic and foreign goods consist of all existing varieties of domestic and foreign goods, respectively, as follows:

$$c_{d,i} \equiv \left[\sum_{j=1}^{n_{d,i}} \gamma_{d,ij} \frac{1}{\sigma_{d,i}} c_{d,ij}^{\frac{\sigma_{d,i}-1}{\sigma_{d,i}}} \right]^{\frac{\sigma_{d,i}}{\sigma_{d,i}-1}} \quad (3)$$

$$c_{f,i} \equiv \left[\sum_{k=1}^{n_{f,i}} \gamma_{f,ik} \frac{1}{\sigma_{f,i}} c_{f,ik}^{\frac{\sigma_{f,i}-1}{\sigma_{f,i}}} \right]^{\frac{\sigma_{f,i}}{\sigma_{f,i}-1}} \quad (4)$$

In (3), $c_{d,ij}$ is domestically produced variety j of good i , $c_{f,ik}$ is imported variety k of good i . $\sigma_{d,i}$ is the substitution elasticity among domestically produced varieties of good i . $\sigma_{f,i}$ is its foreign counterpart. For a particular variety to be consumed, we have, $\gamma_{d,ij} > 0$ and $\gamma_{f,ik} > 0$, for domestic and foreign varieties, respectively.

The consumer demand function derived for domestic firm j in industry i is expressed as follows:

$$c_{d,ij} = \gamma_{d,ij} \left(\frac{p_{d,ij}}{p_{d,i}} \right)^{-\sigma_{d,i}} \beta_i \left(\frac{p_{d,i}}{p_i} \right)^{-\sigma_{df,i}} \alpha_i \left(\frac{p_i}{p} \right)^{-\sigma} y \quad (5)$$

The parameters, $\gamma_{d,ij}$, β_i and α_i , are the weight of domestic consumption variety ij in the domestic composite good, the weight of all domestic varieties in the composite good of industry i , and the weight of industry i in total utility, respectively. $p_{d,ij}$ is the “own” price charged by firm ij , $p_{d,i}$ is a price index of prices charged by all domestic producers of i , p_i is a price index incorporating all domestic and all foreign producers of i , and p is the overall price index generating real income y .

2.2 Producers

We assume, for tractability, the simplest possible cost conditions, namely constant short-run marginal cost. The marginal cost of the domestic producer j is given by a linear combination of wage and material unit cost as follows:

$$MC_{d,ij} = (a_{d,ijl} W_{d,i} + a_{d,ijm} P_{d,i}^M) \quad (6)$$

In (6), W and P^M are the nominal wage rate and the price of materials, respectively, while $a_{d,ijl}$ and $a_{d,ijm}$ give the unit labour and materials requirements, respectively. Marginal cost in (6) is linear homogenous in output and additive in input prices weighted by the physical productivity of each input, which makes its calculation from manufacturing census data straightforward.²

The analysis centres on two cases. In the first case, the reaction is assumed to be in the form of output reactions, which includes the polar case of Cournot conjectures. In the second case, other firms are assumed to react in terms of a price response, which includes the polar case of Bertrand conjectures.

Domestic firms maximize profits, where the operating profit of firm ij is defined as follows:

$$\pi_{ij} \equiv p_{d,ij} c_{d,ij} - \left[(a_{d,il} W_{d,i} + a_{d,im} P_{d,i}^M) c_{d,ij} \right] \quad (7)$$

The following relation between price and marginal cost then gives first-order condition for maximum profits with respect to output for firm ij :

$$P_{d,ij} \left[1 + \frac{1}{\varepsilon_{ij}} \right] = MC_{ij} \quad (8)$$

In (8), ε_{ij} is the perceived elasticity of demand facing firm ij , and MC_{ij} is short-run marginal cost.³ Firm ij 's perceived elasticity, ε_{ij} , incorporates its expectations regarding the response of rivals to changes in its own price or quantity. The influence of production costs on the domestic price in (8) is direct, while the influence of other factors, including the influence of domestic and foreign competition, occurs implicitly through the perceived price elasticity of demand.

Since the emphasis of this paper is empirical, we use the conjectural variation approach to model the reactions of competitors. The use of conjectural variations parameters allows a straightforward meaning to the degree of competition in an industry and also allows different models to be analysed within the same unifying framework (Dixit, 1986, p. 107). Bloch and Heijdra (1994) show that the perceived price elasticity under Cournot conjectures, ε_{ij} (CCE), and Bertrand conjectures, ε_{ij} (BCE), are given by:

² A particular production function that yields a short-run marginal cost function in the form of (6) is the Leontief, or fixed coefficients, functional form (see Chong 2002, 43-44).

³ We assume that the firm has no storage opportunity, so production always equals demand. Given this assumption in deriving the pricing behaviour for firms, we apply the resulting econometric specification to only non-durable goods and exclude consideration of durable goods industries.

$$\frac{1}{\varepsilon_{ij}(CCE)} = -\frac{1}{\sigma_{d,i}} + \left[\frac{1}{\sigma_{d,i}} - (1 - S_{d,i}) \frac{1}{\sigma_{df,i}} - (1 - S_i) S_{d,i} \frac{1}{\sigma} \right] \times [S_{d,ij} + \xi_i (1 - S_{d,ij})] \quad (9)$$

$$\varepsilon_{ij}(BCE) = -\sigma_{d,i} + \{ \sigma_{d,i} - (1 - S_{d,i}) \sigma_{df,i} - (1 - S_i) S_{d,i} \sigma \} \times [S_{d,ij} + \theta_i (1 - S_{d,ij})] \quad (10)$$

In (9) and (10), $S_{d,ij}$ is the revenue share of domestic firm ij in total revenue of industry i , $S_{d,i}$ is the revenue share of domestically produced composite good i in total spending on good i , and S_i is the budget share of composite good i in total spending. In (9), ξ_i is the conjectural quantity-reaction elasticity, while in (10), θ_i is the conjectural price-reaction elasticity, where:⁴

$$\theta_i = \frac{\delta \ln p_{d,ik}}{\delta \ln p_{d,ij}} \quad \xi_i = \frac{\delta \ln c_{d,ik}}{\delta \ln c_{d,ij}} \quad j \neq k \quad 0 \leq \theta_i, \xi_i \leq 1 \quad (11)$$

3. Econometric Specifications

This paper concentrates on the empirical analysis over time of domestic producer pricing and the share of imports. Industry structure and the conjectural elasticities are assumed to be constant. Further, symmetric equilibrium is adopted for simplicity. This symmetry assumption implies that each firm in an industry faces the same elasticity of demand for its product and the same short-run marginal cost (MC).

Following Cowling and Waterson (1976), under the assumption of symmetry, the identical price-cost margin to achieve a profit maximum for each firm j in industry i (denoted by PCM_i) is:

$$PCM_i \equiv \frac{\bar{p}_{d,i} - MC_i}{\bar{p}_{d,i}} = -\frac{1}{\varepsilon_{ij}} \quad (12)$$

⁴ This paper invokes the semi-small country assumption, which in the present context means that the conjectural reaction coefficients of foreign competitors are assumed to be zero. Domestic producers react to domestic and foreign rivals, but foreign producers only react to foreign rivals. From an econometric perspective this effectively makes the foreign prices exogenous.

Substituting from the expression in (9) for the unobservable elasticity value in (12) gives an econometric specification for the price-cost margin in terms of the observable shares for the case of Cournot conjectural variations as follows:

$$PCM_i = \omega_{0,i} + \omega_{1,i}S_i + \omega_{2,i}S_i * S_{d,i} \quad (13)$$

For Bertrand case, price-cost margin is a non-linear function of the shares given by:⁵

$$\frac{1}{PCM_i} = -\varepsilon_{ij}(BCE) = \sigma_{d,i} - [\sigma_{d,i} - (1 - S_{d,i})\sigma_{df,i} - (1 - S_i)S_{d,i}\sigma] \theta_i^* \quad (14)$$

In order to compare with Cournot case, LHS of (14) is linearized around a point, PCM_i^* , which yields:

$$PCM_i = \delta_{0,i} + \delta_{1,i}S_i + \delta_{2,i}S_i * S_{d,i} \quad (15)$$

Each oligopoly model leads to the prediction that the coefficient of the domestic producer share of industry output, S_i , is positive, provided that the elasticity of substitution between domestic and foreign varieties exceeds the corresponding elasticity between the industry's product and those of other industries (see the Appendix for details). However, the two cases of conjectural variations can be distinguished empirically by the sign of the relationship between the price-cost margin and the variable for the product of budget share for the industry, S_i , and the domestic producer share of the industry, $S_{d,i}$. In the Cournot case this relationship is predicted to be negative, while in the Bertrand case it is predicted to be positive.⁶

⁵ Details of this derivation and those below are given in the Appendix.

⁶ An increase in the elasticity of substitution between consumption goods, σ , lowers the price-cost margin under both Cournot and Bertrand competition. However, in the Cournot case this relationship involves having the price-cost margin negatively related to the inverse of the elasticity, while in the Bertrand case the relationship is positive.

The domestic producer share of industry i as derived from the demand function in (5) is written as a function of the ratio of foreign price to domestic price, $\frac{P_{f,i}}{P_{d,i}}$:

$$S_{d,i} = \frac{1}{1 + \left(\frac{1 - \beta_i}{\beta_i} \right) \left(\frac{P_{f,i}}{P_{d,i}} \right)^{(1 - \sigma_{df,i})}} \quad (16)$$

Likewise, the budget share for the industry in terms of the ratio of domestic producer price index for industry i to the general price index, $\frac{P_{d,i}}{P}$, is given by:

$$S_i = \alpha_i \left(\frac{P_{d,i}}{P} \right)^{(1 - \sigma)} \quad (17)$$

4. Data and Estimation Strategy

The model set out above is applied to quarterly data over 1984 (first quarter) to 2000 (first quarter) covering manufacturing industries at the two-digit classification level in the Australia and New Zealand Standard Industrial Classification (ANZSIC). Only industries producing primarily consumer non-durable goods are included in the estimation, as the demand model outlined above is based on consumer decision making for currently consumed goods. The included industries are ‘Food, Beverage and Tobacco’ (Industry 21), ‘Textile, Clothing, Footwear and Leather (Industry 22) and ‘Printing, Publishing and Recorded Music’ (Industry 24).

For simplicity in reporting results without excessive subscripts, the domestic producer share is denoted, PRS, the budget share of the industry is denoted, IRS, and the product of these of shares is denoted, PDT. Further, the ratio of foreign to domestic industry price is denoted, PFPD, and the ratio of the domestic industry price to the general price index is denoted, PDP. Measures for the price-cost margin (PCM), domestic producer share of industry sales, PRS, the industry share of total expenditure, IRS, and the relative price measures, PFPD and PDP, are constructed using data from the

Australian Bureau of Statistics (ABS). The particular publication sources and methods are described in the Data Appendix.

As is now standard in studies using time-series data, the time series are each tested for the existence of a unit root. The results are presented in Table 1. The t-statistic of the last included lag is presented under the value of the DF or ADF statistic. Also shown is the value of the Lagrange multiplier (LM) test for auto-correlation and the lag length for the DF or ADF test. The criterion for selecting lag length is “testing down” from 5 lags. By dropping one lag, a F-statistic is calculated for the exclusion of the lag and the existence of autocorrelation associated with each lag is also taken into consideration. The “D” notation in front of the variables indicates that the first difference of the variable is being used.

Table 1: Unit Root Tests for Price-Cost Margin

Variables	Food, Beverage and Tobacco (Industry 21)		Textile, Clothing, Footwear and Leather (Industry 22)		Printing, Publishing and Recorded Media (Industry 24)	
	DF/ADF	LM test for Auto-correlation AR [1-4]	DF/ADF	LM test for Auto-correlation AR [1-4]	DF/ADF	LM test for Auto-correlation AR [1-4]
PCM	-1.7266 [1.897]	0.7183 [lag4]	-0.46792 [2.638]	0.9139 [lag4]	-1.9299 [-1.930]	0.8809 [lag0]
DPCM	-3.4763* [-1.849]	0.6705 [lag3]	-3.1756** [-3.031]	0.8347 [lag3]	-8.5319** [-8.532]	0.7997 [lag0]
PRS	-1.7536 [-1.957]	0.0256* [lag1]	-3.1493 [2.699]	0.0457* [lag4]	-1.7702 [-3.453]	0.0438* [lag3]
DPRS	-10.034** [-10.034]	0.4812 [lag0]	-4.5017** [1.888]	0.0273* [lag4]	-9.2174** [4.528]	0.0113* [lag2]
IRS	-2.3463 [4.436]	0.1285 [lag4]	-3.0147 [2.194]	0.5280 [lag4]	-2.1546 [-1.932]	0.1164 [lag3]
DIRS	-3.2593* [-3.559]	0.2267 [lag3]	-22.545** [-22.545]	0.2973 [lag0]	-4.7024** [1.957]	0.1923 [lag5]
PDT	-2.2850 [4.199]	0.1549 [lag4]	-3.7746* [-3.775]	0.6845 [lag0]	-2.1319 [-2.157]	0.3061 [lag3]
DPDT	-3.2355* [-.305]	0.3119 [lag3]	-6.5804** [1.703]	0.0734 [lag1]	-7.5125** [3.234]	0.8420 [lag2]
PFPD	-2.3909 [3.116]	0.2216 [lag1]	-3.4547 [3.699]	0.3376 [lag5]	-2.0715 [-2.072]	0.6564 [lag0]
DPFPD	-5.1546** [-5.155]	0.6542 [lag0]	-5.6655** [-5.666]	0.9848 [lag0]	-7.1069** [-7.107]	0.9756 [lag0]
PDP	-2.1800 [-2.180]	0.5031 [lag0]	-1.8820 [-3.597]	0.2272 [lag0]	-1.8862 [2.394]	0.2808 [lag1]
DPDP	-8.1971** [-8.197]	0.2865 [lag0]	-6.2733** [-6.273]	0.0125* [lag0]	-5.1330** [-5.133]	0.6761 [lag0]

* Indicates statistical significance at the 5 percent level test

** Indicates statistical significance at the 1 percent level test

The DF and ADF statistics reported in Table 1 show that the hypothesis of a unit root cannot be rejected for any of the original data series, with the exception of the PDT series for ‘Textile, Clothing, Footwear and Leather’, for which a unit root is rejected at the five percent significance level. In contrast, testing the first difference of each series leads to rejection of the hypothesis of a unit root at either the five percent level or the one percent level. This indicates that the series generally are I(1) variables, since the data in levels exhibit non-stationarity while the first differences are stationary.⁷ Hence, the estimation in the next section is based on differenced data to avoid spurious relationships.

5. Results

The full model that is estimated below consists of an equation for the domestic producer share of industry sales (domestic share), as in (16), an equation for the industry share of consumer expenditures (budget share), as in (17), and an encompassing PCM equation, which is in the form of both (13) and (15). Seasonal dummy variables and a time trend are initially added to each equation. The PCM equation is linear in (13) and (15) and is estimated in that form. However, the share equations are non-linear in (16) and (17), so they are transformed to yield linear relationships. In particular, the budget-share equation is transformed by taking logarithms of both sides, which yields a linear equation between the logarithm of the budget share, denoted by LIRS, and the logarithm of the ratio of the domestic producer price index to the general price index, denoted by LPDP. A more complex transformation of the domestic share equation is required, which is set out in the Appendix and results in a linear equation between the transformed domestic producer share variable, denoted by S, and the transformed ratio of domestic producer price to import price, denoted by RP.

Up to five lags are included for each independent variable together with the seasonal dummies. The data are used in first differences as discussed above, which is denoted by a D in place of each variable name. Thus, the constant term provides an estimate of the time trend in the relationships. After transformation to linear equations for

⁷ Since price-cost margin is bounded between zero and one, a non-stationarity property is not sensible from a theoretical standpoint. However, given the small sample period of 63 quarters, the ADF test is weak.

(16) and (17) as well as adding lags and seasonal dummies, the system of equations to be estimated becomes:

$$DPCM_i = a_0 + a_1 DPRS_i + a_{2,t-j} \sum_{j=1}^5 DPRS_{i,t-j} + a_3 DPDT_i + a_{4,t-j} \sum_{j=1}^5 DPDT_{i,t-j} + a_5 S1 + a_6 S2 + a_7 S3 \quad (18)$$

$$DS_i = a_0 + a_1 DRP_i + a_{2,t-j} \sum_{j=1}^5 DRP_{i,t-j} + a_5 S1 + a_6 S2 + a_7 S3 \quad (19)$$

$$DLIRS_i = a_0 + a_1 DLPDP_i + a_{2,t-j} \sum_{j=1}^5 DLPDP_{i,t-j} + a_5 S1 + a_6 S2 + a_7 S3 \quad (20)$$

Equations (19) and (20) provide estimates for transformed share variables, which appear in their original form in the price-cost margin equation. Further, the domestic producer price varies with the price-cost margin when the level of unit direct cost is given. As a result, the price-cost margin affects the share equations indirectly. Thus, the price-cost margin equation and the two share equations constitute a potentially interdependent system for estimation purposes. Estimation is carried out using alternatively seemingly unrelated regression (SUR) and three-stage least squares (3SLS) regression. In each case, insignificant lags and seasonal dummies are dropped.

Table 2 presents the results from estimating equations (18) to (20) for Food, Beverage and Tobacco Manufacturing (Industry 21). The F-statistic with SUR estimation for each equation is statistically significant at the one percent level, suggesting a fair degree of explanatory power. There is no corresponding test for the 3SLS estimates, but the standard errors of estimate are comparable to those from SUR estimation. The DW statistic suggests no evidence of autocorrelation in the residuals. Finally, the share and price variables in the various equations generally have coefficients that are individually statistically significant.

Table 2: SUR and 3SLS Estimates for Food, Beverage and Tobacco Manufacturing (Industry 21)

$$DPCM\ 21 = a_0 + a_1 DPRS\ 21 + a_{2,t-j} \sum_{j=1}^5 DPRS\ 21_{t-j} + a_3 DPDT\ 21 + a_{4,t-j} \sum_{j=1}^5 DPDT\ 21_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS\ 21 = a_0 + a_1 DRP\ 21 + a_{2,t-j} \sum_{j=1}^5 DRP\ 21_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS\ 21 = a_0 + a_1 DLPDP\ 21 + a_{2,t-j} \sum_{j=1}^5 DLPDP\ 21_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

Coefficient	Seemingly Unrelated Regression			Three-Stage Least Squares		
	DPCM21	DS21	DLIRS21	DPCM21	DS21	DLIRS21
a_0	-0.0004188 [-0.20815]	0.0098267 [1.0506]	0.075901 [10.2702***]	-0.00003388 [-0.01672]	0.0099576 [1.090]	0.076552 [10.21***]
a_1	-0.1166 [-0.32341]	0.67483 [1.8673*]	-0.57995 [-1.3399]	0.52209 [0.7901]	0.73914 [1.708*]	-0.65637 [-0.5411]
$a_{2,t-j}$		1.0299 [lag 4] [2.9195***]	-1.8438 [lag 1] [-4.3790***] -1.7225 [lag 5] [-3.7000***]		0.99675 [lag 4] [2.707***]	-1.8824 [lag 1] [-4.382***] -1.8198 [lag 5] [-2.757***]
a_3	0.45464 [1.9685*]			0.59549 [2.328**]		
a_5			-0.10343 [-10.7570***]			-0.10450 [-10.74***]
a_6			-0.12490 [-12.7553***]			-0.12428 [-12.70***]
a_7			-0.054404 [-5.5667***]			-0.055502 [-5.653***]
F-Statistic	3.1606**	3.9946**	23.8562***			
DW-Statistic	2.1424	2.4853	1.8927			
S.E. of Regression	0.015122	0.070103	0.031430	0.015040	0.068205	0.029279

Note: 57 observations used for estimation from 1986Q1 to 2000Q1
t-ratios are in parentheses.

* Indicates statistical significance at the 10 percent level of test statistic.

** Indicates statistical significance at the 5 percent level of test statistic.

*** Indicates statistical significance at the 1 percent level of test statistic.

The implications of the results for the elasticity of substitution and price elasticity of import and domestic demand for Industry 21 are discussed below together with those for the other industries. Here we focus on the specific results relating to firm behaviour. First, it should be noted that there is evidence against perfectly competitive behaviour in the industry. The price-cost margin is dependent on market shares only under imperfect competition. For Industry 21, the price-cost margin regression results indicate a statistically significant relationship between the margin and the multiplicative share variable, DPDT, but no consistent sign or statistical significance for the coefficients of

the domestic producer share variable. A positive coefficient for DPDT, as found in both the SUR and 3SLS results is expected in the case of a Bertrand-type oligopoly with price conjectures. In the SUR estimates the coefficient of DPDT is positive and is statistically significant at the 10 percent level. In the 3SLS estimates, DPDT also has a positive relationship with PCM, and it is statistically significant at the 5 percent level. With this congruence, the results for Food, Beverage and Tobacco Manufacturing suggest that there is firm behaviour based on oligopoly with price conjectures.

Table 3 presents the results from estimating equations (18) to (20) for Textile, Clothing, Footwear and Leather Manufacturing (Industry 22). The F-statistic with SUR estimation for each equation is statistically significant at the one percent level, suggesting a fair degree of explanatory power as with Industry 21. For the 3SLS estimates, the standard errors of estimate are comparable to those from SUR estimation, except for a substantially higher standard error in the PCM equation. The DW statistic suggests no evidence of autocorrelation in the residuals of the PCM equation, but some evidence for the two share equations. Also, worrying for interpretation of the share equations is that none of the relative price variables have coefficients that are statistically significant, with only the constant (representing the time trend) and the seasonal dummies having statistically significant coefficients in either the SUR or 3SLS estimates. Thus, there are several reasons for treating the results from this industry with extreme caution.

With regard to indication of firm behaviour, both the SUR and 3SLS results suggest a deviation from perfectly competition, as there are statistically significant coefficients for share variables in both cases. However, the results are not supportive of either Cournot-type or Bertrand-type behaviour. The coefficients of the domestic share variable in both the SUR and 3SLS results are negative and statistically significant at the one percent level, contrary to the expectation of a positive sign. Further the sign of the DPDT variable differs between SUR and 3SLS. The SUR estimate of the coefficient of PDT is positive and statistically significant at the one percent level, suggesting that firms behave with price conjectures as in Industry 21. However, the corresponding estimate from 3SLS, which allows for the possible endogeneity of the share variables, is negative and also significant at the one percent level, suggesting firms behave with quantity conjectures. In view of the statistical problems with the estimates that are noted above, it

seems best to conclude that the model does not produce reliable results for Textiles, Clothing, Footwear and Leather Manufacturing.

Table 3: SUR and 3SLS Estimates for Textile, Clothing, Footwear and Leather Manufacturing (Industry 22)

$$DPCM22 = a_0 + a_1 DPRS22 + a_{2,t-j} \sum_{j=1}^5 DPRS22_{t-j} + a_3 DPDT22 + a_{4,t-j} \sum_{j=1}^5 DPDT22_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS22 = a_0 + a_1 DRP22 + a_{2,t-j} \sum_{j=1}^5 DRP22_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS22 = a_0 + a_1 DLPDP22 + a_{2,t-j} \sum_{j=1}^5 DLPDP22_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

Coefficient	Seemingly Unrelated Regression			Three-Stage Least Squares		
	DPCM22	DS22	DLIRS22	DPCM22	DS22	DLIRS22
a_0	-0.011360 [-3.1855***]	-0.083050 [-2.9522***]	-0.092895 [-10.4078***]	-0.069990 [-3.418***]	-0.083100 [-3.033***]	-0.091764 [-10.29***]
a_1	-0.51126 [-6.3108***]	0.30869 [0.5789]	0.52314 [0.67196]	-2.0260 [-6.558***]	-0.023667 [-0.07632]	1.7296 [0.7681]
$a_{2,t-j}$						
a_3	2.7556 [2.8673***]			-36.007 [-5.192***]		
a_5		0.28821 [7.1564***]	0.17352 [11.4163***]		0.27297 [7.610***]	0.17344 [11.46***]
a_6	0.043889 [5.2210***]	-0.12016 [-3.1464***]		0.16635 [6.387***]	-0.12676 [-3.361***]	
a_7		0.24079 [5.9156***]	0.16542 [10.7129***]		0.25770 [7.371***]	0.16093 [11.29***]
F-Statistic	12.5834***	33.6811***	61.8254***			
DW-Statistic	1.9845	2.4195	2.4678			
S.E. of Regression	0.020469	0.11005	0.047196	0.13848	0.10563	0.046605

Note: 57 observations used for estimation from 1986Q1 to 2000Q1
t-ratios are in parentheses.

* Indicates statistical significance at the 10 percent level of test statistic.

** Indicates statistical significance at the 5 percent level of test statistic.

*** Indicates statistical significance at the 1 percent level of test statistic.

Table 4 presents the results from estimating equations (18) to (20) for Printing, Publishing and Recorded Media (Industry 24). The F-statistic with SUR estimation for each equation is only statistically significant at the one percent level for the industry share equation, suggesting that the full model does not fit well in Industry 24.⁸ The DW

⁸ The SHAZAM regression program does not provide an F-statistic value for the PCM equation, which suggests that this value is implausible (eg negative), as is possible when systems of equations are estimated with maximum likelihood methods.

statistic for the producer share equation provides evidence of autocorrelation, but there is no such evidence for the PCM and the industry share equations. Also, worrying for interpretation of the producer share equation is that none of the relative price variables have coefficients that are statistically significant. In the industry share equation there are significant coefficients on relative price variables, but the sign of the current relative price changes between the SUR and 3SLS estimates. Thus, as with Industry 22, there are several reasons for treating the results from this industry with extreme caution.

Table 4: SUR and 3SLS Estimates for Printing, Publishing and Recorded Media (Industry 24)

$$DPCM24 = a_0 + a_1DPRS24 + a_{2,t-j} \sum_{j=1}^5 DPRS24_{t-j} + a_3DPDT24 + a_{4,t-j} \sum_{j=1}^5 DPDT24_{t-j} + a_5S1 + a_6S2 + a_7S3$$

$$DS24 = a_0 + a_1DRP24 + a_{2,t-j} \sum_{j=1}^5 DRP24_{t-j} + a_5S1 + a_6S2 + a_7S3$$

$$DLIRS24 = a_0 + a_1DLPDP24 + a_{2,t-j} \sum_{j=1}^5 DLPDP24_{t-j} + a_5S1 + a_6S2 + a_7S3$$

Coefficient	Seemingly Unrelated Regression			Three-Stage Least Squares		
	DPCM24	DS24	DLIRS24	DPCM24	DS24	DLIRS24
a_0	0.016673 [2.6975***]	-0.043708 [-1.9431*]	0.028624 [3.7578***]	0.022166 [2.813***]	-0.040351 [-1.843*]	0.013109 [0.9926]
a_1	-0.93547 [-4.7905***]	-0.29410 [-0.68494]	-0.77215 [-1.9235*]	-2.2252 [-2.284***]	0.037288 [0.08081]	2.3256 [1.041]
$a_{2,t-j}$			0.81453 [lag 3] [1.9986*]			1.2512 [lag 3] [2.240**]
a_3	-5.2472 [-3.1612***]			-1.0361 [-0.1844]		
a_5	-0.036785 [-3.2958***]	0.066899 [1.7432*]	-0.065484 [-5.1162***]	-0.041409 [-3.423***]	0.061102 [1.643]	-0.058907 [-4.263***]
a_6			-0.033717 [-3.0886***]			-0.034797 [-2.569***]
a_7	-0.023212 [-2.4964**]	0.082687 [2.1691**]		-0.039493 [-2.730***]	0.077256 [2.072**]	
F-Statistic	None	1.9896	7.4014***			
DW-Statistic	2.1406	2.8083	1.9855			
S.E. of Regression	0.033643	0.11825	0.040727	0.042886	0.11449	0.048106

Note: 57 observations used for estimation from 1986Q1 to 2000Q1

t-ratios are in parentheses.

* Indicates statistical significance at the 10 percent level of test statistic.

** Indicates statistical significance at the 5 percent level of test statistic.

*** Indicates statistical significance at the 1 percent level of test statistic.

With regard to indication of firm behaviour, both the SUR and 3SLS results again suggest a deviation from perfect competition, as there are statistically significant coefficients for share variables in both cases. As in Industry 22, the coefficients of the domestic producer share variable are negative and statistically significant, contradicting the prediction of both oligopoly models. The SUR estimate of the coefficient of DPDT is negative and statistically significant at the one percent level, suggesting that firms behave with quantity conjectures. However, the corresponding estimate from 3SLS, which allows for the possible endogeneity of the share variables, while negative is not statistically significant. Thus, the evidence of Cournot-type behaviour is weak at best.

An advantage of using estimating equations derived from a model of consumer and producer behaviour is that values of the underlying parameters determining behaviour can be obtained from the estimated coefficients in the regression equations. For the model used here, particular parameters of interest are the two measures of elasticity of substitution from the CES utility function. These are of interest in their own right and because they can be used to generate estimates of the price elasticity of demand and enter into calculation of estimates of the conjectural elasticity for either the Bertrand-type or Cournot-type model of oligopoly. The estimated coefficient of the DRP in the domestic producer share equation is equal to one minus $\sigma_{df,i}$, the elasticity of substitution between domestic and imported product varieties. Likewise, the estimated coefficient of DLPDP in the industry share equation is equal to one minus σ , the elasticity of substitution between the industry product and those of other manufacturing industries.

Values of the conjectural elasticities for producers can also be calculated from the regression results. Indeed, the values of the conjectural elasticity for either oligopoly model are over-identified. The most direct estimate of the conjectural elasticity is obtained from the estimated coefficient of DPDT together with the value for σ . A second estimate is obtained from the coefficient of DPRS together with values for both $\sigma_{df,i}$ and σ . The calculation differs depending on whether the oligopoly model of Cournot-type or Bertrand-type is relevant. The equation for the relationship between the coefficient of each variable, DPDT and DPRS, and the conjectural elasticity is given for each oligopoly model in the Appendix.

The calculated value of the each elasticity of substitution is shown in Table 5. A positive value suggests that products are substitutes, while a negative value suggests the products are complements. In the underlying consumer demand model, we assume that all products are substitutes, so the negative values in Table 5 suggest that the consumer demand model may not fit at least some aspects of behaviour in these industries. Further, our sign prediction for the domestic producer share variable in the equation for the price-cost margin are based on the assumption that the elasticity of substitution between domestic and foreign varieties within an industry is more positive than that between the industry's aggregate product and that of other industries. A common problem in working with data at this high level of aggregation is that substantial amounts of imports may be intermediate products, even in these consumer goods industries (for example, unprocessed foodstuffs used in further manufacturing). Strong substitutability is indicated only in Food, Beverage and Tobacco Manufacturing, with large positive estimates of σ , the elasticity of substitution between the industry's aggregate product and the products of all other industries. Even here, the ordering of the elasticities is contrary to assumptions, as the estimates for $\sigma_{df,i}$ are negative, rather than more positive than the estimates of σ .

Values of the conjectural elasticity derived from each the coefficients for both DPRS and DPDT for each estimation method, SUR and 3SLS, are also shown in Table 5. If the estimated coefficient of DPDT is positive, the values are listed as being values for the price conjectural elasticity, ξ , while if the coefficient of DPDT is negative, the values are listed as values of the quantity conjectural elasticity, θ . The usual expectation for the values of a conjectural elasticity is between zero (for either the pure Cournot model in the case of quantity conjectures or the pure Bertrand model in the case of price conjectures) and one (for the case of implicit collusion). Estimates close to falling within these bounds are found only for the Food, Beverage and Tobacco Industry, the only industry for which the regressions results pass the usual diagnostic statistical tests and yield coefficient estimates generally consistent with the restrictions of the underlying consumer and producer behaviour assumptions. Ignoring the anomalous result for the 3SLS estimation of the coefficient of DPRS, the values for this industry suggest behaviour that is close to that of implicit collusion.

Table 5: Calculated Values of the Elasticity of Substitution

Industry/ Parameters	Food, Beverage and Tobacco Manufacturing		Textile, Clothing, Footwear and Leather Manufacturing		Printing, Publishing and Recorded Media	
σ	5.15 [SUR]	5.86 [3SLS]	0.48 [SUR]	-2.23 [3SLS]	0.96 [SUR]	-0.10 [3SLS]
$\sigma_{df,i}$	-0.70 [SUR]	-0.80 [3SLS]	0.69 [SUR]	1.06 [3SLS]	1.29 [SUR]	1.08 [3SLS]
\mathcal{E} (DPDT)	na	na	na	-80.4 [3SLS]	5.02 [SUR]	-0.10 [3SLS]
θ (DPDT)	1.37 [SUR]	1.57 [3SLS]	106.1 [SUR]	na	na	na
\mathcal{E} (DPRS)	na	na	na	1.46 [3SLS]	-3.44 [SUR]	0.21 [3SLS]
θ (DPRS)	0.31 [SUR]	-1.21 [3SLS]	-43.7 [SUR]	na	na	na

The values of the elasticity of substitution from Table 5 can be used together with mean values of the variables to calculate the price elasticity of demand, specifically the price elasticity for import demand and for domestic industry demand.⁹ Table 6 lists the values of the price elasticity of import demand and domestic producer demand that are calculated from the elasticity of substitution values in Table 5. Two values of the import demand elasticity are given. When import prices change, this has a direct effect on import demand and an indirect effect through changes in domestic producer prices (through the PCM equation). The value of ε_{f1} is calculated as the direct impact of import price on imports through the domestic producer share equation along with the indirect effect on domestic producer prices in the same equation. The value of ε_{f2} includes these effects plus the impact of the change in domestic producer price in the industry share equation, so this measure is in a sense a more inclusive measure of elasticity.

⁹ See Chong (2002, 134-143) for details.

Table 6: Calculated Values of the Price Elasticity of Demand

Industry	ε_{f1}		ε_{f2}		ε_d	
	SUR	3SLS	SUR	3SLS	SUR	3SLS
Food, Beverage and Tobacco Manufacturing	-4.91	-5.63	-4.27	-4.55	-0.65	-0.77
Textile, Clothing, Footwear and Leather Manufacturing	0.17	2.54	0.20	2.15	-0.68	-0.89
Printing, Publishing and Recorded Media	0.26	0.91	0.32	1.09	-1.28	-1.02

We concentrate the discussion of the value of the estimated price elasticity in Food, Beverage and Tobacco Manufacturing (Industry 21), as the results for the other industries are noted above as being unreliable due to statistical anomalies. All of the values of the price elasticity for Industry 21 are negative, with the demand for imports shown as being very price sensitive. The elasticity of demand facing domestic producers is much less sensitive, but in the mildly inelastic range generally associated with these ‘necessity’ products. Interestingly, the price elasticity in the other industries is shown as more elastic in spite of the statistical problems with the estimates. Also, it is interesting that in each industry the alternative estimation methods have little impact on the calculated price elasticity of demand facing domestic producers, even though the elasticity of import demand is often substantially different across methods.

6. Conclusion

This paper uses a structural model to identify consumer demand and oligopoly behaviour in Australian consumer non-durable goods manufacturing. This leads to an econometric specification with an equation for the industry price-cost margin and two revenue-share equations. The econometric specification is the same for each industry, but the estimation results suggest important differences exist in the performance of the model.

Satisfactory estimates in terms of statistical properties are obtained only in Food, Beverages and Tobacco Manufacturing. The estimates from the equation for the price-

cost margin in this industry suggest that firms use price conjectures in determining their behaviour, as in the Bertrand oligopoly model. Further, the estimates show a high degree of substitution between this industry's product and those of other industries. Finally, the implied price elasticity of import demand in this industry is found to be very elastic (on the order of -5), but the demand for domestic producers is found to be inelastic (in line with estimates generally found for products of this type).

The results for Textile, Clothing, Footwear and Leather Manufacturing and Printing, Publishing and Recorded Music fail key statistical tests. Also, many coefficient estimates are inconsistent with predictions based on the underlying model of consumer and producer behaviour. It would have been surprising if consumer and producer behaviour in all industries followed the pattern set out in our highly restrictive model. Also, we work with relatively aggregated data, so a single model may not apply to all the products in an industry leading to potential misspecification of the estimating equations. This can be a particular problem when some products are delivered to either intermediate demand or investment demand.

The reasonable estimation results for Food, Beverage and Tobacco Manufacturing illustrate the potential gains from empirical work employing econometric specifications based on explicit models of consumer and producer behaviour. There is clearly much opportunity for further research. Alternative models of consumer preferences and firm behaviour would lead to alternative estimating equations. Also, work with more disaggregated data sets might provide more precise estimates. We encourage other researchers to take up the challenge.

References:

- Allen, Chris (1998), "An Empirical Model of Pricing, Market Share and Market Conduct: An Application to Import Competition in US Manufacturing", *Manchester School*, **66**, 196-221.
- Bloch, Harry (1992), "Pricing in Australian Manufacturing", *The Economic Record*, **68**, 365-376.
- Bloch, Harry and Heijdra, Ben J. (1994), "Domestic Oligopoly Pricing and Import Flows in Australian Manufacturing", unpublished, Department of Economics, University of Tasmania.
- Bloch, Harry and Olive, Michael (1999), "Cyclical and Competitive Influences on Pricing in Australian Manufacturing", *Economic Record*, **75**, 268-279.
- Caves, Richard E. (1989), "International Differences in Industrial Organization", in R. Schmalensee and R. Willig, eds, *Handbook of Industrial Organization, Volume 2*, North-Holland, Amsterdam.
- Chong, Han Hwee (2002), "Imports and Oligopoly Behaviour in Australian Manufacturing" unpublished PhD thesis, School of Economics and Finance, Curtin University of Technology.
- Cowling, Keith and Waterson, Michael (1976), "Price-Cost Margins and Market Structure", *Economica*, **43**, 267-274.
- Dixit, Avinash K. (1986), "Comparative Statics for Oligopoly", *International Economic Review*, **27**, 107-122.
- Dixit, Avinash K. & Stiglitz, Joseph E. (1977), "Monopolistic Competition and Optimum Product Diversity", *The American Economic Review*, **67**, 297-308.
- Goldberg, Pinelopi Koujianou and Knetter, Michael M. (1997), "Goods Prices and Exchange Rates: What Have We Learned?", *Journal of Economic Literature*, **35**, 1243-1272.
- Helpman, Elhanan and Krugman, Paul (1985), *Market Structure and Foreign Trade*, MIT Press, Cambridge MA.
- Kohli, Ulrich R. (1983), "The Le Chatelier Principle and the Demand for Imports in the Short Run and the Medium Run: Australia, 1959-60-1978-79", *Economic Record*, **59**, 149-165.
- Krugman, Paul (1994), *Rethinking International Trade*, MIT Press, Cambridge MA.

- Lyons, Bruce (1981), "Price-cost Margins, Market Structure and International Trade", in D. Currie, D. Peel and D. Peters, eds, *Microeconomic Analysis*, Croom-Helm, London.
- Martin, Stephen (1993), *Advanced Industrial Economics*, Blackwell Publishers, Malden MA.
- Olive, Michael (2002), *Price and Markup Behaviour in Manufacturing: A Cross-Country Study*, Edward Elgar, Cheltenham UK.
- Rogoff, Kenneth (1996), "The Purchasing Power Parity Puzzle", *Journal of Economic Literature*, **34**, 647-668.
- Spence, A. Michael (1976) "Product Selection, Fixed Costs, and Monopolistic Competition" *Review of Economic Studies*, **43**, 217-236.
- Stålhammar, Nils-Olov (1991), "Domestic Market Power and Foreign Trade", *International Journal of Industrial Organization*, **9**, 407-424

Appendix

In the PCM equation for the case of quantity conjectures (Cournot case), the $\omega_{x,i}$ ($x=0,1,2$) parameters are defined in terms of preference and conjectural parameters as follows:

$$\omega_{0,i} \equiv \frac{1}{\sigma_{d,i}} - \xi_i^* \left(\frac{1}{\sigma_{d,i}} - \frac{1}{\sigma_{df,i}} \right)$$

$$\omega_{1,i} \equiv \xi_i^* \left(\frac{1}{\sigma} - \frac{1}{\sigma_{df,i}} \right)$$

$$\omega_{2,i} \equiv -\frac{1}{\sigma} \xi_i^*$$

$$\xi_i^* \equiv \left(\frac{1}{n_{d,i}} + \xi_i \left(1 - \frac{1}{n_{d,i}} \right) \right)$$

In the corresponding case of price conjectures (Bertrand case), the $\delta_{x,i}$ ($x=0,1,2$) parameters are defined in terms of preference parameters, the reaction elasticity and the linearization point as follows:

$$\delta_{0,i} \equiv 2PCM_i^* + (PCM_i^*)^2 \left[-\sigma_{d,i} + \theta^* (\sigma_{d,i} - \sigma_{df,i}) \right]$$

$$\delta_{1,i} \equiv PCM_i^{*2} \theta_i^* (\sigma_{df,i} - \sigma)$$

$$\delta_{2,i} \equiv PCM_i^{*2} \sigma \theta_i^*$$

$$\theta_i^* \equiv \left(\frac{1}{n_{d,i}} + \theta_i \left(1 - \frac{1}{n_{d,i}} \right) \right)$$

In order to provide signs for the $\omega_{x,i}$ and $\delta_{x,i}$ parameters, the following assumptions are made:

1. Assumption 1 (Tree Principle): The substitution elasticity increases with the level of disaggregation. In the present set-up this implies $0 \leq \sigma < \sigma_{df,i} < \sigma_{d,i}$.
2. Assumption 2 (Proximity Principle): $\sigma/(1-s_i) < \sigma_{df,i}$ and $\sigma_{df,i}/(1-s_{d,i}) < \sigma_{d,i}$.

In the Cournot case, using assumption 1, it is straightforward to derive the following comparative static signs: $\omega_{0,i} > 0$, $\omega_{1,i} > 0$, and $\omega_{2,i} < 0$. When assumption 2 also holds, the sum of coefficients is restricted with $\omega_{1,i} + s_i \omega_{2,i} > 0$. These predictions are

consistent with intuition. The implied value of the price-cost margin in Cournot case is guaranteed to be positive for any values of the market share variables. Further, in view of the definition of ξ_i^* it is also possible to derive that $\delta PCM_i / \delta n_{d,i} < 0$ and $\delta PCM_i / \delta \xi_i > 0$. A higher degree of industry concentration (proxied by a lower $n_{d,i}$) increases the price-cost margin, and a higher reaction elasticity increases the price-cost margin.

In the Bertrand case, using assumption 1, it is straightforward to derive the following comparative static effects: $\delta_{\theta,i} > 0$, $\delta_{l,i} > 0$, and $\delta_{2,i} > 0$. These predictions guarantee a positive implied value of price-cost margin. The signs for the derivatives of the price-cost margin with respect to the number of domestic suppliers and the reaction elasticity are the same as in the Cournot case. Thus, with either Bertrand or Cournot competition, the predictions accord with intuition concerning the relationship between price-cost margins and the degree of concentration and recognition of interdependence among domestic producers.

Transformation to linear equations for PRS_i and IRS_i

The price-cost margin is linear in both (13) and (150), but the share equations in (16) and (17) are not. The share equations are each linearized to establish a linear system of equations. For the domestic producer share, the steps are as follows:

$$(16) \quad S_{d,i} = \frac{1}{1 + \left(\frac{1 - \beta_i}{\beta_i} \right) \left(\frac{P_{f,i}}{P_{d,i}} \right)^{(1 - \sigma_{df,i})}}$$

$$S_{d,i} = 1 / \left[1 + \beta \left(\frac{P_{f,i}}{P_{d,i}} \right)^\alpha \right]$$

$$S_{d,i}^{-1} = \left[1 + \beta \left(\frac{P_{f,i}}{P_{d,i}} \right)^\alpha \right]$$

$$S_{d,i}^{-1} - 1 = \beta \left(\frac{P_{f,i}}{P_{d,i}} \right)^\alpha$$

Differencing:

$$\left[S_{d,i}^{-1} - 1 \right] - \left[S_{d,i}^{-1(-1)} - 1 \right] = \left[\beta \left(\left(\frac{P_{f,i}}{P_{d,i}} \right) \right)^\alpha \right] - \left[\beta \left(\frac{P_{f,i}}{P_{d,i(-1)}} \right)^\alpha \right]$$

Taking logarithms of both sides:

$$\ln \left[S_{d,i}^{-1} - 1 \right] - \ln \left[S_{d,i}^{-1(-1)} - 1 \right] = \alpha \ln \left[\frac{P_{f,i}}{P_{d,i}} / \frac{P_{f,i}}{P_{d,i(-1)}} \right]$$

The left-hand side variable is denoted DS and the right hand side variable is denoted DRP, thus, $DS_i = \alpha DRP_i$.

The transformation for the equation with the industry share of domestic manufacturing sales (budget share) is as follows:

$$(17) \quad S_i = \alpha_i \left(\frac{P_{d,i}}{P} \right)^{(1-\sigma)}$$

Taking logarithms of both sides of equation (17) gives,

$$\ln[S_i] = \ln \alpha_i + (1 - \sigma) \ln \left(\frac{P_{d,i}}{P} \right)$$

Differencing,

$$\ln[S_i] - \ln[S_{i(-1)}] = (1 - \sigma) \left[\ln \left(\frac{P_{d,i}}{P} \right) - \ln \left(\frac{P_{d,i}}{P_{(-1)}} \right) \right]$$

If the budget share is denoted IRS and the relative price is denoted PDP, this can be expressed as:

$$DLIRS_i = c_1 DLPDP_i$$

where,

$$DLIRS_i = \ln[IRS_{i,t}] - \ln[IRS_{i,t-1}]$$

$$DLPDP_i = \ln[PDP_{i,t}] - \ln[PDP_{i,t-1}] \quad \text{and}$$

$$c_1 = (1 - \sigma)$$

Data Appendix

The price-cost margin is built up from a base PCM for the average value in 1989-1990. PCM_{base} is given by:

$$PCM_{base} = (\text{Value Added}_{base} - \text{Wages}_{base}) / \text{Turnover}_{base}$$

Quarterly PCM is then calculated from quarterly indexes of unit cost and domestic producer price using the formula:

$$PCM = \{ \text{Price} - [(1 - PCM_{base}) * \text{Unit Cost}] \} / \text{Price}$$

Unit cost is calculated as a weighted average of indexes for unit labour cost (a wage index divided by an output per employee index) and materials prices. Data on value added per person, number of employees, wages and salaries and turnover are taken from Australian Bureau of Statistics (ABS) Catalogue 8221. Data on the price index for output are taken from *Price Index of Articles Produced by Manufacturing Industry* (ABS Catalogue 6412). Data on output are for gross added value (chain volume measures) taken from ABS 5206. Data on the price of materials are taken from ABS Catalogue 6411. Finally, data on the value of purchased materials are taken from ABS Catalogue 8202.

Quarterly domestic producer revenue share (PRS) is calculated as follows:

$$S_{d,i} = (\text{sales} - \text{export}) / (\text{sales} - \text{export} + \text{import})$$

The data on sales in current dollars come from ABS Catalogue 5629, while data on imports and exports come from ABS Catalogue 5433 (superseded by ABS Catalogue 5422) and ABS Catalogue 5432 (superseded by ABS Catalogue 5422), respectively.

Quarterly industry revenue share (IRS) is calculated as follows:

$$S_d = (\text{sales} + \text{import} - \text{export}) / \text{Total Manufacturing} (\text{sales} + \text{import} - \text{export})$$

The data for total manufacturing are constructed by adding together data for the separate two-digit classifications of manufacturing industry.

The relative price of domestic and foreign product within an industry is calculated as follows:

$$\text{PFPD} = (\text{import price index}) / (\text{domestic price index})$$

Further, the relative price for domestic product in an industry to the average price of domestic manufactures is calculated as:

$$\text{PDP} = (\text{domestic price index}) / (\text{general price index})$$

Data for the domestic industry price indexes are taken from, *Price Index of Articles Produced by Manufacturing Industry* (ABS Catalogue 6412), while the import price indexes are taken from ABS Catalogue 5414. The general price index for domestic manufacturing is constructed as the average of nine manufacturing two-digit classifications, each weighted by its share of sales for total manufacturing.