School of Economics and Finance

Imports and Oligopoly Behaviour in Australian Manufacturing

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Declaration

This thesis contains no material which has been accepted for the award of any other degree or diploma in any university.

To the best of my knowledge and belief this thesis contains no material previously published by any other person except where due acknowledgment has been made.

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Date: 31/03/2003

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. This paper concentrates on the responsiveness of import flows to import price in the context of trade with imperfect competition. The empirical work analyses the behaviour over time of the interaction between domestic industry prices and domestic costs as well as foreign competitors' prices.

A structural model is employed for estimation purposes with consumer demand derived from a CES (constant elasticity of substitution) utility function of domestic and foreign composites of goods. Domestic firms are assumed to face Leontief production functions and maximise profit independently subject to their conjectures about the reactions of rivals. Firm behaviour is modelled using conjectural variations to identify market power, distinguishing two models of oligopoly, namely, Cournot and Bertrand conjectural variations. This leads to the econometric specification of pricing, import and budget share equations consistent with oligopolistic equilibrium. The interrelationship between the budget share equations and the price-cost margin provides encompasses either Cournot or Bertrand conjectural variations. The econometric specification is applied to each of the two digit Australian manufacturing industries using quarterly data covering the period from 1984 to 2000.

Results of the industrial behaviour indicate that industries that produce consumer products are generally react to price movements The classification of industry 21 to 24 is more proximate to consumer products as compared to higher industrial numbering. The regression results for industry 25 to 28 suggest quantity reactions. This is in line with the nature of the products produce by these industries, which are heavy industrial manufacturing products.

The elasticity with respect to foreign price is distinguished between the "partial" and the "total" effect. The partial elasticity of import demand ranges from .6205 to 4.9497, while the total elasticity of import demand ranges from .6505 to 19.8132. The elasticity of demand ranges from .0191 for Wood and Paper Product manufacturing to 3.4093 for Food, Beverage and Tobacco manufacturing.

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Chapter 1: Introduction

The major thrust of the empirical work on the behaviour of international trade flows has been largely centred on the single-equation studies. Specifically in the literature of import demand, most of the studies focus on the relationship of import flows to import price in aggregate form. The norm that dominates the empirical studies is to regress import volumes on income and on relative traded goods' prices in a single-equation model, with attention closely focused on the estimated income and price elasticities of demand. Advances have been registered in terms of estimation techniques, but little has been achieved in the specification of the trade flow model itself. Even up to the present time, the prevailing empirical studies of import demand are mostly based on single-equation modelling and little attention has been paid to the theoretical structure of the model.

The prevailing empirical studies with a single-equation import demand depend greatly on the assumption that the supply-price elasticities are infinite. The assumption of infinite supply-price elasticity justifies estimation of import demand equation by single-equation methods, since import prices can be viewed as exogenous.

Wilkinson (1992) provides an excess demand function for Australian imports, derived from a simple production theory. The model is in aggregate form and takes explicit account of non-stationarities in the data. Wilkinson finds that movements in imports are well explained by movements in domestic activity, relative prices and overtime. A long-run equilibrium model is also presented using cointegration technique. In another study by Yeung (1994), a simple single-equation modelling of demand for imports into Australia is presented. Cointegration technique is applied to model the long-run equilibrium behaviour. The coefficient estimates in the model appear to be on the low side, especially when compared to those obtained by Wilkinson (1992). Athukorala and Menon (1995) model Australian imports as dependent on relative prices and domestic economic activity net of cyclical demand effects, with estimates based on an autoregressive distributed lag model.

There is no strong theoretical basis for the use of single-equation models. Even if the assumption of infinite supply-price elasticities is applied, the appropriateness of the assumption should be tested. Furthermore, the use of single-equation models also has the disadvantage of lacking simultaneity between the interaction of the supply and the demand sides, as compared to the structural model. A structural model is derived from a theoretical background, which usually incorporates the demand and supply within that theoretical framework.

A structural model can increase our knowledge about economic relationships and can be used to test hypotheses about economic behaviour. If a structural model is derived from consumer theory, it describes the factors that determine the amounts spent by the consumer on the goods and services that are available in the market place. In other words, it derives from maximising an utility function.

In a study of Australian imports, Kohli (1983) examines the role of prices and factor endowments in the determination of Australian imports within a structural framework. Kohli criticises the use of single-equation model studies context by pointing out that there is relatively little attention paid to the underlying structure, with the choice of explanatory variables resting largely on ad hoc considerations. His import demand functions are estimated jointly with the other demand and supply functions derived from the same technology.

The structure of import demand modelling often centres on a perfect competitive environment. However, some researchers have modelled imperfect competition. This departure from perfect competition mainly stresses product differentiation, where the firms have some degree of market power. This introduction of monopolistic competition to the international trade flows model provides a new insight that helps fill the lacuna within the perfect competitive models.

Within the framework of imperfect competition, the application of oligopoly models provides a newer framework for the trade flows literature. Bloch and Heijdra (1994) use an oligopoly model to analyse the potential influence of movements in currency values on trade flows. Their model attempts to explain the sluggish response of trade flows to changes in exchange rates. Lyons (1981) presents a model of pricing behaviour by domestic producers faced with fixed import prices and making Cournot conjectures about the response of rivals, while a corresponding model with Bertrand conjectures is presented in Bloch (1994). In both models, firm behaviour depends in part on its share of the market in which it sells. The pricing behaviour of domestic firms as a group thus depends on their collective market share, which equals one minus the import share.

Cournot's assumption about oligopolists' behaviour is usually prone to criticism.[1] The use of conjectural variation partly overcomes this objection. It permits us to model firm behaviour when firms expect their own actions to affect the actions of other firms.[2] In addition, many different models can be analysed within the same

[1] See Martin (1993, pp. 24-30) for summary.
[2] See Martin (1993).

unifying framework; and the use of conjecture variation parameters also allows a straightforward meaning to the degree of competition in an industry (Dixit, 1986, p. 107).[3]

The emphasis of this thesis is to provide a theoretically sound structural model in modelling import flows in response to import price. Import flows are dependent on the price of imports relative to the price of domestic substitutes. A small-open-economy assumption is generally imposed in empirical studies of import flows in Australia. This assumption means that import prices are determined independently of conditions in the Australian market. A test of this assumption is included in the empirical results presented in the thesis.

The theory of consumer behaviour along with the production theory provides the base of the model. Domestic prices and import shares are treated as jointly determined by import prices, domestic production costs, the underlying demand for the product and the oligopoly behaviour of the domestic producers.

Firms are assumed to behave in a non-collusive oligopoly environment, which leads to a specification of the price-cost margin equation. This leads to an econometric specification in which Cournot and Bertrand behaviour can be distinguished through the pattern of estimated coefficients in an equation for the industry price-cost margin. The results are meant to illustrate the potential gains from empirical work employing econometric specifications with a coherent theoretical basis.

Chapter 2 presents a literature review as background for import demand modelling. Attention is drawn to the choice of functional form commonly applied to the study of import demand. Issues of the time-series properties are raised together with implications for the type of estimating methods. In particular, the issue or time-series stationarity properties and cointegration analysis are presented. This leads to discussion of the error correction model. Structural simultaneous-equation models are presented next. Utility maximisation and the almost ideal demand system are noted as among the commonly used structural models in the import demand literature. Estimation methods of the simultaneous-equation model are also reviewed in this chapter.

In Chapter 3, a model of the joint determination of domestic price and import share is presented. The consumer demand function is derived from a constant elasticity of substitution (CES) utility function with composite goods as arguments and where consumers are assumed to have nested preferences over composite

[3] Examples include Cournot conjectures, Bertrand conjectures, and rational conjectures.

goods. The composite good for each industry is a CES function of domestic and foreign composites, which in turn are CES functions of the product varieties produced by domestic and foreign firms, respectively. The demand functions for the various goods and varieties can be derived by means of two-stage budgeting, given the utility tree has been set up in the appropriate manner. Each level of demand function is derived from an optimising solution, confined by the budget constraint. This model allows for a rich set of alternatives in terms of substitution among varieties and the extent of preference for domestic or foreign varieties.

Domestic firms are assumed in Chapter 3 to face Leontief production functions with fixed coefficients. A cost function is derived with a fixed capital stock, since the emphasis of the paper is on the short-run pricing decision of domestic firms. The derived cost function is linear homogenous in output and additive in input prices weighted by the physical productivity of each input. This leads to a profit maximising specification and each firm maximises profits independently subject to its conjectures about the reaction of rivals.

The analysis is centred on two main cases. In the first case, the reaction is assumed to be in the form of output reactions, which includes the polar case of Cournot behaviour. In the second case, other firms are assumed to react in terms of a price response, which includes the polar case of Bertrand behaviour. Output and price conjectures are modelled separately. Price can be seen to equal mark-up times marginal cost, which implies that the influence of production costs on the domestic price is direct. The influence of other factors, including the influence of domestic and foreign competition, occurs implicitly through the perceived price elasticity of demand.

Consumer demand in the model is disaggregated among categories of consumption goods. The products within categories are meant to be closer substitutes than those outside of the category. Ideally, there would be a sharp differentiation, so that the assumptions of the *tree principle* and the *proximity principle* (discussed in the chapter) apply.

Estimates of the econometric model are provided for each of nine two-digit classification of *Australia and New Zealand Standard Industrial Classification* (*ANZSIC*). Quarterly data covering the period from 1984 through 2000 are used in the estimation process. The variables used in estimation are each constructed from raw data contained in published and unpublished series provided by the Australian Bureau of Statistics (*ABS*). The choice of the sample and the data used are discussed in Chapter 4. Included is a discussion of the time-series properties of the data.

Chapter 5 presents the empirical results. A system of three equations is estimated using the ordinary least squares and the instrumental variables methods. These estimated equations are in first differences of the data. The ordinary least squares results are backed up by the test for variable exogeneity property, namely, the Wu-Hausman test. Some industries show positive results by ordinary least squares estimation. In particular, the estimated coefficients for the Food, Beverages and Tobacco Manufacturing (industry 21), the Textile, Clothing, Footwear and Leather Manufacturing (industry 22) and the Printing, Publishing and Recorded Media (industry 24) are consistent with a equilibrium based on price or Bertrand-type conjectures, while the estimated coefficients for the Non-Metallic Mineral Product Manufacturing (industry 26) and the Machinery and equipment Manufacturing (industry 28) are consistent with equilibrium based on quantity or Cournot-type conjectures. The instrumental variables estimation generally produces insignificant results. However, estimates for the Food, Beverages and Tobacco Manufacturing (industry 21) are consistent with a equilibrium based on Bertrand conjectures.

Cointegration analysis is performed on the system of three equations in Chapter 5. Two models are proposed. A vector error correction model is estimated for those Industries that satisfy the cointegration test. For Model 1, the estimates for the Food, Beverages and Tobacco Manufacturing (industry 21) and Printing, Publishing and Recorded Media (industry 24) suggest that there is an error-correction mechanism in the long run, where the long-run estimates suggest each is consistent with equilibrium based on Bertrand-type conjectures. In Model 2, the estimates for industry 21 and 24 are consistent with equilibrium based on Bertrand-type conjectures, while the Textile, Clothing, Footwear and Leather Manufacturing (industry 22), the Petroleum, Coal, Chemical and Associated Product Manufacturing (industry 25), the Non-Metallic Mineral Product Manufacturing (industry 26), the Metal Product Manufacturing (industry 27) and the Machinery and Equipment Manufacturing (industry 28) are consistent with equilibrium based on Cournot-type conjectures.

Results of the industrial behaviour indicate that industries that produce consumer products are generally sensitive to price movements The classification of industry 21 to 24 is more proximate to consumer products as compared to higher industrial numbering. Only estimation results from *VECM2* in industry 22 suggest a Cournot-type conjecture. The regression results for industry 25 to 28 suggesting quantity reaction sensitivity. This is in line with the nature of the products produce by these industries, which are heavy industrial manufacturing products. There are no significant estimates that can classify Other Manufacturing (industry 29) into either Bertrand or Cournot reactions. Since industry 29 contains the residual productions that cannot be classified into any industrial classification, the nature of this industry is mixed. The structural model is not able to identify the oligopolistic nature of this industry.

The elasticity with respect to foreign price and to domestic price is reported in Chapter 5 as well. The elasticity with respect to foreign price is distinguished between the "partial" and the "total" effect. The partial elasticity of import demand ranges from .6205 to 4.9497 and the total elasticity of import demand ranges from .6505 to 19.8132. Industry 23, which manufactures wood and paper product has the least partial and total elasticity of import demand, while industry 21, which manufactures food, beverage and tobacco, is most elastic. The elasticity of demand ranges from .0191 for Wood and Paper Product manufacturing to 3.4093 for Food, Beverage and Tobacco manufacturing.[4]

[4] The positive value of demand elasticity is due to the derivation of elasticity in terms of consumption share. Value less than one is acceptable.

Chapter 2: Literature Review

2.0 Background of Import Demand Literature

In the literature of import demand, most of the studies focus on the relationship of import flows to import price in aggregate form. In this relation, the aggregate import quantity is the common dependent variable.[5] The theory of demand suggests that quantity of import is the appropriate dependent variable since the quantity consumed depends on the price. However, the most readily available data in aggregate imports are in value rather than quantity terms. To obtain the quantity of imports, one has to deflate the value series by a measure of prices (Leamer and Stern, 1970, p. 8). For example, Norton and Jackson (1969) use the imports of goods and services at current prices deflated by the implied price index for imports as the dependent variable to estimate the demand for imports into Australia. For the manufacturing sector in particular, Athukorala and Menon (1995) use real imports as the dependent variable to investigate the manufactured import flow to Australia.

The basic approach to import demand views the quantity of imports determined as the solution of a two-good utility maximisation or cost minimisation problem. The quantity of imports is then derived as a function of domestic real income or output, the price of imports, and the price of a domestic substitute. Most often, the absence of money illusion is postulated. This hypothesis implies that the demand function is homogeneous of degree zero in prices and nominal income. Leamer and Stern (1970, p. 10) point out that absence of money illusion is the form that has traditionally been employed in demand analysis in international trade. Thus, the import demand function is:

$$(2.1) \quad M = f\left[\frac{Y}{P_Y}, \frac{P_M}{P_Y}\right]$$

M is the real import, Y/P_Y, P_M is the real income, and P_m/P_Y is the relative price of imports to domestic price of substitutes.[6] Equation (2.1) satisfies the no money

[5] The discussion of imports in this chapter will concentrate on the aggregate level unless otherwise stated.
[6] Note that there is potential for spurious correlation when import price index is measured with error.

illusion hypothesis and the theory of demand. As a result, equation (2.1) has dominated the empirical research of import demand and is often referred to as the conventional approach in estimating the import demand relation.

2.1 Choice of Functional Form

2.1.1 Linear and Log-Linear Functional Form

In order to fit equation (2.1) statistically, a particular functional form must be chosen. In the scope of international trade, the two most commonly encountered functional forms of import demand are the linear equation (2.2) and the log-linear equation (2.3) formulations.

$$(2.2) \quad M = a + b\frac{Y}{P_Y} + c\frac{P_M}{P_Y} + u$$

$$(2.3) \quad logM = loga_1 + b_1 log\frac{Y}{P_Y} + c_1 log\frac{P_M}{P_Y} + logu$$

Equation (2.2) states that the demand for real import, *M*, depends on the autonomous consumption of the foreign product, *a*, the real income, Y/P_Y (*y*), and he relative price of imports to price of domestic substitutes, P_M/P_Y (*p*). *u* is an error term that is assumed to be uncorrelated with the explanatory variables. Income elasticity can be calculated for the linear demand equation using the coefficient for the real income, *b*(y/M)*. The price elasticity of income can be obtained in the same manner using the coefficient, *c*(p/M)*. While, for the log-linear functional form, the income elasticity and price elasticity are measure by the coefficients $b_1 = \delta(log\ M)/\delta(log\ y)$ and $c_1 = \delta(log\ M)/\delta(log\ P)$, respectively.

Early studies that apply single equation estimation using linear and log linear form include Uzawa (1962), Ball and Marwah (1962), Houthakker and Magee (1969), Khan and Ross (1977), and Boylan, Cuddy and O'Muicheartaigh (1980). Some newer studies are Pattichis (1999), and Mah (2000).

Ball and Marwah (1962) apply a single equation to post-war quarterly data using a log-linear functional form. Total imports are broken down into six groups and estimations are made for each of these groups individually using ordinary least squares.[7] The basic hypothesis that underlies the analysis is that variations in import demand are explained by variations in output or income and import prices relative to domestic prices. No clear-cut conclusion emerges from these estimations. It seems that, if prediction alone is the aim, working with overall rather than disaggregated equations probably loses little. They conclude that relative prices are a significant factor in determining the volume of imports of the United States.

Athukorala and Menon (1995) model and estimate import demand functions for Australian manufacturing imports with emphasis on the import functions formulation, explicit treatment of cyclical demand effects and the potential for aggregation bias in the presence of binding quantitative restrictions. Using a log-linear functional form, they model the demand for imports as dependant on relative price, the domestic economic activity and a measure of general scarcity of domestic supplies. An autoregressive distributed lag model with seasonal dummies to capture the seasonal movements in imports not captured by the other explanatory variables. Import functions are estimated for total manufactured imports as well as for each of the 2-digit classification under the Manufacturing Division of the Australian Standard Industrial Classification. Their study provides import-price elasticity estimates based on actual import prices as against import price proxies. The results may be of relevance in illustrating the behaviour of different types of imported goods and highlighting the nature and extent of the bias involved in import elasticity estimates based on aggregated data.

The choice between the linear and log-linear functional forms has generally been made on grounds of convenience. For instance, if forecasting is the primary purpose, then one tends to prefer a linear relationship. This form implies a decreasing price elasticity of import demand and an income elasticity tending towards unity. This can be viewed as a drawback since the price elasticity will diminish as income grows (Leamer and Stern, 1970, p.18).

A more general approach to choose the appropriate functional form is proposed by Box and Cox (1964). This proposed method allows the data to determine the functional form of the relationship instead of having to formulate it in advance. Khan and Ross (1977, pp. 153-154) provide a description of the Box-Cox

[7] This particular breakdown is largely dictated by the convenience of presentation of the basic data on merchandise trade published by the Department of Commerce in the *Survey of Current Business*.

method as applied to import functions. The specification of Box-Cox is a general power function that contains both the linear and log-linear specifications as special cases. The power function in the case of equilibrium import demand is:

$$(2.4) \quad \left[\frac{M_t^\lambda - 1}{\lambda}\right] = a_0 + a_1\left[\frac{P_t^\lambda - 1}{\lambda}\right] + a_2\left[\frac{Y_t^\lambda - 1}{\lambda}\right] + e_t$$

where price and income elasticities from equation (2.4) are $a_1(P_t / M_t)^\lambda$ and $a_2(Y_t / M_t)^\lambda$, respectively. When λ takes the value of 1, the equation becomes identical to a linear equation, and when λ approaches 0, it approaches the log-linear equation. The parameters can be obtained by maximum-likelihood methods for the transformed model for each such λ. Then, finding the value of λ for which the maximum log likelihood, $L_{max}(\lambda)$, in relation to the original observations is maximized. Finally, this maximum value of λ allows one to determine whether the function should be linear, log-linear or some other form.

Khan and Ross (1977) specify import demand to depend on domestic income in real terms and the ratio of import price to domestic price. The purpose of their paper is to decide on empirical grounds the appropriate form of the aggregate import demand equation for United States, Canada and Japan. This paper also acknowledges the cost involved in the adjustment of actual imports to the desired flow by introducing a partial-adjustment mechanism for imports, in order to have continuous equilibrium. This mechanism is represented by the difference between the demand for imports in current period and the actual level of imports in the previous period. By applying Box-Cox analysis of transformation, the results indicate that for the standard specifications of the import equation, a log-linear form is better than a linear one. Since in the area of international trade relationships one is primarily interested in obtaining price and income elasticities, the specification of relationships in log-linear form is very convenient, as these elasticities are directly obtained from the regression equation.

Boylan et al. (1980) present the results of the estimation of a generalised import demand function for three smaller European economies. With the primary concern centred on import demand equations rather than the actual specification of the variables, they use the conventional specification of international trade model.[8] By applying the Box-Cox analysis of transformation, the log-linear formulation also emerges as the appropriate choice. The results, therefore, which are directly comparable to those of Khan and Ross (1977), hold for three economies, which in terms of economic structure and level of development, are substantially different. Hence, it would appear that the Khan and Ross (1977) results do generalise.

A rigorous study is carried out by Thursby and Thursby (1984) in an attempt to determine which of the frequently used single equation models of import demand are appropriate. An appropriate model is defined as one, which generates unbiased (or at least consistent) and efficient elasticity estimates. This paper examines nine models of aggregate import demand for each of five countries (Canada, Germany, Japan, United Kingdom, and United States). Altogether, 324 estimating equations of the linear and the log-linear forms in various autogregressive distribution lags are estimated. This paper shows that models without lagged adjustment perform rather poorly, while, models including dynamic behaviour through lagged values of the dependent variable are frequently accepted.

Since the specification of an equation in log-linear terms allows the dependent variable to react proportionally to a rise or fall in the explanatory variables, it has an edge on theoretical grounds because it exhibits "interaction" between the impacts.[9] However, it implies constant elasticities with respect to price and income (Boylan et al., 1980, p. 561). Nonetheless, questions about the microeconomic foundation of the log-linear functional form arise since it is not derived from utility maximisation. Besides the attractive simplicity of the log-linear functional form, it does have a serious drawback.

From equation (2.3), let,

$$(2.5) \quad Y = \sum_{i=1}^{n} P_{M,i} M_i + \sum_{j=1}^{h} P_{Y,j} q_j$$

be the total expenditure. $P_{M,i}$ and M_i are the price for imported good i and the quantity demand for imported good i, respectively. $P_{Y,j}$ and q_j are the price for

[8] The traditional trade equation relates quantity of imports to income and the ratio of the price of imports to the domestic price level.

domestic good *j* and the quantity demand for domestic good *j*, respectively. For simplicity, equation (2.5) is written as:

(2.6) $Y = \sum_{k=1}^{l} P_k Q_k$.

Equation (2.7) gives the proportion of income devoted to imported good *i*.[10] This is referred to as the budget share of the import.

(2.7) $w_i = M_i / y$

The budget shares are positive and, in view of (2.6), have a unit sum. Multiplication of the budget share by the corresponding income elasticity from equation (2.3), yields the marginal share of imported good *i*:[11]

(2.8) $w_i b_{1,i} = \delta(M_i)/\delta(y)$

or

(2.9) $\theta_i = \delta(M_i)/\delta(y)$

As the additional income is entirely spent, the marginal shares have a unit sum. Combining (2.8) and (2.9) shows that the income elasticity can also be expressed as the ration of the marginal share to the corresponding budget share:

(2.10) $b_{1,i} = \theta_i / w_i$

As the marginal shares have a unit sum, it follows from equation (2.10) that a budget share weighted average of the income elasticities is equal to unity,

(2.11) $\sum_{i=1}^{n} w_i b_{1,i} = \sum_{i=1}^{n} \theta_i = 1$

Theil and Clements (1987) compute the marginal shares using the study by Houthakker (1957). Houthakker estimates demand equation (2.12) using the log-

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[9] See Khan and Ross, 1977, p.150.
[10] Note that equation (2.7) is dealing with nominal values, where prices are absent.
[11] As the additional income is entirely spent, the marginal shares have a unit sum.

linear form, where all participating families pay approximately the same price for each good:

(2.12) $\log q_i = \alpha_i + \eta_i \log Y$

where q_i is the quantity demanded for good *i* and *Y* is the income. From equation (2.12), the logarithmic change in expenditure on good i is a constant multiple η_i if the change in income,

(2.13) $d(\log p_i q_i) = \eta_i \, d(\log Y)$

Accordingly, if the income elasticity η_i exceeds unity, then expenditure on that particular good, let say good *i*, increases at a faster rate than does income. If income keeps rising, expenditure on good *i* will eventually exceed income, which violates the adding-up constraint of equation (2.6) (Theil and Clements, 1987, p. 7). Therefore, a weakness of the log-linear functional form is that it does not satisfy the adding-up constraint for all values of income. And the marginal shares computed by Theil and Clements (1987, p. 7) do not sum to unity exactly, which makes (2.11) invalid.

2.1.2 Transcendental Logarithmic (translog)

The most widely used flexible form in international trade literature is the transcendental logarithmic (translog) function.[12] The translog function can be viewed as a second-order approximation to an arbitrary twice-differentiable logarithmic cost function introduce by Christensen, Jorgenson and Lau (1973). The translog cost function takes the form:

(2.14)
$$\log \kappa(Y,p) = \xi_0 + \sum_{i=1}^{n} \xi_i \log p_i + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \xi_{ij} \log p_i \log p_j + \xi_k \log Y + \sum_{i=1}^{n} \gamma_i \log p_i \log Y + \gamma_k \log Y^2$$

where ξ_0, ξ_i, ξ_{ij} and ξ_k are constants. *Y* is the production function generating income and p_x ($x = i, j$) is the price of input. Note that ξ_{ij} is equals to ξ_{ji} by Young's Theorem. Also $\xi_k = 1$, and γ_k and γ_i equal zero, for constant returns to scale. Two years later, by using Roy's theorem, Christensen, Jorgenson and Lau (1975) introduce the translog indirect utility function that takes the form:[13]

$$U_I(Y,p) = \beta_0 + \sum_{i=1}^{n} \beta_i \log\frac{p_i}{Y} + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \beta_{ij} \log\frac{p_i}{Y}\log\frac{p_j}{Y} + \sum_{i=1}^{n} \beta_{iY} \log\frac{p_i}{Y}\log Y + \sum_{j=1}^{n} \beta_{jY} \log\frac{p_j}{Y}\log Y + \beta_Y \log Y \tag{2.15}$$

where β_i, β_{ij}, β_{iY} and β_{jY} are constants. Y is income and p_x ($x = i, j$) is the price of good i and good j. If consumable goods can be differentiated between the imported goods and the local production, the translog indirect utility function can provide a consumer specification behaviour. Subscripts i and j would be represent the imported goods and local production, respectively. Empirically, the specification of an output is estimated using the budget shares form from the translog indirect utility function. Take imports as an example:

$$w_i = \frac{\beta_i + \sum_{j=1}^{n} \beta_{ij} \log\frac{p_j}{Y}}{\sum_{Y=1}^{n} \beta_Y + \sum_{Y=1}^{n}\sum_{j=1}^{n} \beta_{kj} \log\frac{p_j}{Y}} \tag{2.16}$$

Traditionally, import demand equation implicitly treats all imports either as a single final good, which enters into the consumer's utility functions and is separable from all other products or intermediate goods. These are assumed separable from primary factors in the productive process, until Burgess (1974a) introduces import as a factor of production. Burgess argues that the traditional import demand equation is not derivable from an underlying model of optimal behaviour, and it assumes that imports are final goods, which are separable from all other commodities in the utility function. Even if a functional form imposes separability restrictions a priori, this assumption of separability between imports and alternative factors or commodities would constitute a maintained hypothesis that could not be tested (Burgess, 1974a, p. 225).

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[12] See Burgess (1974(a), 1974(b)), Kohli (1978, 1982), Aw and Roberts (1985), and more recent work by Kohli (1994), and Truett and Truett (1998).

[13] Roy's theorem gives a second way of generating a system of demand equations, namely, specify an algebraic form of the differentiated indirect utility function.

Burgess includes imports as an additional factor and postulates a technological relationship for output delivered to final demand. He assumes that the technology is described by a joint cost function and that the producing sector combines capital and labour with imported materials to minimise the cost of producing a specified bundle of consumption and investment goods, which are purchased either by domestics or foreigners. The functional form used takes the form of the translog functional form that is assumed to provide an exact description of the minimum cost of producing the vector of output y given the vector of factor prices *p*.

$$\ln C(y,p) = \alpha_0 + \sum_{i=1}^{m}\alpha_i \ln y_i + \sum_{j=1}^{n}\beta_j \ln p_j + \frac{1}{2}\sum_{i=1}^{m}\sum_{j=1}^{m}\delta_{ij}\ln y_i \ln y_j + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}\gamma_{ij}\ln p_i \ln p_j + \sum_{i=1}^{m}\sum_{j=1}^{n}\rho_{ij}\ln y_i \ln p_j \tag{2.17}$$

The hypothesis that the technology is separable between inputs and outputs are tested by imposing the restriction that ρ_{ij} is zero. The additional hypothesis that the input function is separable with respect to a partitioning between primary factors and imported materials is tested by imposing the restriction that γ_{ij} is zero. Burgess estimates the cost and revenue share equations by taking the logarithmic differentiation of equation (2.17) with respect to input prices and output quantities, respectively. Two-stage least squares estimation is performed since the disturbances from each of the included cost and revenue share equations are likely to be correlated since errors in cost minimisation, that result in overstating one factor share will systematically affect other factor shares. Burgess finds convincing evidence against the hypothesis that the technology is separable with respect to a partitioning between inputs and output. The imports and capital services are complementary inputs. This implies that if rental rate on capital services rises, it will reduces the demand for imports. Furthermore, a change in the composition of final demand towards consumption goods and away from investment goods will tend to raise the demand for labour services and lower the demand for both capital services and imports at given factor prices.

More recently, Truett and Truett (1998) use the translog cost function to investigate Korea's demand for imports as productive inputs and the effects of trade liberalization on the demand for the country's domestic inputs. Viewing imports as a factor of production allows the observation of the impact of higher import prices caused by tariffs or other restrictive trade practice on the demand for domestic inputs and the prices of domestic outputs, as well as on the quantity demanded of imports. The impact of reduced trade restrictions would be altogether positive on the demand for domestic inputs if they had a complementary relationship with imports. A substitution relationship prevails if a reduction in import restrictions decreases the demand for domestic inputs, as imports are substituted for them in production. Although viewing imports as an input allows us to analyse the effect of changing trade restriction, input-output separability is a testable hypothesis because it is related to the impact, if any, of a change in the composition of output on the demand for each respective input (Truett and Truett, 1998, pp.104-105). Their finding is consistent with the hypothesis that a substitute relationship exists between domestic capital and imports and as well between domestic labour and imports. The latter result is consistent with the belief of Korean policy makers that, at least in the short run, removal of all import controls would have a negative effect on the demand for domestic inputs.

2.1.3 Other Functional Form

In another approach, Marquez (1994) explains bilateral U.S. import volume and prices where spending decisions follow the Rotterdam model and where individual products are differentiated by Armington-type of nesting.[14] The Rotterdam model can be represented by equation (2.23). To derive the Rotterdam model, consider a Marshallian demand function of $x_i(p, Y)$, where p is a vector of prices and Y is the income. The differential of x_i gives:

(2.18) $$dx_i^* = \sum_{j=1}^{n} \left(\delta x_i^* / \delta p_j\right) dp_j + \left(\delta x_i^* / \delta Y\right) dY \text{ or}$$

(2.19) $$x_i^* * d\ln\left(x_i^*\right) = \sum_{j=1}^{n} \left(\delta x_i^* / \delta p_j\right) p_j * d\ln\left(p_j\right) + \left(\delta x_i^* / \delta Y\right) Y * d\ln\left(Y\right)$$

multiplying by (p_i / Y) yields,

[14] The Rotterdam model, by design, embodies all the properties of utility maximisation and does not treat trade elasticities as autonomous parameters. This model also restricts the marginal budget share and Slutsky coefficient to be invariant.

(2.20) $\left[\left(p_i * x_i^*\right)/Y\right] d\ln\left(x_i^*\right) = \sum_{j=1}^{n}\left(\delta x_i^*/\delta p_j\right)\left(p_i p_j/Y\right) d\ln\left(p_j\right) + p_i\left(\delta x_i^*/\delta Y\right) d\ln(Y)$

By denoting the *i-th* budget share by $w_i = (p_i * x_i) / Y$, and using the Slutsky equation gives:[15]

(2.21)
$$w_i^* * d\ln\left(x_i^*\right) = \sum_{j=1}^{n}\left(\delta x_i^c/\delta p_j\right)\left(p_j p_i/Y\right) d\ln\left(p_j\right) - \sum_{j=1}^{n}\left(\delta x_i^*/\delta Y\right)\left(p_i w_j^*\right) d\ln\left(p_j\right) + p_i\left(\delta x_i^*(p,Y)/\delta Y\right) d\ln(Y)$$

If $\beta_{ij} = \left(\delta x_i^c/\delta p_j\right)\left(p_j p_i/Y\right)$ and $\beta_i = p_i\left(\delta x_i^*/\delta Y\right)$ gives the marginal propensity to consumer the *i-th* commodity, equation (2.21) then becomes,

(2.22) $w_i^* d\ln\left(x_i^*\right) = \sum_{j=1}^{n}\beta_{ij} d\ln\left(p_j\right) - \sum_{j=1}^{n}\beta_i w_j^* d\ln\left(p_j\right) + \beta_i d\ln(Y)$

or

(2.23) $w_i^* d\ln\left(x_i^*\right) = \sum_{j=1}^{n}\beta_{ij} d\ln\left(p_j\right) + \beta_i\left[d\ln(Y) - \sum_{j=1}^{n} w_j^* d\ln\left(p_j\right)\right]$

Treating the β's as parameters, this is the standard specification of the Rotterdam model.

Marquez's pricing behaves according to the pricing-to-market hypothesis, which allows exporters to discriminate. He embeds this analysis in a Cobb-Douglas production framework. This yields competitive domestic pricing behaviour. His study follows the model of imperfectly competitive pricing for imports developed by Gagnon and Knetter (1990). Marquez points out that the econometric analyses of U.S. imports using log-linear functional form assume that trade elasticities are autonomous parameters. That is both cross-price effects and simultaneity biases are absent, and that expenditures on domestic and foreign goods can be studied independently of each other. Treating trade elasticity as autonomous implies either

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[15] Slutsky equation states: $\delta x_i(p,Y)/\delta p_j = \delta h_i(p,v(p,Y))/\delta p_j - \delta x_i(p,Y)/\delta Y\, x_j(p,Y)$. For further information, see Varian (1992, p. 119-120).

that the associated propensities and shares are fixed or that their changes are mutually offsetting.[16] If individuals optimise spending decisions subject to a linear budget constraint, the income elasticity will be unit elastic and the own price elasticity and cross price elasticity will be –1 and 0, respectively. Hence, making all econometric estimation redundant. Empirical estimation relies on the Full Information Maximum Likelihood (FIML) approach and uses annual bilateral price and trade flow data for the period of 1965-1987. The statistical results show that the gap in elasticity predictions between the traditional log-linear model and the Rotterdam model is large. This suggests that explaining U.S. imports with constant-elasticity models carries a loss of information. Further, the evidence of Marquez's paper indicates that treating trade elasticity as autonomous is inappropriate, because the empirical results cannot reject the presence of cross-price effects. Thus, the expenditures on domestic and foreign goods cannot be studies independently of each other.

2.2 Stationarity and Cointegration

In most attempts to model imports up to the 1980s, it is implicitly assumed that all variables used in the regression exhibit stationarity.[17] When variables are non-stationary, conventional econometric results must be interpreted with care, as the classical assumptions about the behaviour of the random variables used in the regression no longer hold.

Before the actual estimation of the model is carried out, the time-series properties of the data must be investigated to see if they exhibit stationarity or non-stationarity.[18] In most previous attempts to model imports, it has been implicitly assumed that all explanatory variables in the regression exhibit stationarity.[19] If the

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[16] For example, the income elasticity of the i^{th} good is given by $(\delta p_i q_i/\delta y_i)/(p_i q_i/y_i)$, where p is price, q is quantity and y is income; where the numerator is the marginal propensity to purchase the i^{th} good and the denominator is the associated expenditure share. Because these shares vary through time, the assumed invariance of the elasticity requires offsetting changes in $(\delta p_i q_i/\delta y_i)$, a response with no theoretical basis.

[17] That is, the distribution of each variable is assumed to be constant and thus its mean and variance do not change over time.

[18] That is, testing for the absence or presence of unit roots. Dickey-Pantula (1987), Dickey-Fuller (1979) and Philips-Perron (1988) tests can be used to test for stationarity.

[19] The distribution of each variable is assumed to be constant and thus its mean and variance do not change over time, i.e. this property ensures that any sample mean and variance gives a true representation of the population mean and variance for a series. See Horton and Wilkinson (1989) for more details.

variables that enter the import demand relation contain a unit root, ignoring non-stationarity in these variables may cause serious inference problems if one uses conventional econometric method, such as ordinary least square method, to regress the model.[20] Furthermore, when variables are non-stationary, the assumptions about the behaviour of the random variables used in the regression no longer hold.

2.2.1 Stationary Time Series

From theoretical point of view, a time series is a collection of random variables. Such a collection of random variables ordered in time is called a stochastic process. One important class of stochastic processes is that of stationary stochastic processes. A time series is stationary if following conditions are satisfied (Harvey 1990, p.23):

(2.24) $E\left(y_y\right)=\mu$

(2.25) $E\left\{(y_t-\mu)^2\right\}=\operatorname{var}(y_t)=\chi(0)$

(2.26) $E\left\{(y_t-\mu)\left(y_{t-\tau}-\mu\right)\right\}=\operatorname{cov}(y_t,y_{t-\tau})=\chi(\tau)$

$$\tau=1,2,\ldots$$

Equations (2.24) and (2.25) require the process to have a constant mean and variance for all *t*. Equation (2.26) requires the autocovariance depends only on the time interval between any two values of τ, and not on the point in time *t*. Thus, a time series is stationary if its mean, variance and autocovariances are independent of time.

2.2.1.1 The First Order Autoregressive Process

To illustrate further on stationarity, consider the process defined by

[20] Mah (1999) points out that Melo and Vogt (1984), and Boylan and Cuddy (1987) ignore

(2.27) $y_t = \rho y_{t-1} + \varepsilon_t$

$$t = \ldots, -1, 0, 1, \ldots$$

where ε_t is a sequence of independently and identically distributed (*IID*) random variables with expected value zero and variance σ^2. The process in equation (2.27) is stationary when ρ is less than one in absolute value, i.e. $-1 < \rho < 1$. [21]

To view ρ being less than one in absolute value as the stationarity condition in another perspective, it is useful to introduce the lag operator, *L*, where $Ly_t = y_{t-1}$; and write the AR(1) in equation (2.27) as:

(2.28) $y_t - \rho y_{t-1} = y_t - \rho L y_t = (1 - \rho L) y_t = \varepsilon_t$

The root of equation (2.28) (i.e. $(1 - \rho L)y_t = 0$) is given by $L = (1/\rho)$. The condition ρ has absolute value less than one is equivalent to requirement that the root of $1 - \rho L$ is greater than one in absolute value. The stationary condition is not satisfied, if and only if ρ is one, that is, $1 - \rho L$ has a unit root (Holden and Perman, 1994, pp 50-51).[22]

There are two ways of dealing with non-stationary variables in order to use standard regression techniques. Detrending or differencing the data series to manipulate the non-stationary data series in order to make them stationary is one of them. However, this will cause the data series to lose information. One cannot infer the long-run steady-state relationships between variables from the estimated model.

2.2.2 Cointegration and Error Correction Model (ECM)

Following the advance in econometrics, it is possible to test whether any of the non-stationary series are cointegrated with each other. Cointegration means that although the individual time series exhibit nonstationary properties, linear

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the nonstationarity issue, and their results might have been those of spurious regression.

[21] The fact that $E(y_t)$, $var(y_t)$ and $cov(y_t, y_{t-\tau})$ are independent on time means that the AR(1) in (2.27) process is indeed stationary when ρ is less than one in absolute value. See Holden and Perman (1994), p.50 for further details.

[22] A "shock" or "innovation" has a sustained effect in the unit root case and an effect that diminishes with time in the stationary case.

combinations of these variables exhibit stable properties (Horton and Wilkinson, 1989, p.7). This technique models the long-run, steady-state relationships. Holden and Perman (1994) provide a comprehensive discussion about unit roots and cointegration techniques. If variables are cointegrated, a linear combination of these variables may exhibit a stationary property. This is refered to as the error correction model (ECM).

If it is necessary to difference a series *r* times to make it stationary, then the series is defined as being integrated of order *r*, denated I(*r*). Therefore, stationary variables are I(0). Engle and Granger (1987) show that when a number of I(1) variables are cointegrated, there always exists a system of equations having error-correcting form, which represent the dynamics of the series.[23] Having imposed the cointegrating relationship, the coefficients on the lagged differenced series influence the path of adjustment back to equilibrium of the dependent variable.

Engle and Granger (1987) prove that, if a system has two variables, x_t and y_t, integrated of order 1 and assuming they are cointegrated,[24] the Granger representation theorem says that in this case, x_t and y_t may be considered to be generated by error correction model (ECM) of the form:

$$(2.29) \quad \Delta x_t = \alpha_1 * z_{t-1} + \beta_1 * lagged(\Delta x_t, \Delta y_t) + \gamma_1 * e_{1t}$$

$$(2.30) \quad \Delta y_t = \alpha_2 * z_{t-1} + \beta_2 * lagged(\Delta x_t, \Delta y_t) + \gamma_2 * e_{2t}$$

Within this system, at least one of the coefficients on the cointegrating term, z_{t-1}, must be non-zero. The term z_{t-1}, measures the extent to which the system deviates form its long run equilibrium relationship. If α_1 is negative, the system moves back towards its long run equilibrium whenever there is a disturbance in the form of

[23] An error-correction model implies that changes in the dependent variable are a function of the level of disequilibrium in the cointegrating relationship, that is the departure from the long run equilibrium, as well as changes in other explanatory variables.

[24] So that $z_t = x_t - \hat{A} * y_t$ is I(0).

positive or negative z_{t-1}. As a result, the size and sign of the previous equilibrium error, z_{t-1}, influences the magnitude and direction of movement in x_t.

By using cointegration techniques, Wilkinson (1992) finds strong evidence of a cointegrating relationship between aggregate import volumes, domestic activity and relative trade prices in Australia. She finds that cycles in both domestic activity and relative prices are highly correlated with cycles in imports, with the contribution of relative prices outweighing that of activity. This confirms the earlier research by Horton and Wilkinson (1989). The cointegration technique follows Engle and Granger (1987). It also uses Johansen and Juselius (1990) as an alternative method to tackle the shortcoming of Engle-Granger approach.[25] Yueng (1994), and Athukorala and Menon (1995) also use the cointegration approach in estimating the import demand for Australia.[26] Both these studies for Australia find a cointegration relationship between the variables.

2.3 Structural Models

The major obstacle to the testing of trade theories has been the difficulty of constructing tests that all would agree are theoretically sound (Deardorff, 1984). The empirical tests of the single equation method are often faulted on the grounds that they test propositions that are not derived rigorously from economic theory. The pitfalls seem to lie in the specification and estimation of trade models themselves (Goldstein and Khan, 1985, p. 1097), which are seldom stated in forms that are compatible with the real world complexities that empirical research cannot escape.

The bulk of the time series work on import demand literature has addressed the supply side only by assumption. Goldstein and Khan (1985) point out that the prevailing practice has been to assume that the supply price elasticities for imports are infinite, thus, the price of imports is exogenous. In the econometrics point of view, an exogenous import price as the explanatory variable implies no correlation between the determining variables in the equation and the error term using ordinary least squares method. This assumption permits the satisfactory estimation of the import demand equation by single equation methods. In a study of modeling the U.S. demand for imports, Carone (1996, p. 4) justifies the single equation by using

[25] The major limitation of the Engle-Granger approach is that it implicitly assumes there is only one cointegrating relationship between the series. If there is more than one, the Engle-granger equations are misspecified and the parameter estimates are biased.
[26] For an example of an United States study, see Carone (1996).

this assumption. If the supply elasticities are less than infinite, one should estimate the full structural simultaneous model.[27]

Furthermore, single equation estimation is not generally derived from consumption theory. It does not describe the factors that determine the amounts spent by the consumer on the goods and services that are available in the market place. In other words, it does not derive from a utility function, where the consumer selects the particular commodity basket to maximises his/her utility subject to the financial limitations. This emphasises the need for a full structural simultaneous model. A structural model also provides a crucial inductive method to increase our knowledge about economic relationships and to test hypotheses about economic behaviour. Almost all economic theory is concerned with structural models, so that the unresolved questions of economics will usually be set within a structural framework (Hausman, 1983, p. 396).

2.3.1 Utility Maximisation

The utility function can be written as:

$$(2.31)\quad U(x)=U(x_1,\ldots,x_n)$$

where x stands for the quantity vector with elements $x_1, \ldots, x_n$. This utility function should be interpreted as measuring the consumer's satisfaction when the consumer buys and consumes, during the period under consideration, x_1 units of the first commodity, x_2 units of the second, and so on.

The utility function is maximised subject to constraints to the consumer's financial limitation. These constraints are expressed by the budget constraint,

$$(2.32)\quad \sum_{i=1}^{n} p_i x_i \leq y$$

where p_i are the prices that prevail during the period concerned and y is the total income by the consumer in that period. Maximising the utility function subject to the budget constraint leads to a unique solution for the quantity demanded as a function

[27] A structural model can be expressed as a system of equations, each equation involving some relationships among the exogenous variables, the endogenous variables, and the

of income and prices. This dependence of the quantities on the income and prices is called the demand equation.

If we substitute the demand equation into the utility function, utility becomes a function of income and prices,

$$(2.33)\quad u_I = u(q(Y,p)) = u_I(Y,p)$$

u_I is called the indirect utility function. It gives the maximum utility attainable corresponding to given values of income and prices. To obtain the demand for good *i*, Roy's theorem says,

$$(2.34)\quad q_i = -\frac{\delta u_I / \delta p_i}{\delta u_I / \delta Y}$$

$$i = 1, \ldots, n$$

Roy's theorem gives a second way of generating a system of demand equations (Theil, 1987, p.13).

2.3.2 Almost Ideal Demand System (AIDS)

Ever since Stone (1954) first estimated a system of demand equations derived explicitly from consumer theory, there has been a continuing search for alternative specifications and flexible functional forms. Many models have been proposed, but perhaps the most important in current use in international trade is the AIDS model.

Anderton, Pesaran and Wren-Lewis (1992) criticise the use of log-linear functional form in the import demand literature. Theoretically, the choice of a log-linearity in the import demand function implies a different, non-linear functional form for the demand for domestic output. There is no a priori theoretical reason for treating these two demands as different in character. Furthermore, log-linearity yields a non-constant relative price elasticity of the demand for domestic output, although constant relative price elasticity of imports remains an attractive property of the log-linear functional form.

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parameters. This system of equations is knows as a structural model.

Anderton et al. (1992) propose an alternative functional form based on the Almost Ideal Demand System (AIDS) specification by Deaton and Muellbauer (1980). Deaton and Muellbauer suggest the consumer's cost function,

(2.35) $$C(u,p) = e^{a(p)+ub(p)}$$

where,

(2.36) $$a(p) = \alpha_0 + \sum_{i=1}^{n} \alpha_i \ln(p_i) + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n} \gamma_{ij} \ln(p_i) \log(p_j)$$

$$i = 1, \ldots, n$$

(2.37) $$b(p) = \beta_0 \prod_{i=1}^{n} p_i^{\beta_i}$$

with the α_i, γ_{ij} and β_i all constants.

Since the indirect utility function of equation (2.33) is strictly increasing in income, *Y*, we can invert the function and solve for *Y* as a function of the level of utility; that is, given any level of utility, we can solve for the minimal amount of income necessary to achieve utility at a given price. The function that relates income and utility in this way is known as the expenditure function. The expenditure function gives the minimum cost of achieving a fixed level of utility. It is also completely analogous to the cost function. As a result, we can use a cost function to achieve a specification for consumer demand. Suppose that we have an expenditure function or cost function, *C(u,p)*, we can obtained the Hicksian demand function from Shephard's lemma:

(2.38) $$h_i(u,p) = \frac{\delta C(u,p)}{\delta p_i}$$

The Hicksian demand function states the consumption bundle achieves a target level of utility and minimises total expenditure. As a consequence, the specification of AIDS by Anderton et al. (1992) provides an expenditure function approach to consumption analysis.

Deaton and Muellbauer apply Shephard's lemma to this cost function, which gives a demand system in terms of utility and prices. Shephard's lemma states that if *C(u,p)* is differentiable at *(u, p)*, there is an unique vector *q* such that $\delta C(u, p)/\delta p_i = q_i$ and q_i is the factor demand for input *i*.

(2.39) $p_i q_i / C = (\delta C / \delta p_i)(p_i / C)$,

or

(2.40) $w_i = \delta \ln(C) / \delta \ln(p_i)$

where $w_i(u, p) = p_i q_i / C$ is the *i-th* Hicksian expenditure share for the *i-th* commodity, *i* = 1, ..., *n*. They then use the indirect utility function to express utility in terms of income and prices, which yields a demand system in terms of income and prices of the budget shares' form:

(2.41) $w_i = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} \ln(p_j) + U\beta_i b(p)$

$$i = 1, \ldots, n$$

Equation (2.41) involves Hicksian behaviour, which is unobservable since utility, *U*, is typically not directly observable. Thus, we need to transform this expression into the corresponding Marshallian behaviour, which is directly observable. In the context of the AIDS specification, this gives:

(2.42) $w_i = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} \ln(p_j) + V\beta_i b(p)$

where

(2.43) $V(p, Y) = [\ln(Y) - a(p)] / b(p)$

Thus, equation (2.43) can also be written as:

(2.44) $w_i = \alpha_i + \sum_{j=1}^{n} \alpha_{ij} \ln(p_j) + \beta_i [\ln(Y) - a(p)]$

where, *a*(*p*) and *b*(*p*) are given in equation (2.36) and equation (2.37), respectively, and

$$(2.45)\quad \ln P = \alpha_0 + \sum_{i=1}^{n}\alpha_i \ln(p_i) + \frac{1}{2}\sum_{i=1}^{n}\sum_{j=1}^{n}\alpha_{ij}\ln(p_i)\ln(p_j)$$

Deaton and Muellbauer refer to equation (2.44) as the almost ideal demand system.[28] In terms of the demand for imports, the budget share w_i will be the budget share for imports. α_i, β_i and γ_{ij} are constants and p_j is the price vector for all other import substitutes of domestic goods.

The AIDS formulation of the manufacturing import equation has the real import of manufacturing goods relative to total demand for manufactured goods as the dependable variable. This variable is explained by the conventional total expenditure for manufactured goods variable, and the relative price of imported goods to the price of domestic substitutes. In addition, Anderton et al. add time trend, which is proxied by the 'specialisation of international production' (SPEC) index. The SPEC index measures the moving average of world trade in manufactures to world industrial production. If this time trend proxy is significant, it justifies that UK imports are vulnerable to the international specialisation of the manufacturing production. In order to pick up the non-price competitiveness factor, a capacity utilisation variable is included as the explanatory variables. Capacity utilisation is proxied by the manufacturing output index relative to UK manufacturing capacity. This AIDS functional form is tested against the log-linear specification using the test statistics based on Pesaran and Pesaran (1989). Pesaran and Pesaran (1989) suggest a method of calculating Cox's (1962) non-nested test statistics by stochastic simulations, as noted by Anderton et al., which can be applied to general non-nested models. Test results favours the AIDS specification compared to the log-linear model.

Lim et al. (1996) also use the AIDS specification to model the import demand function for 3 sectors of Singapore economy, namely the agriculture and mining, fuels, and manufacturing sectors, for the period from 1975-1992. They use retained imports, which is total imports less re-exports, as the left hand side variable to be explained. This retained import consists essentially of the component of domestic absorption and the cost component of domestic exports. This characterisation is

[28] AIDS gives an arbitrary first-order approximation to any demand system. It satisfies the axioms of choice exactly. It aggregates perfectly over consumers without invoking parallel linear Engel curves. It has a functional form, which is consistent with known household-budget data. It is simple to estimate, largely avoiding the need for non-linear estimation; and it can be used to test the restriction of homogeneity and symmetry through linear restrictions on fixed parameters (Deaton and Muellbauer, 1980, p. 312).

reasonable for the case of Singapore, since raw materials for production of domestic exports are mostly imported, as noted in the paper.

Instead of using the usual GDP proxy for income, Lim et al. use the real aggregate retained import expenditure to proxy the income variable. They also impose the homogeneity of degree zero and assume exogeneity of the price variable. Lim et al. justify the use of exogeneity of price based on the small country assumption that the world supply of goods is infinite.

The price and the income elasticities estimated by Lim et al. have the correct signs, with the income elasticities generally higher than the price elasticities. This AIDS specification is then compared to the traditional log-linear functional form. The log-linear functional form uses all the variables as in the AIDS, except the income variable is replaced by the usual GDP variable. The homogeneity restriction is not imposed, and standard OLS regression is performed. The results show that the price elasticities and the income elasticities carry the wrong signs. Based on these results, the AIDS specification is favoured.

2.3.3 Other Structural Models

Gregory (1971) criticises traditional modelling that is not derived from utility functions and does not have microfoundations. He specifies the consumer utility function in terms of vectors of goods and services in the first level of utility as:

(2.46) $U = F\left\{ \phi_1\left(X^{(1)}\right), \phi_2\left(X^{(2)}\right) \right\}$

where $X^{(1)}$ and $X^{(2)}$ are vectors of goods and services, respectively. Gregory's primary concern is the first branch of the utility function, that is, the interest lies in the allocation of resources between goods, and in particular, the allocation between goods produced at home, $X_1^{(1)}$, and goods imported from overseas, $X_2^{(1)}$. The second level of utility function follows the constant elasticity of substitution (CES) specification: [29]

[29] The advantage of this model is that the estimating equation yields an estimate of the elasticity of substitution between imports and domestic goods from which an estimate of the own price elasticity of demand for imports can be readily obtained. However, Burgess (1974(b)) criticises the model by mentioning the maintained hypothesis of separability between imports and all types of domestic goods, which is equivalent to the assumption that the partial elasticities of substitution between imports and all types of domestic goods are

(2.47) $\phi_1\left(X^{(1)}\right)=\left[\sum_{i=1}^{2}\delta_i\left(X_i^{(1)}\right)^{-\rho}\right]^{-\frac{1}{\rho}}$

Maximising the utility function with respect to the budget constraint yields the equality of the marginal utility ratio to the ratio of prices. Adding a taste multiplier, allows the model to capture the relative change in tastes between domestic and foreign goods. He also adds a Koyck lag structure to capture the delayed response arising from costs of adjustment to changes in relative prices.

Most import demand studies explain the level of imports by national income and the ratio of import to domestic prices. Gregory (1971) suggests that the normal income and price responses of traditional theory are not sufficient to explain the cyclical behaviour of imports. There is a separate response, which arises from excess demand.[30] Gregory argues that when there is excess demand in the United States and pressure is exerted upon domestic resources, consumers turn to foreign suppliers.[31] The result is an increase in imports, which would not be predicted from the movement of either relative prices or domestic income.[32] With the belief that actual prices are slow to adjust to their equilibrium, this implies that the markets are being cleared by other variables as well as the usual price variable. Gregory uses effective prices, rather than treat the price as a one-dimensional variable.[33] In conclusion, this study assumes producers do not adjust prices to meet fluctuations of demand in the short run. Price elasticity of substitution is larger with the inclusion of effective price rather than the traditional specification.

Clarida (1994) uses a utility function, which incorporates the rational-expectations permanent-income model, to derive a structural econometric equation that can be used to estimate the parameters of the demand for imported nondurable

equal. Also, he notes the failure to recognise that the bulk of international trade occurs in intermediate goods requiring further processing.

[30] Prices are slow to adjust and markets are cleared by a number of other variables acting as rationing mechanisms.

[31] When there is excess demand, domestic waiting times increase, credit becomes more difficult to obtain, suppliers are less vigorous in the pursuit of new orders, and consumers therefore turn to foreign suppliers.

[32] Gregory (1971) predicts the increase in imports by taking account of the extent to which domestic prices deviate from equilibrium as well as the relationship between income and potential output.

[33] Gregory (1971) treats price as a vector possessing many dimensions. Its elements are the actual quoted price, the waiting time, the trade credit terms, rebates and any other ancillary aspects of the contract which are relevant for the decision to purchase or not.

consumer goods. Clarida incorporates consumer assets in the next period to the budget constraint to derive the log of demand for imports as a linear function of the log of the relative price of imports, the log of the demand for domestic goods, and the log of an unobservable shock to tastes. Using the cointegration technique by Engle and Granger (1987), the study finds that the variables are cointegrated. Senhadji (1998) uses a similar approach in a cross-country analysis, which incorporates the real business cycle theory.

On the other hand, one can approach the structural model by looking at the firm's behaviour, for example, Kohli (1983). In this paper, Kohli examines the role of prices and factor endowments in the determination of Australian imports. Kohli notes that most of the estimates of import price and quantity elasticities available for Australia are obtained from single equation models, with relatively little attention paid to the underlying structure, and with the choice of explanatory variables resting largely on *ad hoc* consideration. These estimated elasticities only indicate partial effects, and when assessing them, it is essential to bear in mind what the 'other things held constant' actually are. In order to evaluate the total effects, knowledge of the full structural model is generally needed.

Kohli (1983) examines two models of import demand using annual data from 1959-60 to 1978-79. The first model assumes small-open-economy hypothesis of international trade theory that considers domestic factor endowments and the price of traded goods as exogenous variables. In the second model, employment of labour is allowed to vary, while continuing to assume the exogeneity of capital stock. This treatment allows for a distinction between the short-run and the medium-run models. Imports are treated as intermediate goods that enter the production process together with domestic factor services.[34] Kohli assumes a large number of firms that operate under perfect competition in all markets. These firms choose the quantities of their inputs (including imports) and outputs in order to maximise their profits subject to the technology, and input and output prices under a perfect competition environment.

In the short-run, Kohli assumes that the country's factor endowments are given and all goods are tradeable in a small-open-economy environment. Kohli describes the country's technology by two primary factors, namely, labour and

[34] Kohli (1983) points out that this treatment seems most appropriate for aggregate imports, since a substantial share of Australian imports consists of raw materials and intermediate products, and since even most finished goods are still subject to domestic handling, transportation, and retail changes before reaching final demand, in which case domestic value added may account for significant proportion of the final price tag.

capital, and one import and one output. Kohli then maximises a profit function subject to the country's technology. By using the Hotelling's lemma, the profit-maximising supply of output and demand for imports can be obtained by differentiation.[35] Since the supply of output and two inverse demand for inputs are derived simultaneously with the demand for imports, it is statistically most efficient to estimate all demand and supply functions jointly, taking into account that they are all obtained from the same variable profit function.

In the medium-run, an alternative technology description is employed by Kohli. The employment, output and imports are considered as variable while continuing to assume the capital stock exogenous. This gives an alternative profit function in the medium-run. The profit maximising supply of output, and demand for imports and labour can be obtained in the same fashion as in the short-run. The medium-run import demand function is estimated together with the output supply and factor demand functions to gain the most efficient estimates.

Kohli uses the translog functional form to express the two profit functions.[36] In the first model, the profit function can be written as:

$$(2.48)\quad \ln\pi = a_0 + \sum a_i \ln p_i + \sum b_j \ln q_j + \frac{1}{2}\sum\sum c_{ih} \ln p_i \ln p_h + \frac{1}{2}\sum\sum f_{jk} \ln q_j \ln q_k + \sum\sum d_{ij} \ln p_i \ln q_j$$

$$i, h = Y, M; \qquad j, k = L\ K$$

where Y, M , L and K stand for gross output, imports, labour and capital, respectively. Equation (2.48) is twice differentiable, so that the Hessian of this equation is symmetrical. This gives rise to a set of restrictions relating the parameters of the cross-partial derivatives of c_{ih} = c_{hi} and f_{jk} = f_{kj}. The translog functional form also exhibits linear homogeneity with respect to prices and constant return to scale, thus, $\sum a_i = 1$, $\sum b_j = 1$, $\sum c_{ih} = 0$, $\sum f_{jk} = 0$, $\sum_i d_{ij} = 0$ and $\sum_j d_{ij} = 0$. The q denotes quantities and the p denotes prices. The output supply,

[35] The inverse demand for inputs can be obtained in the same way.
[36] Kohli choses the translog functional form mainly because of the simplicity of the form of the derived demand and supply equations, the ease with which allowance for autocorrelation can be made, the possibility of imposing convexity or concavity, and the fact that it contains separability as parametric restrictions.

import demand, and inverse factor demand functions can then be derived in share form as follows:

(2.49) $p_i q_i / \pi = w_i = a_i + \sum c_{ih} \ln p_h + \sum d_{ij} \ln q_j$

(2.50) $p_j q_j / \pi = w_j = b_j + \sum d_{ij} \ln p_i + \sum f_{kj} \ln q_k$

$$i, h = Y, M; \;\; j, k = L, K$$

The sign of (2.49) is positive for output and negative for imports.

In the case of profit function for model 2, the translog function can be written as:

(2.51) $\ln R = \alpha_0 + \sum \alpha_1 \ln p_i + \frac{1}{2} \sum \sum \gamma_{ih} \ln p_i \ln p_h + \ln q_k$

$$i, h = Y, M, L; \; k = K$$

R is used in this case to differentiate the short-run (model 1) from the medium-run (model 2). The output supply, the import demand, and the labour demand functions are derived in share form:

(2.52) $p_i q_i / R = \omega_i = \alpha_i + \sum \gamma_{ih} \ln p_h$

$$i, h = Y, M, L$$

The sign on the left-hand side of equation (2.52) is positive for output, and negative for imports and labour.

The data are uncorrected for technological change and it is therefore unlikely that factor growth alone can account fro the entire output growth. A time trend or disembodied exponential technological change that affects both inputs and output is added to capture the technological change for both models. A disembodied factor augmenting technological change at constant exponential rates is added in this study. Let $\tilde{q}_L$ and $\tilde{q}_K$ be th quantities of labour and capital measured in efficiency units, Kohli assumes:

(2.53) $\tilde{q}_L = q_L e^{\mu_L{}^t}$, $\tilde{q}_K = q_k e^{\mu_K{}^y}$

where $\mu_L, \mu_K \geq 0$ are the rates of technological change of labour and capital respectively, t is time and q_L and q_K are measured quantities. In the case of model 1, equation (2.49) and (2.50) become:

$$(2.54) \quad w_i = a_i + \sum c_{ih} \ln p_h + \sum d_{ij} \ln q_j + \sum d_{ij} \mu_j t$$

$$(2.55) \quad w_j = b_j + \sum d_{ij} \ln p_i + \sum f_{jk} \ln q_k + \sum f_{jk} \mu_k$$

$$i, h = Y, M; \;\; j, k = L, K$$

in the case of model 2, by allowance for technological change, equation (2.52) becomes:

$$(2.56) \quad w_i = \alpha_i + \sum \gamma_{ih} \ln p_h - \gamma_{iL} \mu_L t$$

$$i, h = Y, M, L$$

Kohli finds that the own partial price elasticity of the demand for imports is larger (in absolute value) in the medium run than in the short run (0.7 vs. 0.6 approximately). In the results about separability, the hypotheses cannot be rejected that imports and output on one hand, and capital and labour on the other hand, can be aggregated in the Australian case. Thus, the results are consistent with the existence of a domestic real value added function, but unit elasticity of substitution between labour and capital is not supported by the data.

2.3.4 Estimation of Simultaneous Equation Models

Economics provides unique insight from economic theory in terms of the simultaneous determination of economic variables through an equilibrium model. For example, in a demand or supply curve, both quantity and price are simultaneously determined by the actions of the market. To understand the quantity and price relationship we need to treat the two variables as jointly endogenous. With jointly endogeneity, the single equation least squares regression method will produce inconsistent estimates. The single equation least squares estimates are inconsistent because of possible correlation between the endogenous variable with the error term.

In simultaneous equations models, variables are classified as endogenous and exogenous. The endogenous variables (jointly determined) are variables that are determined by the economic model and exogenous variables (predetermined) are those determined from outside the system. A general method of obtaining consistent estimates of the parameters in simultaneous equations models is the instrumental variable method. An instrumental variable is a variable that is uncorrelated with the error term but correlated with the explanatory variables in the equation. In practice, it is rather hard to find valid instrument variables. Usually, the instrumental variables are some variables that are "around", that is, whose data are available but do not belong in the question (Maddala, 1992, p. 462). The reason for the instrumental variable to be uncorrelated with the error term but correlated with the dependent variable is that we want the covariance of the instrumental variable and the error term to be zero and covariance of the dependent variable and the instrumental variable to be nonzero.

Anderton et al. (1992) use both the single equation least square and the instrumental variable method in estimating their AIDS formulation of the import equation. Anderton et al. use the logarithm of capital utilisation (up to 4 lags) as an instrumental variable. Without instrumentation, the estimated coefficient for capital utilisation is negative. Compared to instrumental variable estimation, this coefficient is significantly positive, which is consistent with a rise in utilisation leading to a decline in non-price competitiveness. As a result, the single equation least squares estimates reflect the simultaneity bias.

Chapter 3: Empirical Modelling

3.0 The Basic Model

This chapter examines the responsiveness of import flows to import price. The results are meant to illustrate the potential gains from empirical work employing econometric specifications with a coherent theoretical basis. The basic model is based on Bloch and Heijdra (1994). Cournot and Bertrand conjectures are modelled separately. This leads to an econometric specification in which Cournot and Bertrand behaviour can be distinguished through the pattern of estimated coefficients in an equation for the industry price-cost margin.

3.1 Consumers

The consumer demand function is derived from a constant elasticity of substitution (CES) utility function with composite goods as arguments and where consumers are assumed to have nested preferences over composite goods. This is a direct route in modelling the consumer utility function, noting that the convexity of indifference surfaces of a conventional utility function defined over the quantities of all potential commodities already embodies the desirability of variety.[37]

At the top level, consumer demand is derived from a general type of CES utility function over m composite consumption goods (c_i, i = 1, ..., m):

(3.1) $$U = f(c)$$

where

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

α_i is the weight of consumption good i consumed, which add up to unity. σ is the substitution elasticity between the m consumption goods.

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[37] See Spence (1976) and Dixit and Stiglitz (1977).

By using the assumption by Armington (1969), 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 ($c_{f,i}$):

$$(3.3) \quad c_i \equiv \left[\beta_i^{\frac{1}{\sigma_{df,i}}} c_{d,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} + (1-\beta_i)^{\frac{1}{\sigma_{df,i}}} c_{f,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} \right]^{\frac{\sigma_{df,i}}{\sigma_{df,i}-1}}$$

where $0 \leq \beta_i \leq 1$.[38] 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 are assumed to be made up of the existing varieties of the domestic and foreign goods, respectively, as follows:

$$(3.4) \quad c_{d,i} \equiv \left[\sum_{j=1}^{n_{d,i}} \gamma_{d,ij}^{\frac{1}{\sigma_{d,i}}} c_{d,ij}^{\frac{\sigma_{d,i}-1}{\sigma_{d,i}}} \right]^{\frac{\sigma_{d,i}}{\sigma_{d,i}-1}}$$

$$(3.5) \quad c_{f,i} \equiv \left[\sum_{k=1}^{n_{f,i}} \gamma_{f,ik}^{\frac{1}{\sigma_{f,i}}} c_{f,ik}^{\frac{\sigma_{f,i}-1}{\sigma_{f,i}}} \right]^{\frac{\sigma_{f,i}}{\sigma_{f,i}-1}}$$

$c_{d,ij}$ 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. Finally, $\gamma_{d,ij} > 0$ and $\gamma_{f,ik} > 0$.

3.1.1 Derivation of the Consumption Demand Facing Domestic Firm

The demand functions for the various goods and varieties can be derived by means of two-stage budgeting, given the utility tree has been set up in the appropriate manner. At the top level, maximise the choice of c_i, assuming $U = c$

38 At the two extreme points, $\beta_i = 0$ specifies that good i is a pure import good and $\beta_i = 1$ specifies good i is only sourced domestically.

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

subject to:

(3.7) $$Y = \sum_{i=1}^{m} p_i c_i$$

where Y is some measure of nominal income. In order to solve the optimisation, the Lagrangian function is applied.

(3.8) $$L = \left[\sum_{i=1}^{m} \alpha_i^{\frac{1}{\sigma}} c_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{\sigma}{\sigma-1}} - \lambda \left[Y - \sum_{i=1}^{m} p_i c_i \right]$$

for all i,

The first derivative yields,

(3.9) $$\frac{\delta L}{\delta c_i} = \frac{\sigma}{\sigma - 1} \left[\sum_{i=1}^{m} \alpha_i^{\frac{1}{\sigma}} c_i^{\frac{\sigma-1}{\sigma}} \right]^{\frac{1}{\sigma-1}} \frac{\sigma - 1}{\sigma} \left[\alpha_i^{\frac{1}{\sigma}} c_i^{-\frac{1}{\sigma}} \right] + \lambda p_i = 0$$

(3.10) $$\frac{\delta L}{\delta \lambda} = \sum_{i=1}^{m} p_i c_i - Y = 0$$

Equation (3.9) applied to goods i and j implies,

(3.11) $$\left[\frac{\alpha_i}{\alpha_j} \right]^{\frac{1}{\sigma}} \left[\frac{c_j}{c_i} \right]^{\frac{1}{\sigma}} = \frac{p_i}{p_j}$$

which yields,

(3.12) $$c_j = \left[\frac{p_i}{p_j} \right]^{\sigma} \left[\frac{\alpha_j}{\alpha_i} \right] c_i$$

Substitutes (3.12) into (3.10) gives,

$$(3.13)\quad c_i = \frac{\alpha_i p_i^{-\sigma} Y}{\left(\sum_{j=1}^{m} \alpha_j p_j^{1-\sigma}\right)} = \alpha_i \left(\frac{p_i}{p}\right)^{-\sigma} y$$

Once c_i has been determined, the domestic and foreign composite goods $c_{d,i}$ and $c_{f,i}$ must be determined in an optimal fashion. The sub-problem is as follows. Maximise by choice of $c_{d,i}$ and $c_{f,i}$:

$$(3.3)\quad c_i \equiv \left[\beta_i^{\frac{1}{\sigma_{df,i}}} c_{d,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} + (1-\beta_i)^{\frac{1}{\sigma_{df,i}}} c_{f,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}}\right]^{\frac{\sigma_{df,i}}{\sigma_{df,i}-1}}$$

subject to:

$$(3.14)\quad p_i c_i = p_{d,i} c_{d,i} + p_{f,i} c_{f,i}$$

The Lagrangian function is as follows:

$$(3.15)\quad L = \left[\beta_i^{\frac{1}{\sigma_{df,i}}} c_{d,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} + (1-\beta_i)^{\frac{1}{\sigma_{df,i}}} c_{f,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}}\right]^{\frac{\sigma_{df,i}}{\sigma_{df,i}-1}} - \lambda\left[p_i c_i - p_{d,i} c_{d,i} - p_{f,i} c_{f,i}\right]$$

The first derivative yields the following:

$$(3.16)\quad \frac{\delta L}{\delta c_{d,i}} = \frac{\sigma_{df,i}}{\sigma_{df,i}-1}\left[\beta_i^{\frac{1}{\sigma_{df,i}}} c_{d,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} + (1-\beta_i)^{\frac{1}{\sigma_{df,i}}} c_{f,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}}\right]^{\frac{1}{\sigma_{df,i}-1}} \times \left[\frac{\sigma_{df,i}-1}{\sigma_{df,i}}\right]\left[\beta_i^{\frac{1}{\sigma_{df,i}}} c_{d,i}^{-\frac{1}{\sigma_{df,i}}}\right] + \lambda p_{d,i} = 0$$

(3.17)
$$\frac{\delta L}{\delta c_{f,i}} = \frac{\sigma_{df,i}}{\sigma_{df,i}-1}\left[\beta_i^{\frac{1}{\sigma_{df,i}}} c_{d,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}} + (1-\beta_i)^{\frac{1}{\sigma_{df,i}}} c_{f,i}^{\frac{\sigma_{df,i}-1}{\sigma_{df,i}}}\right]^{\frac{1}{\sigma_{df,i}-1}} \times \left[\frac{\sigma_{df,i}-1}{\sigma_{df,i}}\right]\left[(1-\beta_i)^{\frac{1}{\sigma_{df,i}}} c_{f,i}^{-\frac{1}{\sigma_{df,i}}}\right] + \lambda p_{f,i} = 0$$

(3.18)
$$\frac{\delta L}{\delta \lambda} = p_{d,i}c_{d,i} + p_{f,i}c_{f,i} - p_i c_i = 0$$

(3.16) and (3.17) imply

(3.19)
$$\left[\frac{\beta_i}{1-\beta_i}\right]^{\frac{1}{\sigma}}\left[\frac{c_{d,i}}{c_{f,i}}\right]^{-\frac{1}{\sigma_{df,i}}} = \frac{p_{d,i}}{p_{f,i}}$$

Equation (3.19) yields,

(3.20)
$$c_{d,i} = \left\{\left[\frac{p_{f,i}}{p_{d,i}}\right]\left[\frac{1-\beta_i}{\beta_i}\right]^{\frac{1}{\sigma_{df,i}}} c_{f,i}^{-\frac{1}{\sigma_{df,i}}}\right\}^{-\sigma_{df,i}}$$

(3.21)
$$c_{f,i} = \left\{\left[\frac{p_{f,i}}{p_{d,i}}\right]\left[\frac{\beta_i}{1-\beta_i}\right]^{\frac{1}{\sigma_{df,i}}} c_{d,i}^{-\frac{1}{\sigma_{df,i}}}\right\}^{-\sigma_{df,i}}$$

Equation (3.21) is then substituted in to equation (3.18) to solve for $c_{d,i}$. $c_{f,i}$ can be solved by substituting equation (3.20) into equation (3.18). The solutions for $c_{d,i}$ and $c_{f,i}$ are as follows:

(3.22)
$$c_{d,i} = \frac{\beta_i p_{d,i}^{-\sigma_{df,i}} p_i c_i}{\left[\beta_i p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i) p_{f,i}^{1-\sigma_{df,i}}\right]} = \beta_i \left(\frac{p_{d,i}}{p_i}\right)^{-\sigma_{df,i}} c_i$$
$$c_{f,i} = \frac{(1-\beta_i) p_{f,i}^{-\sigma_{df,i}} p_i c_i}{\left[\beta_i p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i) p_{f,i}^{1-\sigma_{df,i}}\right]} = (1-\beta_i)\left(\frac{p_{f,i}}{p_i}\right)^{-\sigma_{df,i}} c_i$$

p_i is a consistent price index whose form is uniquely defined by the second step of the maximisation problem. From equation (3.14),

$$(3.23) \quad p_i = \frac{p_{d,i}\, c_{d,i} + p_{f,i}\, c_{f,i}}{c_i}$$

Substituting $c_{d,i}$ and $c_{f,i}$ of equation (3.22) into equation (3.23) gives the consistent price index.

$$(3.24) \quad p_i \equiv \left[\beta_i p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i) p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}}$$

The composite demands $c_{d,i}$ and $c_{f,i}$ must now be allocated over the different varieties in existence. For $c_{d,i}$, for example, this amounts to maximising the following by choice of $c_{d,ij}$:

$$(3.4) \qquad c_{d,i} \equiv \left[\sum_{j=1}^{n_{d,i}} \gamma_{d,ij}^{\frac{1}{\sigma_{d,i}}} c_{d,ij}^{\frac{\sigma_{d,i}-1}{\sigma_{d,i}}}\right]^{\frac{\sigma_{d,i}}{\sigma_{d,i}-1}}$$

subject to:

$$(3.25) \quad \sum_{j=1}^{n_{d,i}} p_{d,ij}\, c_{d,ij} = p_{d,i}\, c_{d,i}$$

The Lagrangian function is as follows:

$$(3.26) \quad L = \left[\sum_{j=1}^{n_{d,i}} \gamma_{d,ij}^{\frac{1}{\sigma_{d,i}}} c_{d,ij}^{\frac{\sigma_{d,i}-1}{\sigma_{d,i}}}\right]^{\frac{\sigma_{d,i}}{\sigma_{d,i}-1}} - \lambda\left[p_{d,i}c_{d,i} - \sum_{j=1}^{n_{d,i}} p_{d,ij}c_{d,ij}\right]$$

The first derivative yields the followings:

(3.27) $$\frac{\delta L}{\delta c_{d,ij}}=\frac{\sigma_{d,i}}{\sigma_{d,i}-1}\left[\sum_{j=1}^{n_{d,i}}\gamma_{d,ij}^{\frac{1}{\sigma_{d,i}}}c_{d,ij}^{\frac{\sigma_{d,i}-1}{\sigma_{d,i}}}\right]^{\frac{1}{\sigma_{d,i}}}\left[\frac{\sigma_{d,i}-1}{\sigma_{d,i}}\right]\left[\gamma_{d,ij}^{\frac{1}{\sigma_{d,i}}}c_{d,ij}^{-\frac{1}{\sigma_{d,i}}}\right]+\lambda p_{d,ij}=0$$

(3.28) $$\frac{\delta L}{\delta c_{d,ik}}=\frac{\sigma_{d,i}}{\sigma_{d,i}-1}\left[\sum_{k=1}^{n_{d,i}}\gamma_{d,ik}^{\frac{1}{\sigma_{d,i}}}c_{d,ik}^{\frac{\sigma_{d,i}-1}{\sigma_{d,i}}}\right]^{\frac{1}{\sigma_{d,i}}}\left[\frac{\sigma_{d,i}-1}{\sigma_{d,i}}\right]\left[\gamma_{d,ik}^{\frac{1}{\sigma_{d,i}}}c_{d,ik}^{-\frac{1}{\sigma_{d,i}}}\right]+\lambda p_{d,ik}=0$$

(3.29) $$\frac{\delta L}{\delta\lambda}=p_{d,i}c_{d,i}-\sum_{j=1}^{n_{d,i}}p_{d,ij}c_{d,ij}=0$$

The division of (3.27) and (3.28), gives:

(3.30) $$\left[\frac{\gamma_{d,ij}}{\gamma_{d,ik}}\right]^{\frac{1}{\sigma_{d,i}}}\left[\frac{c_{d,ik}}{c_{d,ij}}\right]^{\frac{1}{\sigma_{d,i}}}=\frac{p_{d,ij}}{p_{d,ik}}$$

which implies,

(3.31) $$c_{d,ik}=\left[\frac{p_{d,ij}}{p_{d,ik}}\right]^{\sigma_{d,i}}\left[\frac{\gamma_{d,ik}}{\gamma_{d,ij}}\right]c_{d,ij}$$

Substitutes (3.31) in to (3.29) gives the solutions for $c_{d,ij}$ $\left(j=1,\ldots,n_{d,i}\right)$.

(3.32) $$c_{d,ij}=\frac{\gamma_{d,ij}p_{d,ij}^{-\sigma_{d,i}}p_{d,i}c_{d,i}}{\left(\sum_{j=1}^{n_{d,i}}p_{d,ij}^{1-\sigma_{d,i}}\right)}=\gamma_{d,ij}\left(\frac{p_{d,ij}}{p_{d,i}}\right)^{-\sigma_{d,i}}c_{d,i}$$

The solutions for $c_{f,ik}$ $\left(k=1,\ldots,n_{f,i}\right)$ can be found in a similar fashion.

(3.33) $$c_{f,ik}=\frac{\gamma_{f,ik}p_{f,ik}^{-\sigma_{f,i}}p_{f,i}c_{f,i}}{\left(\sum_{k=1}^{n_{f,i}}p_{f,ik}^{1-\sigma_{f,i}}\right)}=\gamma_{f,ik}\left(\frac{p_{f,ik}}{p_{f,i}}\right)^{-\sigma_{f,i}}c_{f,i}$$

The consistent price indices $p_{d,i}$ is form uniquely by the third level of optimisation. From equation (3.25),

$$(3.34)\quad p_{d,i} = \frac{\sum_{j=1}^{n_{d,i}} p_{d,ij}\, c_{d,ij}}{c_{d,i}}$$

Substituting the solution for $c_{d,i}$ and $c_{d,ij}$ of equations (3.22) and (3.32), respectively, gives the following:

$$(3.35)\quad p_{d,i} \equiv \left[\sum_{j=1}^{n_{d,i}} \gamma_{d,ij}\, p_{d,ij}^{1-\sigma_{d,i}} \right]^{\frac{1}{1-\sigma_{d,i}}}$$

The consistent price indices $p_{f,i}$ is form in the same manner.

$$(3.36)\quad p_{f,i} \equiv \left[\sum_{k=1}^{n_{f,i}} \gamma_{f,ik}\, p_{f,ik}^{1-\sigma_{f,i}} \right]^{\frac{1}{1-\sigma_{f,i}}}$$

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

$$(3.37)\quad c_{d,ij} = \gamma_{d,ij} \left(\frac{p_{d,ij}}{p_{d,i}} \right)^{-\sigma_{d,i}} \beta_i \left(\frac{p_{d,i}}{p_i} \right)^{-\sigma_{df,i}} \alpha_i \left(\frac{p_i}{p} \right)^{-\sigma} y$$

where $\gamma_{d,ij}$ and β_i are the weight of domestic consumption good ij and weight of all domestic varieties in industry i, 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 for real income, y.

3.2 Producers

Production is the process of transforming inputs into outputs. The fundamental reality that firms must contend with in this process is technological feasibility. The state of technology determines and restricts what is possible in combining inputs to produce output, and there are several ways that we can represent this constraint.

In particular, we assume short-run production function describing firm *ij*'s production is a Leontief production function:

(3.38) $$y_{d,ij} \equiv Min\left[\frac{l_{d,ij}}{a_{d,ijl}}, \frac{m_{d,ij}}{a_{d,ijm}}, \frac{k_{d,ij}}{a_{d,ijk}}\right]$$

(3.39) $$y_{f,ij} \equiv Min\left[\frac{l_{f,ij}}{a_{f,ijl}}, \frac{m_{f,ij}}{a_{f,ijm}}, \frac{k_{f,ij}}{a_{f,ijk}}\right]$$

where l_{ij}, m_{ij} and k_{ij} are the labour force, the input of materials and the capital stock of firm *ij*, respectively. The subscripts *d* and *f* are used to identify domestic production from its foreign counterpart. The denominators are the respective input requirement coefficients that are assumed to be specific to firm and industry.

Under Leontief technology, firms will not waste any input with a positive price, thus, the firm must operate at a point where $y_{x,ij} = a_{x,ijl}\ l_{x,ij} = a_{x,ijm}\ m_{x,ij} = a_{x,ijk}\ k_{x,ij}\ (x = d\ or\ f)$. The solution for the labour input, material input and capital input are given as:

(3.40) $$l_{x,ij} = \frac{y_{x,ij}}{a_{x,ijl}}$$

(3.41) $$m_{x,ij} = \frac{y_{x,ij}}{a_{x,ijm}}$$

(3.42) $$k_{x,ij} = \frac{y_{x,ij}}{a_{x,ijk}}$$

$$for\ x = d\ or\ f$$

The general cost function is given as:

(3.43) $C_{x,ij} = W_{x,i}l_{x,ij} + P^M_{x,i}m_{x,ij} + P^k_{x,i}k_{x,ij}$

Since the emphasis of the paper is on the short-run pricing decision of domestic firms, the firm's capital stock is assumed fixed. Up to capacity given by $k_{d,i}/a_{d,ijk}$, the cost function for domestic firms is given as follows:

(3.44) $C_{d,ij} = \left(a_{d,il}W_{d,i} + a_{d,im}P^M_{d,i}\right)y_{d,ij} + P^k_{d,i}k_{d,ij}$

W, P^M and P^k are the nominal wage rate, the price of materials, and the price of capital, respectively. The cost function in (3.44) is linear homogenous in output and additive in input prices weighted by the physical productivity of each input.

3.3 Non-Collusive Oligopoly

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

Domestic firms are assumed to have maximising profit as their objective. Operating profit of firm *ij* in the short run is defined as follows.

(3.45) $\pi_{ij} \equiv p_{d,ij}y_{d,ij} - \left[\left(a_{d,il}W_{d,i} + a_{d,im}P^M_{d,i}\right)y_{d,ij} + P^k_{d,i}k_{d,ij}\right]$

Maximising profit by choice of production yields the following first-order condition for firm *ij*:

(3.46) $\dfrac{\delta\pi_{ij}}{\delta y_{d,ij}} = p_{d,ij}\left(\dfrac{\delta y_{d,ij}}{\delta y_{d,ij}}\right) + \left(\dfrac{\delta p_{d,ij}}{\delta y_{d,ij}}\right)y_{d,ij} - \left(a_{d,il}W_{d,i} + a_{d,im}P^M_{d,i}\right)\left(\dfrac{\delta y_{d,ij}}{\delta y_{d,ij}}\right) = 0$

which gives,

(3.47) $P_{d,ij}\left[1 + \dfrac{1}{\varepsilon_{ij}}\right] = SMC_{ij}$

where ε_{ij} is the perceived elasticity of demand facing firm *ij*, and SMC_{ij} is short-run marginal cost $\left(a_{d,il}W_{d,i} + a_{d,im}P_{d,i}^{M}\right)$.[39] Firm *ij*'s perceived elasticity, ε_{ij}, incorporates its expectations regarding the response of rivals to changes in its own price or quantity. Price in (3.47) can be seen to equal mark-up times marginal cost, which implies that the influence of production costs on the domestic price is direct. 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. Conjectural variation parameters give a straightforward meaning to the degree of competition in an industry and also allow different models to be analysed within the same unifying framework.

3.3.1 Derivations of the Perceived Demand Elasticities

3.3.1.1 Cournot Conjectures

Under Cournot competition, the reactions by other firms are assumed to be in the form of quantity reactions. The inverse demand facing firm *ij* can be obtained from equation (3.32),

$$(3.48)\quad p_{d,ij} = \left(\frac{c_{d,ij}}{\gamma_{d,ij}c_{d,i}}\right)^{-\frac{1}{\sigma_{d,i}}} p_{d,i}$$

By sequentially substituting the inverse demand functions for $c_{d,i}$ and c_i into equation (3.48) and taking logarithms, and ignoring constant terms α_i, β_i and γ_i, the following expression can be obtained for $\ln p_{d,ij}$ in terms of quantity indices:

$$(3.49)\quad \ln p_{d,ij} = -\frac{1}{\sigma_{d,i}}\left[\ln c_{d,ij} - \ln c_{d,i}\right] - \frac{1}{\sigma_{d,fi}}\left[\ln c_{d,i} - \ln c_i\right] - \frac{1}{\sigma}\left[\ln c_i - \ln c\right]$$

The inverse price elasticity can be calculated using equation (3.49),

[39] Assume that firm has no storage opportunity, so production always equals demand, or $y_{d,ij} = c_{d,ij}$.

$$\frac{1}{\varepsilon_{ij}(CCE)} \equiv \frac{\delta \ln p_{d,ij}}{\delta \ln c_{d,ij}} = -\frac{1}{\sigma_{d,i}} + \left[\frac{1}{\sigma_{d,i}} - \frac{1}{\sigma_{df,i}}\right]\frac{\delta \ln c_{d,i}}{\delta \ln c_{d,ij}}$$

(3.50)

$$+\left[\frac{1}{\sigma_{df,i}} - \frac{1}{\sigma}\right]\frac{\delta \ln c_i}{\delta \ln c_{d,ij}} + \left[\frac{1}{\sigma}\right]\frac{\delta \ln c}{\delta \ln c_{d,ij}}$$

The conjectural reactions between domestic producers in the same industry are incorporated in the calculation of the elasticity between $c_{d,i}$ and $c_{d,ij}$. In view of equation (3.4), this elasticity can be calculated as follows:

(3.51) $$\frac{\delta \ln c_{d,i}}{\delta \ln c_{d,ij}} = PRS_{ij} + \sum_{\substack{k=1 \\ k \neq j}}^{n_{d,i}} PRS_{ik}\xi_i = PRS_{ij} + \xi_i\left(1 - PRS_{ij}\right)$$

where PRS_{ij} is defined as:

(3.52) $$PRS_{ij} \equiv \frac{\gamma_{d,ij} p_{d,ij}^{1-\sigma_{d,i}}}{\sum_{j=1}^{n_{d,i}} \gamma_{d,ij} p_{d,ij}^{1-\sigma_{d,i}}} = \frac{p_{d,ij} c_{d,ij}}{p_{d,i} c_{d,i}}$$

and the conjectural quantity reaction elasticity is given as:

(3.53) $$\xi_i = \frac{\delta \ln c_{d,ik}}{\delta \ln c_{d,ij}}$$

In view of equation (3.3), the industry-wide quantity-index effect can be calculated as follows:

(3.54) $$\frac{\delta \ln c_i}{\delta \ln c_{d,ij}} = PRS_i\left(\frac{\delta \ln c_{d,i}}{\delta \ln c_{d,ij}}\right)$$

where PRS_i is defined as:

$$(3.55)\quad PRS_i \equiv \frac{\beta_i p_{d,i}^{1-\sigma_{df,i}}}{\left[\beta_i p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i) p_{f,i}^{1-\sigma_{df,i}}\right]} = \frac{p_{d,i} c_{d,i}}{p_i c_i} \qquad 0 < PRS_i < 1$$

Equation (3.54) incorporates the small open economy assumption in the sense that foreign quantities are perceived not to react to changes in the domestic quantities.

Finally, in view of the definition of c in equation (3.2), the general quantity index effect can be calculated as follows:

$$(3.56)\quad \frac{\delta \ln c}{\delta c_{d,ij}} = IRS_i * PRS_{d,i} \left(\frac{\delta \ln c_{d,i}}{\delta \ln c_{d,ij}} \right)$$

where IRS_i is the budget share of composite good i in total spending as:

$$(3.57)\quad IRS_i = \alpha_i \left(\frac{p_i}{p} \right)^{(1-\sigma)}$$

Combining equations (3.50), (3.51), (3.54) and (3.56), the final expression for $\varepsilon_{ij}(CCE)$ is obtained.

$$(3.58)\quad \frac{1}{\varepsilon_{ij}(CCE)} = -\frac{1}{\sigma_{d,i}} + \left[\frac{1}{\sigma_{d,i}} - (1 - PRS_i)\frac{1}{\sigma_{df,i}} - (1 - IRS_i) PRS_i \frac{1}{\sigma} \right] \times \left[PRS_{ij} + \xi_i \left(1 - PRS_{ij}\right) \right]$$

3.3.1.2 Bertrand Conjectures

The demand facing firm ij is defined in equation (3.37). Manipulating equation (3.37) yields the perceived demand elasticity, $\varepsilon_{ij}(BCE)$, which can be written as follows:

$$\varepsilon_{ij}(BCE) \equiv \frac{\delta \ln c_{d,ij}}{\delta \ln p_{d,ij}} = -\sigma_{d,i} + \left[\sigma_{d,i} - \sigma_{df,i}\right] \frac{\delta \ln p_{d,i}}{\delta \ln p_{d,ij}}$$

(3.59)

$$+ \left[\sigma_{df,i} - \sigma\right] \frac{\delta \ln p_i}{\delta \ln p_{d,ij}} + \sigma \frac{\delta \ln p}{\delta \ln p_{d,ij}}$$

The conjectural reactions between domestic producers in the same industry are incorporated in the calculation of the elasticity between $p_{d,i}$ and $p_{d,ij}$. In view of $p_{d,i}$ in equation (3.35), this conjectural elasticity can be calculated as follows:

(3.60) $$\frac{\delta \ln p_{d,i}}{\delta \ln p_{d,ij}} = PRS_{ij} + \sum_{\substack{k=1 \\ k \neq j}}^{n_{d,i}} PRS_{ik} \theta_i = PRS_{ij} + \theta_i \left(1 - PRS_{ij}\right)$$

where $\sum_{j=1}^{n_{d,i}} PRS_{ij} = 1$ and PRS_{ij} is the revenue share of domestic firm *ij* in total revenue of industry *i*, defined in equation (3.52), and θ_i is the conjectural price reaction elasticity, which is defined as:

(3.61) $$\theta_i = \frac{\delta \ln p_{d,ik}}{\delta \ln p_{d,ij}}$$

In view of equation (3.24), the industry-wide terms-of-trade effect can be calculated as follows:

(3.62) $$\frac{\delta \ln p_i}{\delta \ln p_{d,ij}} = PRS_i \left(\frac{\delta \ln p_{d,i}}{\delta \ln p_{d,ij}} \right)$$

where PRS_i is the revenue share of domestically produced composite good *i* in total spending on good *i* given in equation (3.55). Note that equation (3.62) incorporates the small economy assumption in the sense that foreign prices are perceived not to react to changes in the domestic prices.

Finally, the general price index is defined as:

(3.63) $$p = \left[\sum_{i=1}^{m} \alpha_i p_i^{1-\sigma} \right]^{\frac{1}{1-\sigma}}$$

The effect can be calculated as follows:

(3.64) $$\frac{\delta \ln p}{\delta \ln p_{d,ij}} = \frac{\alpha_i p_i^{1-\sigma}}{\left[\sum_{i=1}^{m} \alpha_i p_i^{1-\sigma} \right]} \left(\frac{\delta \ln p_i}{\delta \ln p_{d,ij}} \right) \equiv IRS_i * PRS_i \left(\frac{\delta \ln p_{d,i}}{\delta \ln p_{d,ij}} \right)$$

$$0 < IRS_i < 1$$

where IRS_i is the budget share of composite good i in total spending. Combining equations (3.59), (3.60), (3.62) and (3.64), the final expression for $\varepsilon_{ij}(BCE)$ is obtained as

(3.65) $$\varepsilon_{ij}(BCE) = -\sigma_{d,i} + \left[\sigma_{d,i} - (1 - PRS_i)\sigma_{df,i} - (1 - IRS_i)PRS_i\sigma \right] \times \left[PRS_{ij} + \theta_i (1 - PRS_{ij}) \right]$$

3.4 Econometric Specifications

This paper concentrates on the empirical analysis of the behaviour over time of the interaction between industry prices and both domestic costs and foreign competitors' prices. The 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 (Bloch and Heijdra, 1994, p. 9).

(3.66) $$c_{d,ij} = \bar{c}_{d,i} \qquad p_{d,ij} = \bar{p}_{d,i} \qquad p_{f,ik} = \bar{p}_{f,i} \qquad PRS_{ij} = \frac{1}{n_{d,i}} \qquad \gamma_{d,ij}, \gamma_{f,ik} = 1$$

Following Cowling and Waterson (1976), the price-cost margin in industry i (denoted by PCM_i) is:

(3.67) $PCM_i \equiv \frac{\overline{p}_{d,i} - SMC_i}{\overline{p}_{d,i}} = -\frac{1}{\varepsilon_{ij}}$

There is no difference in using *SMC* over *SVC* because the Leontief production function is linear homogeneous. In this study, *SMC* is being used. The elasticity values are not generally observable, but depending on the assumption regarding the nature of the oligopoly interaction (*BCE* or *CCE*), two specifications for the *PCM* can be derived. In the Cournot case, by combining (3.58) and (3.67), yields the following:

(3.68) $PCM_i = \omega_{0,i} + \omega_{1,i}PRS_i + \omega_{2,i}PDT_i$

where variable PDT_i, is the product of IRS_i and PRS_i. $\omega_{x,i}$ $(x = 0, 1, 2)$ parameters are defined in terms of preference and conjectural parameters as follows:

(3.69)
$$\begin{aligned}
\omega_{0,i} &\equiv \frac{1}{\sigma_{d,i}} - \xi_i^* \left(\frac{1}{\sigma_{d,i}} - \frac{1}{\sigma_{df,i}} \right) \\
\omega_{1,i} &\equiv \xi_i^* \left(\frac{1}{\sigma} - \frac{1}{\sigma_{df,i}} \right) \\
\omega_{2,i} &\equiv -\frac{1}{\sigma} \xi_i^* \\
\xi_i^* &\equiv \left[\frac{1}{n_{d,i}} + \xi_i \left(1 - \frac{1}{n_{d,i}} \right) \right]
\end{aligned}$$

where ξ_i is defined in equation (3.53). In order to provide signs for the $\omega_{x,i}$ parameters, Bloch and Heijdra (1994) make the following assumption:

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

Assumption 2 (Proximity Principle): $\frac{\sigma}{(1 - IRS_i)} < \sigma_{df,i}$ *and* $\frac{\sigma_{df,i}}{(1 - PRS_I)} < \sigma_{d,i}$.

The intuition behind assumption 1 is straightforward. The utility tree has been constructed in such a way that goods substitute better the higher the level of disaggregation. For example, a different brand of a same product substitutes better than different products. Assumption 2 is a stronger form of the principle of ordering of substitutes. Imposition of the stronger assumption ensures that the ordering according to the degree of potential competition from producers of substitutes is independent of the market shares obtained by an industry or by the domestic suppliers in that industry. When assumption 2 holds, the potential competition from domestic firms producing different products is less strong that the potential competition from foreign producers of the same product. Also, the potential competition from foreign producers of a product is less strong than potential competition from domestic producers of the same product.

Using assumption 1, Bloch and Heijdra 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 $\omega_{1,i} + IRS_i\omega_{2,1} > 0$. These predictions are consistent with intuition. The implied value of the price-cost margin in (3.68) is guaranteed to be positive for any values of the market share varibles. 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.

For the Bertrand case, price-cost margin is a nonlinear function of the shares *PRS*PRS_i and IRS_i.

$$(3.70)\quad \frac{1}{PCM_i} = -\varepsilon_{ij}(BCE) = \sigma_{d,i} - \left[\sigma_{d,i} - (1 - PRS_i)\,\sigma_{df,i} - (1 - IRS_i)\,PRS_i\sigma\right]\theta_i^*$$

In order to compare with Cournot case, *LHS* of equation (3.71) is linearised around a linearisation point PCM_i^*. The resulting expression is

$$(3.71)\quad PCM_i = \delta_{0,i} + \delta_{1,i}PRS_i + \delta_{2,i}PDT_i$$

where the $\delta_{x,i}\,(x = 0, 1, 2)$ parameters are defined in terms of preference parameters, the reaction elasticity and the linearisation point as follows:

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

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

(3.72) $$\delta_{2,i} \equiv \left(PCM_i^*\right)^2 \sigma\theta_i^*$$

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

Using assumption 1, the comparative static results in $\delta_{0,i} > 0$, $\delta_{1,i} > 0$ and $\delta_{2,i} > 0$. These predictions guarantee a positive implied value for the price-cost margin in (3.71). Also, 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 case of Cournot competition. 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.

The two cases of oligopolistic interdependence 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, IRS_i, times the domestic producer share of the industry, PRS_i. In the Cournot case this relationship is predicted to be negative, while in the Bertrand case it is predicted to be positive. 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 and direct.

The econometric model is completed by expressions linking the shares PRS_i and IRS_i to relative prices. In view of equation (3.22) the domestic producer share of the industry can be written as follows:

(3.73) $$PRS_i = \frac{1}{1 + \left(\frac{1-\beta_i}{\beta_i}\right) PFPD_i^{\left(1-\sigma_{df,i}\right)}}$$

where $PFPD_i$ is the ratio of the import price index to domestic price index, $\frac{P_{f,i}}{P_{d,i}}$. And also in view of equation (3.13), the budget share for the industry is given by:

(3.74) $IRS_i = \alpha_i PDP_i^{(1-\sigma)}$

where PDP_i is the ratio of domestic price index to general price index, $\frac{P_{d,i}}{P}$. The econometric model now consists of (3.73) and (3.74) combined with either (3.68) or (3.71), where (3.68) and (3.71) are identical estimating equations but have different interpretations depending on the type of oligopolistic interaction (*CCE* or *BCE*).

Chapter 4: Data

4.0 Data

Oligopoly behaviour by Australian firms faced with foreign competition is examined in the context of a market for differentiated products. This study concentrates on the responsiveness of import flows to import price in the context of manufacturing trade with imperfect competition. The empirical work analyses the behaviour over time of the interaction between domestic industry prices and domestic costs as well as foreign competitors' prices. Consumer demand in the model is disaggregated among categories of consumption goods. The products within categories are meant to be closer substitutes than those outside of the category. Ideally, there would be a sharp differentiation, so that the assumptions of the *tree principle* and the *proximity principle* in the previous chapter apply.

The model is applied to data for the two-digit classification of manufacturing industries in *Division C* of the *Australia and New Zealand Standard Industrial Classification* (*ANZSIC*). At this level of aggregation, there are nine industries altogether and sharp differences generally exist between products across classifications, but products contained within the classifications may be poor substitutes or even complements. It is possible to conduct this study at the 3-digit level. However, this study is aimed to analyse the behaviour of the manufacturing industry broadly. Results at the 3-digit level would be voluminous and difficult to fully discuss as is done below for results at the 2-digit level. The nine industries are listed in Table 4.1.

Quarterly data covering the period from 1984 to 2000 are used to estimate the econometric specification given in equation (3.73) and (3.74) together with either (3.68) or (3.71). Data required to construct all variables on a comparable basis are not available for earlier periods. The variables used in estimation are each constructed from raw data contained in published and unpublished series provided by the Australian Bureau of Statistics (*ABS*). Construction of the variables and the data series used are explained later in this chapter. All the parameters of consumer and firm behaviour are assumed constant. Thus, both seasonal variation and trend are allowed in estimating the relationships derived from the analysis.

Table 4.1: Division C of the Australian and New Zealand Standard Industrial Classification (ANZSIC)

ANZSIC	Industry
21	Food, Beverage and Tobacco Manufacturing
22	Textile, Clothing, Footwear and Leather Manufacturing
23	Wood and Paper Product Manufacturing
24	Printing, Publishing and Recorded Media
25	Petroleum, Coal, Chemical and Associated Product Manufacturing
26	Non-Metallic Mineral Product Manufacturing
27	Metal Product Manufacturing
28	Machinery and Equipment Manufacturing
29	Other Manufacturing

4.1 Derivations of Price-Cost Margin

In this study, the quarterly price-cost margin (*PCM*) is constructed first by determining the *PCM* in base year, denoted by PCM_{base}. 1989-90 is used as the base year throughout this study. The proxy for PCM_{base} is estimated by the following formula:

$$(4.1) \quad PCM_{base} = \frac{[Value\ Added_{base} - Wages_{base}]}{Turnover_{base}}$$

The $Value\ Added_{base}$ figures are constructed by multiplying value added per person in the base year to the number of employment in the base year. $Wages_{base}$ is proxy by *Wages and Salaries* published by *ABS*. Figures of $Turnover_{base}$ are the actual turnover variable published by *ABS*. The excess of value added over the wages of production workers is one way of representing the gross profit on production. Turnover is a key measure of the performance of establishments in an industry. It covers the sales of goods and services by an establishment (together with transfers of goods to other parts of the same business) and also includes all other operating revenue generated by the establishment. As a result, equation (4.1) represents the excess of gross profit over cost as a fraction of turnover, which is a reasonable proxy for price-cost margin. The base year price-cost margin is a pure number (a dollar measure divided by another dollar measure), so there is no deflation to a base year required. All of the above data are valued on the base year of 1989-90 and are in *ANZSIC* code.

Table 4.2: Data Sources for PCM_{base}.

Data	Source
Value Added Per Person (1989/90 = 100)	ABS series catalogue 8221.0 (1992-93)
Employment (1989/90 = 100)	ABS series catalogue 8221.0 (1993-94)
Wages and Salaries (1989/90 = 100)	ABS series catalogue 8221.0 (1993-94)
Turnover (1989/90 = 100)	ABS series catalogue 8221.0 (1993-94)

The base year calculation of PCM_{base}, is required to determine a benchmark relationship between price and cost. Once this is done, the quarterly *PCM* is estimated by the equation below:

$$(4.2) \quad PCM = \frac{[Price - (1 - PCM_{base}) \times Unit\ Cost]}{Price}$$

The variation between price and cost is measured in proportion to the price to give the 'margin' as a proportional measure. If the price index and cost index in the base period are 1.0, equation (4.2) correctly gives $PCM = PCM_{base}$. The term $(1 - PCM_{base})$ in equation (4.2) provides a constant weighting of cost relative to price for the quarterly *PCM* estimation. Only in this way, are the changes in *PCM* between quarters solely due to changes in either price or cost captured.

Price is measured by *Price Index of Articles Produced by Manufacturing Industry* published by ABS. *Unit Cost* is constructed by the following:

$$(4.3) \quad Unit\ Cost = [WLC_{base} \times ULC] + [WPM_{base} \times PM]$$

Unit Labour Cost, denoted by *ULC*, is calculated as:

$$(4.4) \quad ULC = \frac{Gross\ Earnings}{Gross\ Product}$$

The underlying concept is to measure expenditure on labour per unit of output. Thus, the measurement of gross product is in real terms. Dividing by nominal gross product is inappropriate because it gives a measure of expenditure per dollar of sales. The *Gross Product* is measured by *Gross Value Added* (*Chain Volume Measures: Original*). The nomenclature, chain volume, refers to the particular method by which nominal gross product is deflated to obtain a "real" measure. As a result, a chain-index measure is an approximation to constant dollar measurement. The publication of *Gross Earnings* data by *ABS* starts from 1989 and ends at 1993. Post 1993 data are obtained directly from *ABS*.

Price of Materials, *PM*, consists of two collections. The first collection is in *ASIC* code and the other is in *ANZSIC* code. From September quarter 1984 to June quarter 1989, data collected is in *ASIC* code and has a base year of 1984-85. Base year for this set of data is re-established to 1989-90. The simple average of the summation of the last two quarters in 1989 and the first two quarters of 1990 is use as a common denominator for the re-basing purposes. The second set of data is collected in *ANSZIC* code. The time series starts in September quarter 1989 till March quarter 2000. Industry 22, 23, 25, 27 and 28 are calculated from data at 3-digit level of aggregation. These industries are added up to form 2-digit level. Appropriate weights are calculated for each of the 3-digit industry by using the 3-digit production level that are assigned to form 2-digit level data. These weights reflect the contribution of each 3-digit industry in proportion to its production level.

These two sets of data are linked to form the full set of time series. Furthermore, since price of materials is in index form, while unit labour cost in equation (4.4) is in real dollar terms, the latter is re-based to index form with the base year of 1989-90, for consistency purposes. The simple average of the last 2 quarters of 1989 and first 2 quarters of 1990 of unit labour cost is used as the base for forming the unit labour cost index. Using the index form is also consistent with the price index that is used to estimates the price-cost margin in equation (4.2).

WLC_{base} and WPM_{base} in equation (4.2) are the weights for labour cost and price of materials, respectively. Both the weights add up to unity. Weights for labour cost and price of materials are calculated using the following formulae:

$$(4.5) \quad WLC_{base} = \frac{Wages_{base}}{\left[Wages_{base} + PT_{base}\right]}$$

$$(4.6) \quad WPM_{base} = 1 - WLC_{base}$$

$Wages_{base}$ *and* PT_{base} are measured by *Wages and Salaries* in base year and *Purchases Transfers In And Selected Expenses* in base year, respectively. Both time series are published by ABS. Constant weights of the base year are used for both labour cost and price of materials to capture the changes in both the labour cost and the price of materials over time, hence, unit cost in equation (4.3).

Table 4.3: Data Sources for Quarterly PCM.

Data	Source
Price Index of Articles Produced by Manufacturing Industry (1989/90 = 100)	ABS series catalogue 6412.0 (Online*) – table 3.
Gross Earnings (current dollar)	Purchase directly from ABS
Gross Value Added (Chain Volume Measures: Original)	ABS series catalogue 5206.0 (Online**) - table 48.
Price indexes of Materials (ANZSIC code: 1989/90=100)	ABS series catalogue 6411.0 (Online***) – table 4.
*Price indexes of Materials (ASIC code: 1984/85 = 100)	ABS series catalogue 6411.0
Purchases Transfer In And Selected Expenses (ASIC code: 1989/90 = 100)	ABS series catalogue 8202.0

** - Base year is re-established to 1989/90. And average of 4 quarters indexes in 1989/90 is used as the common denominator for reestablishment index purposes.*

*Online**
http://www.abs.gov.au/ausstats/abs%40.nsf/w2.1.1!OpenView&Start=1&Count=1500&Expand=29#29

*Online***
http://www.abs.gov.au/ausstats/abs%40.nsf/w2.1.1!OpenView&Start=1&Count=1500&Expand=21#21

*Online****
http://www.abs.gov.au/ausstats/abs%40.nsf/w2.1.1!OpenView&Start=1&Count=1500&Expand=29#29

In this study, the price-cost margin in equation (3.68) and (3.71) is estimated against two independent variables, namely the domestic producer share of the industry (*PRS*) and the product of this share and the budget share for the industry (*IRS*), which is termed *PDT*. The price-cost margin equation is used to distinguish between the two cases of oligopoly behaviour, Cournot and Bertrand. The two cases of oligopolistic interdependence can be distinguished empirically by the sign of the relationship between the price-cost margin and the variable for the product of budget share of the industry and the domestic producer share of the industry (*PDT*). The calculations for *PRS* and *IRS* are shown below.

4.2 Measurement of *PRS* and *IRS*

The quarterly domestic producer share of the industry, denoted by *PRS* and the quarterly budget share of the industry, denoted by *IRS*, are calculated by the following formulae:

$$(4.7) \quad PRS = \frac{[Sales - Export]}{[Sales - Export + Import]}$$

$$(4.8) \quad IRS = \frac{[Sales + Import - Export]}{Total\ Manufacturing\ [Sales + Import - Export]}$$

Sales is measured by *Manufacturers' and Wholesale Trade Sales* (*current dollar*) publish by *ABS*. It includes income from sales of goods and services by businesses classified to the manufacturing industry.

Import and *Export* are measured by *Industry Import* and *Industry Export* that *ABS* publishes. The exports include both Australian produce and re-exports, and imports comprise goods entered directly for domestic consumption together with goods imported into bonded warehouses. Australian produce is defined as goods, materials or articles, which have been produced or manufactured in Australia. Processing and assembly operation that leave imported components and product essentially unchanged are not considered as production or manufacture. Re-exports are defined as goods, materials or articles originally imported into Australia, which are exported in the same condition or after undergoing minor operations (e.g. blending, packaging, bottling, cleaning, husking and shelling) that leave them essentially unchanged.

From September quarter of 1984 till June quarter of 1994, both time series collected are in *ASIC* code. The data series available in *ANZSIC* code start from June quarter of 1993 till first quarter of 2000. The data in *ASIC* code are added up to approximate to *ANZSIC* code in the same fashion as for price of material data. As a result, both import and export time series consists of two parts. The first part is the converted *ASIC* code to *ANZSIC* code time series that starts from September quarter of 1984 till March quarter of 1993. The latter part of the time series is in *ANZSIC* code, which continues the time series till March quarter of 2000.

Table 4.4: Data Sources for Quarterly PRS and IRS Estimations

Data	Source
Manufacturers' and Wholesale Trade Sales (Current Dollar)	ABS series catalogue 5629.0 (Online*) – table 7
Industry Import (current dollar) September 1984 – September 1993	ABS series catalogue 5433.0
Industry Import (current dollar) June 1993 – March 2000	ABS series catalogue 5422.0
Industry Export (current dollar) September 1983 – September 1993	ABS series catalogue 5432.0
Industry Export (current dollar) June 1993 – March 2000	ABS series catalogue 5422.0

*Online**
http://www.abs.gov.au/ausstats/abs%40.nsf/w2.1.1!OpenView&Start=1&Count=1500&Expand=25#25

The *RPS* in equation (4.7) is based on equation (3.73). The only variable used for *PRS* calculation is *PFPD*, the relative of foreign price to domestic price. The *PFPD* is derive as follow:

$$(4.9) \quad PFPD = \frac{Import\ Price\ Index}{Domestic\ Price\ Index}$$

The *Import Price Index* is obtained from *ABS* publication. *ABS* constructs this index using prices directly obtained from importers of the selected items during the quarter in which the goods arrive in Australia. Imports are priced on a 'free on board' (f.o.b.), country of origin basis. Freight and insurance charges involved in shipping goods from foreign to Australian ports are therefore excluded from the prices used in the index, as are Australian import duties and taxes. [40]

The prices used to generate the *Domestic Price Index* by ABS are obtained from principal manufacturers of the articles concerned, but in some cases, prices collected for other indexes are used (adjusted to the correct pricing basis as far as possible). Prices are manufacturers' selling prices and reflect the effects of subsidies and bounties paid to manufacturers. For consistency, prices in general relate to a standard representative set of transactions (in terms of quality, delivery

[40] Average of the elements that are excluded from f.o.b. prices stay relatively constant over the period of estimation and quarterly data are not available.

arrangements, destination, etc.) in order to avoid variations in price that are attributable solely to a changing mix of transactions over time.

The *IRS* in equation (4.8) is empirically estimated against *PDP*, where *PDP* is the ratio of domestic price index to the general price index.

$$(4.10)\quad PDP = \frac{domestic\ \ price\ index}{general\ \ price\ index}$$

The *Domestic Price Index* is the same series used for *PFPD* estimation, while the *General Price Index* is calculated using the domestic price index. Specifically, weights for each of the nine industries in *ANZSIC* code are calculated using sales figure. This sales figure is used to approximate the contribution of each industry to the manufacturing sector as a whole. To construct the general price index, each weight is assigned to its corresponding industry before summation of all the industry taken place. As a result, the general price index is a weighted average of the domestic price index.

Table 4.5: Data Sources for PFPD and PDP

Data	Source
Import Price Index (1989/90 = 100)	ABS series catalogue 6414.0
Domestic Price Index (1989/90 = 100)	ABS series catalogue 6412.0 (online*) - table 3

*Online**
http://www.abs.gov.au/ausstats/abs%40.nsf/w2.1.1!OpenView&Start=1&Count=1500&Expand=29#29

4.3 Concordance between ASIC and ANZSIC codes

Up to 1993/94, the *ASIC* was used to classify industry data. As from 1994/95, the *ANZSIC* has been adopted for *State of the Work Environment* (*SOWE*) reports. Due to the change in classification both, *ASIC* and *ANZSIC* have been used in some publications. Some industry-based data prior to 1994/95 have been adjusted to accommodate *ANZSIC* coding for comparative purposes. The *ASIC* and *ANZSIC* concordance is needed to form price indexes in ANZSIC code. Industry 21 in both codes is similar.[41] The 3-digit *ASIC* industries classified under industry 23 and 24 are approximately equivalent to *ANZSIC* industry 22. Industry 25, 26, 27 and

[41] All ASIC and ANZSIC concordances are based on 3-digit level of aggregation.

28 under *ASIC* code can be directly compared to *ANZSIC* industry 23, 24, 25 and 26, respectively. The combination of *ASIC* industry 29 and 31 is approximately equivalent to *ANZSIC* industry 27, while the combination of *ASIC* industry 32 and 33 is approximately equivalent to *ANZSIC* industry 28 approximation. Finally *ASIC* industry 34 is approximately equivalent to *ANZSIC* industry 29 by 3-digit level of aggregation comparison. The concordance is carried out by calculating the weighted average of the production level for *ASIC* industries in the base year These weights are subsequently assigned to the industries concerned for summation of purposes. For example, weights are calculated for *ASIC* industry 23 and 24 based on their gross product in the base year and these weights are assigned to industry 23 and 24 specifically for summation purposes over the remainder of the sample period.

4.4 Structural Breaks

All the time series, namely, *PCM*, *PRS*, *IRS*, *PFPD* and *PDP*, are checked for possible structural breaks due to different industrial codes being used. The preliminary procedure is by graphing these time series. At this preliminary stage, both *PRS* and *IRS* are found to exhibit structural breaks in the June quarter of 1993. In particular, *PRS* exhibits clearly a structural break for industry 22, 24, 25, 27, 28 and industry 29. The structural break is less noticeable for *IRS*. Only industries 28 and 29 exhibit clear indication of structural break.

Further investigation reveals that there is a mean shift caused by the import and export time series. Since the break starts at June quarter of 1993, it is clear that the causation of the breaks is most likely due to different codes data being used. Data prior to June 1993 are the data that are converted *ASIC* to *ANZSIC* (converted series) and the latter time series are *ANZSIC* code (original) published by *ABS*.

The overlapping data series facilitate further adjustment to the import and export data. A constant is calculated for each industry by:

$$(4.11)\quad \phi_x = \frac{June\ quarter\ 1993\ (converted\ series)}{June\ quarter\ 1993\ (original)}$$

where the subscript x represents industry 21, 22, ..., 29. The ϕ_x acts as constant weight and is used to multiply its corresponding industry from September quarter 1984 till March quarter 1993. As a result, if the constant is a > 1 (< 1) value, the earlier period will be shifted up (down), which eliminates the break in the time series.

This preliminary investigation of structural breaks is done before the series are test for unit root.[42] Further investigation of structural break is then carried out using appropriate econometric test.

4.5 Unit Root Test

The time series that have been checked for structural break are then tested for the existence of unit root. First, consider the basic unit root test model,

$$(4.12)\quad x_t = \beta x_{t-1} + \varepsilon_t$$

where ε_t is a zero-mean stationary process. The null hypothesis for a unit root is

$$(4.13)\quad H_0 = \beta = 1$$

Now consider subtracting x_{t-1} from both side gives,

$$(4.14)\quad x_t - x_{t-1} = \beta x_{t-1} - x_{t-1} + \varepsilon_t$$

or

$$(4.15)\quad \Delta x_t = \gamma x_{t-1} + \varepsilon_t$$

where $\Delta x_t = x_t - x_{t-1}$ and $\gamma = (\beta - 1)$. The null hypothesis in (4.13) is equivalent to

$$(4.16)\quad H_0 : \gamma = 0$$

The unit root test model used to test the time series is the "augmented" Dickey-Fuller (ADF) test. It is appropriate to use 5 lags in the ADF test since the time series are quarterly.[43] The purpose in adding the terms Δx_{t-i} is to allow for ARMA (Autoregressive Moving Average) error processes. If this term is not included, it is just the simple Dickey-Fuller (DF) test for a unit root.

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[42] Most unit root tests would fail if there exist a structural break in the time series.

$$(4.17)\quad \Delta x_t = \alpha + \phi_t + \gamma x_{t-1} + \sum_{i=1}^{5} \Delta x_{t-i} + \varepsilon_t$$

x_t is the time series that is checked for unit root and Δx_t is the first difference of the time series. α is a constant and ϕ_t is a time trend to be included in the unit root test. The criteria for selecting lag length are by "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 taken into consideration. Further discussion of the criteria is discussed in the appendix.

The results are presented in *Table 4.6 – 4.17*. The t-statistic of the last included lag(s) together with the probability are presented in these tables. The test statistic is accompanied by Lagrange multiplier (LM) test for auto-correlation.

The price-cost margin is clearly an I(1) variable, since on the levels data it exhibits non-stationarity and the first difference time series is stationary.[44] The level series of the domestic producer share of the industry is also non-stationary. However, the test statistic for industry 21, 22, 24 and 25 should be interpreted with caution since auto-correlation is evident. The first difference of the *PRS* time series appears to be stationary. Note that for industry 22 and 24 there is statistical significance at the 5 percent level for *LM* test for auto-correlation and for industry 25 is the test statistically significant at the 1 percent level. The budget share of the industry, *IRS*, is clearly an I(1) variable. Since, in general, *PRS* and *IRS* are both I(1) variables, the product of these two time series, *PDT*, would be an I(1) variable too. This is evident from *Table 4.12* and *Table 4.13.* Variable *PFPD* also exhibits I(1) properties although test statistic for industry 26 in the level data is not significant at the 5 percent level. The first difference of industry 25 also suffers from auto-correlation problem at 1 percent significance level. The last but not least, variable *PDP* is non-stationary on the level time series for all the industries except industry 25, which is statistically significant at 5 percent and industry 28, which is statistically significant at 1 percent level.

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[43] Said and Dickey (1984), Phillips (1987), and Phillips and Perron (1988) develop modifications of the Dickey-Fuller tests when ε_t is not white noise. These tests are called the "augmented" Dickey-Fuller (ADF) tests.

[44] 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, ADF test is weak.

Table 4.6: Unit Root Test for PCM

$$\Delta PCM_t = \alpha + \phi_t + \gamma PCM_{t-1} + \sum_{i=1}^{5} \Delta PCM_{t-i} + \varepsilon_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
PCM21	-1.7266	1.897 [lag 4] [0.0637]	[0.7183]
PCM22	-0.46792	2.638 [lag 4] [0.0111]	[0.9139]
PCM23	-1.9108	-2.272 [lag 2] [0.0272]	[0.7090]
PCM24	-1.9299	-1.930 [lag 0] [0.0589]	[0.8809]
PCM25	-1.9410	-1.941 [lag 0] [0.0575]	[0.5517]
PCM26	-2.7154	-2.715 [lag 0] [0.0089]	[0.1719]
PCM27	-2.5326	-2.533 [lag 0] [0.0143]	[0.9962]
PCM28	-2.2655	1.839 [lag 4] [0.0719]	[0.2508]
PCM29	-2.5345	-2.534 [lag 0] [0.0142]	[0.6491]

** Indicates statistical significance at the 5 percent level for DF / ADF test.*
*** Indicates statistical significance at the 1 percent level of DF / ADF test.*
** or ** indication is applied to all the following unit root test tables.*

Table 4.7: Unit Root Test for the First Difference of PCM, namely DPCM

$$\Delta\Delta PCM_t = \alpha + \gamma \Delta PCM_{t-1} + \sum_{i=1}^{5} \Delta\Delta PCM_{t-i} + \mu_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
DPCM21	-3.4763*	-1.849 [lag 3] [0.0702]	[0.6705]
DPCM22	-3.1756**	-3.031 [lag 3] [0.0038]	[0.8347]
DPCM23	-7.0125**	2.453 [lag1] [0.0047]	[0.5721]
DPCM24	-8.5319**	-8.532 [lag 0] [0.0000]	[0.7997]
DPCM25	-8.9408**	-8.941 [lag 0] [0.0000]	[0.1871]
DPCM26	-4.3870**	2.100 [lag 5] [0.0409]	[0.8533]
DPCM27	-7.5290**	-7.529 [lag 0] [0.0000]	[0.6397]
DPCM28	-3.7073**	2.130 [lag 5] [0.0382]	[0.5084]
DPCM29	-8.4939**	-8.4949 [lag 0] [0.0000]	[0.8256]

Table 4.8: Unit Root Test for PRS

$$\Delta PRS_t = \alpha + \phi_t + \gamma PRS_{t-1} + \sum_{i=1}^{5} \Delta PRS_{t-i} + \varepsilon_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
PRS21	-1.7536	-1.957 [lag 1] [0.0553]	[0.0256]*
PRS22	-3.1493	2.699 [lag 4] [0.0095]	[0.0457]*
PRS23	-3.4134	2.212 [lag 4] [0.0316]	[0.2922]
PRS24	-1.7702	-3.453 [lag 3] [0.0011]	[0.0438]*
PRS25	-0.65757	-2.813 [lag 3] [0.0070]	[0.0460]*
PRS26	-1.5696	-2.015 [lag 3] [0.0492]	[0.6614]
PRS27	-1.3480	-2.716 [lag 5] [0.0091]	[0.8297]
PRS28	-2.8987	3.336 [lag 4] [0.0016]	[0.8175]
PRS29	-1.4704	-2.004 [lag 5] [0.0506]	[0.8231]

Table 4.9: Unit Root Test for the First Difference of PRS, namely DPRS

$$\Delta\Delta PRS_t = \alpha + \gamma \Delta PRS_{t-1} + \sum_{i=1}^{5} \Delta\Delta PRS_{t-i} + \mu_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
DPRS21	-10.034**	-10.034 [lag 0] [0.0000]	[0.4812]
DPRS22	-4.5017**	1.888 [lag 4] [0.0648]	[0.0273]*
DPRS23	-4.0780**	1.742 [lag 4] [0.0876]	[0.2031]
DPRS24	-9.2174**	4.528 [lag 2] [0.0000]	[0.0113]*
DPRS25	-7.3357**	3.544 [lag 2] [0.0008]	[0.0036]**
DPRS26	-6.9005**	2.556 [lag 2] [0.0135]	[0.4390]
DPRS27	-5.7764**	3.708 [lag 4] [0.0005]	[0.8567]
DPRS28	-4.2331**	1.809 [lag 5] [0.0766]	[0.7542]
DPRS29	-5.0725**	2.701 [lag 4] [0.0094]	[0.7500]

Table 4.10: Unit Root Test for IRS

$$\Delta IRS_t = \alpha + \phi_t + \gamma IRS_{t-1} + \sum_{i=1}^{5} \Delta IRS_{t-i} + \varepsilon_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
IRS21	-2.3463	4.436 [lag 4] [0.0001]	[0.1285]
IRS22	-3.0147	2.194 [lag 4] [0.0329]	[0.5280]
IRS23	-2.0477	-2.048 [lag 0] [0.0455]	[0.5847]
IRS24	-2.1546	-1.932 [lag 3] [0.0590]	[0.1164]
IRS25	-2.4470	4.448 [lag 4] [0.0000]	[0.2385]
IRS26	-2.7080	-2.708 [lag 0] [0.0090]	[0.2673]
IRS27	-2.1130	2.262 [lag 4] [0.0281]	[0.3339]
IRS28	-1.9273	2.599 [lag 4] [0.0122]	[0.5129]
IRS29	-2.5110	2.604 [lag 5] [0.0121]	[0.4646]

Table 4.11: Unit Root Test for the First Difference of IRS, namely DIRS

$$\Delta\Delta IRS_t = \alpha + \gamma\Delta IRS_{t-1} + \sum_{i=1}^{5} \Delta\Delta IRS_{t-i} + \mu_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
DIRS21	-3.2593*	-3.559 [lag 3] [0.0008]	[0.2267]
DIRS22	-22.545**	-22.545 [lag 0] [0.0000]	[0.2973]
DIRS23	-7.7592**	-7.759 [lag 0] [0.0000]	[0.7132]
DIRS24	-4.7024**	1.957 [lag 5] [0.0560]	[0.1923]
DIRS25	-3.8285**	3.048 [lag 5] [0.0037]	[0.6703]
DIRS26	-9.0545**	-9.055 [lag 0] [0.0000]	[0.9335]
DIRS27	-3.5809**	-1.780 [lag 3] [0.0810]	[0.9741]
DIRS28	-8.6621**	-8.662 [lag 0] [0.0000]	[0.2498]
DIRS29	-3.0970*	2.101 [lag 5] [0.0408]	[0.4288]

*Table 4.12: Unit Root Test for PDT (PRS*IRS)*

$$\Delta PDT_t = \alpha + \phi_t + \gamma PDT_{t-1} + \sum_{i=1}^{5} \Delta PDT_{t-i} + \varepsilon_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
PDT21	-2.2850	4.199 [lag4] [0.0001]	[0.1549]
PDT22	-3.7746*	-3.775 [lag 0] [0.0004]	[0.6845]
PDT23	-2.0835	-2.083 [lag 0] [0.0420]	[0.8645]
PDT24	-2.1319	-2.157 [lag 3] [0.0357]	[0.3061]
PDT25	-1.7268	3.125 [lag 4] [0.0030]	[0.5140]
PDT26	-2.7545	-2.754 [lag 0] [0.0080]	[0.5309]
PDT27	-2.5053	2.776 [lag 4] [0.0077]	[0.2750]
PDT28	-1.6521	2.108 [lag 1] [0.0398]	[0.0000]**
PDT29	-3.7433*	-3.743 [lag 0] [0.0004]	[0.4137]

Table 4.13: Unit Root Test for the First Difference of PDT, namely DPDT

$$\Delta\Delta PDT_t = \alpha + \gamma \Delta PDT_{t-i} + \sum_{i=1}^{5} \Delta\Delta PDT_{t-i} + \mu_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
DPDT21	-3.2355*	-3.305 [lag 3] [0.0017]	[0.3119]
DPDT22	-6.5804**	1.703 [lag 1] [0.0943]	[0.0734]
DPDT23	-8.5814**	-8.581 [lag 0] [0.0000]	[0.9622]
DPDT24	-7.5125**	3.234 [lag 2] [0.0021]	[0.8420]
DPDT25	-3.1482*	-2.870 [lag 3] [0.0060]	[0.4140]
DPDT26	-8.7606**	-8.761 [lag 0] [0.0000]	[0.9790]
DPDT27	-3.3609*	-2.079 [lag 3] [0.0427]	[0.4749]
DPDT28	-2.9923*	-2.837 [lag 3] [0.0065]	[0.2568]
DPDT29	-6.2888**	1.702 [lag 2] [0.0947]	[0.5020]

Table 4.14: Unit Root Test for PFPD

$$\Delta PFPD_t = \alpha + \phi_t + \gamma PFPD_{t-1} + \sum_{i=1}^{5} \Delta PFPD_{t-i} + \varepsilon_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
PFPD21	-2.3909	3.116 [lag 1] [0.0030]	[0.2216]
PFPD22	-3.4547	3.699 [lag5] [0.0005]	[0.3376]
PFPD23	-3.8763*	2.454 [lag 1] [0.0174]	[0.8001]
PFPD24	-2.0715	-2.072 [lag 0] [0.0431]	[0.6564]
PFPD25	-3.2687	3.269 [lag 0] [0.0019]	[0.9242]
PFPD26	-3.6580*	3.324 [lag 5] [0.0017]	[0.7592]
PFPD27	-3.2903	2.708 [lag 5] [0.0093]	[0.4197]
PFPD28	-3.3952	3.284 [lag 5] [0.0019]	[0.4308]
PFPD29	-2.6422	3.280 [lag 5] [0.0019]	[0.9418]

Table 4.15: Unit Root Test for the First Difference of PFPD, namely DPFPD

$$\Delta\Delta PFPD_t = \alpha + \gamma \Delta PFPD_{t-1} + \sum_{i=1}^{5} \Delta\Delta PFPD_{t-i} + \mu_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
DPFPD21	-5.1546**	-5.155 [lag 0] [0.0000]	[0.6542]
DPFPD22	-5.6655**	-5.666 [lag 0] [0.0000]	[0.9848]
DPFPD23	-4.5653**	1.773 [lag 5] [0.0825]	[0.7328]
DPFPD24	-7.1069**	-7.107 [lag 0] [0.0000]	[0.9756]
DPFPD25	-7.2266**	-7.227 [lag 0] [0.0000]	[0.0009]**
DPFPD26	-6.8909**	-6.891 [lag 0] [0.0000]	[0.7785]
DPFPD27	-5.9787**	-5.979 [lag 0] [0.0000]	[0.4367]
DPFPD28	-6.4219**	-6.422 [lag 0] [0.0000]	[0.9272]
DPFPD29	-5.3770**	-5.377 [lag 0] [0.0000]	[0.7209]

Table 4.16: Unit Root Test for PDP

$$\Delta PDP_t = \alpha + \phi_t + \gamma PDP_{t-1} + \sum_{i=1}^{5} \Delta PDP_{t-i} + \varepsilon_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
PDP21	-2.1800	-2.180 [lag 0] [0.0336]	[0.5031]
PDP22	-1.8820	-3.597 [lag 0] [0.0007]	[0.2272]
PDP23	-2.5604	-2.560 [lag 0] [0.0133]	[0.3025]
PDP24	-1.8862	2.394 [lag 1] [0.0202	[0.2808]
PDP25	-4.0600*	-4.060 [lag 0] [0.0002]	[0.8621]
PDP26	-1.2121	2928 [lag 1] [0.0050]	[0.9341]
PDP27	-2.7115	2.171 [lag 4] [0.0347]	[0.6054]
PDP28	-4.1613**	2.439 [lag 1] [0.0181]	[0.7337]
PDP29	-3.4099	1.821 [lag 1] [0.0742]	[0.7860]

Table 4.17: Unit Root Test for the First Difference of PDP, namely DPDP

$$\Delta\Delta PDP_t = \alpha + \gamma \Delta PDP_{t-1} + \sum_{i=1}^{5} \Delta\Delta PDP_{t-i} + \mu_t$$

	DF / ADF	t-statistic for last included lag	LM test for Auto-correlation AR [1-4]
DPDP21	-8.1971**	-8.197 [lag 0] [0.0000]	[0.2865]
DPDP22	-6.2733**	-6.273 [lag 0] [0.0000]	[0.0125]*
DPDP23	-6.7916**	-6.792 [lag 0] [0.0000]	[0.0140]*
DPDP24	-5.1330**	-5.133 [lag 0] [0.0000]	[0.6761]
DPDP25	-6.3137**	-6.314 [lag 0] [0.0000]	[0.0000]**
DPDP26	-4.7974**	-4.797 [lag 0] [0.0000]	[0.8330]
DPDP27	-4.5486**	1.655 [lag 2] [0.1040]	[0.2890]*
DPDP28	-4.7640**	-4.764 [lag 0] [0.0000]	[0.0143]*
DPDP29	-5.1876**	1.829 [lag 2] [0.0732]	[0.2097]

Chapter 5: Empirical Analysis

The econometric analysis can be partitioned into two broad categories. A structural approach to econometric modelling represents the main approach in this thesis. Two estimation methods, namely, the ordinary least squares (*OLS*) and the instrumental variable (*IV*) methods are applied to the time series. The *IV* method is the general method in estimating a structural model, but the use of *OLS* in the estimation of a structural model will need further justification of its validity of the estimates, since *OLS* estimation might cause simultaneity problem and results in inconsistent estimators. In order to justify the validity of the *OLS* estimates, the Wu-Hausman exogeneity test is carried out.

An alternative econometric analysis is based on the general vector autoregressive (*VAR*) and cointegration approach. This approach examines whether a long-run relationship exists between the variables. When a long-run relationship is indicated through cointegration analysis, according to the Granger Representation Theorem there also exists a dynamic error correction representation of the data. Two models of *VAR* and cointegration are proposed.

5.1 A Structural Approach to Econometric Modelling

In this chapter, the econometric model consists of equations (3.73) and (3.74) combined with either (3.68) or (3.71) from Chapter 3. Equations (3.68) and (3.71) are the price-cost margin equations that are identical estimating equations but have different interpretations, depending on the type of oligopolistic interaction (CCE or BCE). Intuitively, if domestic firms have Cournot interaction, the price-cost margin equation will have an inverse relationship with the product of the budget share of the industry and the domestic producer share of the industry. This product is named *PDT*. A Bertrand interaction results in *PDT* that has a direct relationship with the price-cost margin. Thus, the single price-cost margin equation and the two share equations constitute an interdependent system for estimation purposes. $p_{d,i}$ 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.

The three estimating equation are:

(3.68) $PCM_i = \omega_{0,i} + \omega_{1,i} PRS_i + \omega_{2,i} PDT_i$

or

(3.71) $PCM_i = \delta_{0,i} + \delta_{1,i} PRS_i + \delta_{2,i} PDT_i$

(3.73) $$PRS_i = \frac{1}{1 + \left(\frac{1-\beta_i}{\beta_i}\right) PFPD_i^{(1-\sigma_{df,i})}}$$

(3.74) $IRS_i = \alpha_i PDP_i^{(1-\sigma)}$

In Chapter 4, all the variables in the estimation equations above are tested for unit roots. The unit root test results show that each variable can be classified as an I(1) variable.[45] The econometric estimation starts with ordinary least square estimation. Since the variables are I(1), equations (3.68) or (3.71), (3.73) and equation (3.74) are estimated in first differences. The first difference of the *PCM* equation is as follows:

(5.1) $DPCM_i = a_0 + a_1 DPRS_i + a_2 DPDT_i$

Equation (5.1) is applicable for both the oligopoly behaviours, namely the Cournot and the Bertrand reaction. The alphabet *D* is placed prior to the name of the variable to indicate that the variable is the first difference of level.

The estimation equation for the first difference of the domestic producer share of the industry is,

(5.2) $$DPRS_{i,t} = \left[\frac{1}{1 + b_0 (PFPD_{i,t})^{b_1}}\right] - \left[\frac{1}{1 + b_0 (PFPD_{i,t-1})^{b_1}}\right]$$

where

(5.3) $b_0 = \frac{1-\beta_i}{\beta_i}$ and

[45] However, some of the test statistics have to be treated with caution.

(5.4) $b_1 = 1 - \sigma_{df,i}$

The first difference estimation equation for the budget share of the industry is given as:

(5.5) $DIRS_{i,t} = c_0 (PDP_{i,t})^{c_1} - c_0 (PDP_{i,t-1})^{c_1}$

where c_0 is α_i and c_1 is $1-\sigma$.

The econometric model now consists of equations (5.1), (5.2) and (5.5). A time subscript is added to equation (5.2) and (5.5) in order to illustrate the differencing process. These equations are estimated using the ordinary least square method (*OLS*). Equation (5.2) and (5.5) do not yield precise estimates using *OLS* due to a multicollinearity problem. This sort of situation occurs when the independent variables display little variation and/or high intercorrelations (Maddala, 1992, p. 269). With the highly intercorrelations, it becomes difficult to disentangle the separate effects of each of the independent variables on the dependent variable. Maddala points out that the multicollinearity problem cannot be discussed entirely in terms of the intercorrelations among the variables and some solutions often suggested for the multicollinearity problem can actually lead on to a wrong track. However, the estimation process is not venturing toward the solutions to the multicollinearity problem and furthermore, solving the econometrics problem is not the main focus.[46] The other channel to avoid multicollinearity problem is to transform equation (5.2) and (5.5).

The following shows the transformation process. From equation (3.73),

(5.6) $PRS_{i,t}^{-1} - 1 = b_0 (PFPD_{i,t})^{b_1}$

A time subscript is added to facilitate the differencing process later on. Taking the natural log of equation (5.6) gives:

(5.7) $ln[PRS_{i,t}^{-1} - 1] = lnb_0 + b_1 ln[PFPD_{i,t}]$

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[46] Ridge regression is often suggested for the multicollinearity problem.

Since the variables are I(1) variables, the difference of equation (5.7) is undertaken. This gives,

$$(5.8) \quad ln\left[PRS_{i,t}^{-1}-1\right]-ln\left[PRS_{i,t-1}^{-1}-1\right]=b_{1}ln\left[PFPD_{i,t}\right]-b_{1}ln\left[PFPD_{i,t-1}\right]$$

This can be expressed as:

$$(5.9) \quad DS_{i}=b_{1}DRP_{i}$$

where

$$(5.10) \quad \begin{aligned} DS &= ln\left(PRS_{i,t}^{-1}-1\right)-ln\left(PRS_{i,t-1}^{-1}-1\right) \\ DRP &= b_{0}\left[ln\left(PFPD_{i,t}\right)-ln\left(PFPD_{i,t-1}\right)\right] \end{aligned}$$

For IRS_i equation, the transformation is as follows. Taking the natural log of equation (3.74) gives approximately,

$$(5.11) \quad ln\left[IRS_{i,t}\right]=ln\alpha_{i}+(1-\sigma)ln\left[PDP_{i,t}\right]$$

Taking the difference of equation (5.11) will get rid of the I(1) nature of the variables.[47]

$$(5.12) \quad ln\left[IRS_{i,t}\right]-ln\left[IRS_{i,t-1}\right]=(1-\sigma)\left[ln\left(PDP_{i,t}\right)-ln\left(PDP_{i,t-1}\right)\right]$$

This can be expressed as:

$$(5.13) \quad DLIRS_{i}=c_{1}DLPDP_{i}$$

where

[47] Given that almost all data series are non-stationary (according to the unit root tests reported in the previous chapter), first differencing is used as a way of avoiding the "spurious regression problem". But this variable modification has a fundamental limitation: throwing away of valuable long-term information contained in level variable. A time subscript is added to equation (3.74) to facilitate the differencing process.

$$DLIRS_i = ln[IRS_{i,t}] - ln[IRS_{i,t-1}]$$
(5.14) $$DLPDP_i = ln[PDP_{i,t}] - ln[PDP_{i,t-1}] \quad and$$
$$c_1 = (1-\sigma)$$

After transformation, the structural model consists of equations (5.1), (5.9) and (5.13), which are to be estimated using *OLS*. A crucial assumption of *OLS* estimation is that the explanatory variables are independent of the error term. In a simultaneous-equations model, this assumption is often violated.[48] In order to justify the *OLS* estimator in a simultaneous-equations model, the Wu-Hausman test for exogeneity is carried out.[49] This exogeneity test is more properly thought of as a test of explanatory variable "orthogonality", that is, a test of the assumption that there is zero asymptotic correlation between the explanatory variable(s) and the disturbance term. The other purpose of carrying out the *OLS* estimation is to serve as a comparison to *instrumental variable* estimation. In fact, the Wu-Hausman procedure also involves the use of the instrumental variable(s) to construct the test statistics.[50] A joint test of zero restrictions on the coefficients of the variable and its lag(s) are specified in the equation is applied for the *OLS* estimation. This test is also applied to the *IV* estimation.

The *instrumental variable* method (*IV*) is a general method of obtaining consistent estimates of the parameters in simultaneous-equations models. The objective of *IV* estimation is to use the method of moments to generate a consistent estimator by finding an instrument that is correlated with the random explanatory variable(s) but uncorrelated with the random error (Griffiths, Hill and Judge, 1993, p. 462). More simply, an instrumental variable, often referred to as an instrument, is a variable that is uncorrelated with the error term but correlated with the explanatory variables in the equation. Empirically, a number of possible instruments could be chosen and each choice of instruments leads to an alternative consistent estimator, according to Griffiths, Hill and Judge. Hence, the greater the correlation between the instruments with the explanatory variable, the greater is the efficiency of *IV* estimator.

In empirical work, any variables that are thought to be exogenous and independent of the disturbance are retained to serve as an instrument. The same applies to the constant and seasonal dummies. In dynamic analyses, lagged

[48] When the structural equations are estimated by *OLS*, the simultaneity problem will result in inconsistent estimators of the parameters. However, *OLS* provides a starting point of estimation process.
[49] For detail, see Wu (1973).
[50] There is a different way in carrying out Wu-Hausman test that ensures the estimates are consistent under the null, but will vary in a finite sample. See Johnston and DiNardo (1997, p. 257).

variables can be used as instruments for current values (Johnston and DiNardo, 1997, p. 157). The minimum number of instruments has to be equal the number of the explanatory variables for the equation to be exactly-identified.[51] The instruments used for *IV* estimation of equation (5.1) are the first difference of these variables:

$$(5.15)\quad PFUC = \frac{PF}{UC}$$

$$(5.16)\quad UCP = \frac{UC}{P}$$

where *UC* is unit cost given in equation (4.3), *PF* is the import price index used in equation (4.9) and *P* is the general price index in equation (4.10).

Seasonal dummies are initially included in the estimation process together with five lags on each of the explanatory variables.[52] Insignificant seasonal dummy(ies) and insignificant lag(s) of the explanatory variable(s) are dropped at the preliminary stage using *OLS* estimation. Consequently, the seasonal dummy(ies) and lag(s) of the explanatory variable that are included might not show significance after dropping off the other insignificant seasonal dummy(ies) and lag(s) of the explanatory variable(s) at the preliminary stage. Any of the included seasonal dummy(ies) and lag(s) of explanatory variable is(are) used as instrument(s). As a result, the instrument(s) in each industry is(are) unique to its corresponding industry.

As mentioned earlier, the Wu-Hausman test procedure involves the use of the instruments as in the *IV* estimation. To construct the Wu-Hausman statistic, $DDPRS_i$ and $DPDT_i$ in equation (5.1) are regressed separately against all the instruments that are involved in the *IV* estimation for each industry. The residuals from $DDPRS_i$ and $DPDT_i$ regressions are then used as additional variables in the *OLS* estimation. Note that, to be consistent, the Wu-Hausman statistic is constructed using the same sample period as in the *OLS* and *IV* estimation (refer to footnote 8). The Wu-Hausman test statistic is equivalent to the *F* statistic in the variable addition test by *OLS* estimation. The estimation results for both the *OLS* and the *IV* methods for industry 21 to industry 29 are presented in Table 5.1 – 5.9, respectively.

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[51] If there is more than enough instruments, the equation is said to be over-identified and if the equation is under-identified, there are not enough instruments.
[52] The sample period for estimation is reduced to first quarter of 1986 till first quarter of 2000.

The estimation process of the domestic producer share equation (5.9) and the budget share equation (5.13) is similar to the estimation process of price-cost margin equation. The model construction follows the modelling strategy, namely the general-to-specific strategy. Five lags of the independent variable together with seasonal dummies are included in the *OLS* estimation. Insignificant lags and dummies are dropped. The sample period for the estimation is from first quarter of 1986 to first quarter of 2000. The Wu-Hausman test is also performed for both equations.

Instrumental variable estimation is also performed on the two share equations. The domestic producer share equation uses the first difference of the variable in equation (5.15) together with any lag of the independent variables and seasonal dummies as instruments. For the budget share equation, the first difference of equation (5.16) is used as instrument together with the lag independent variables and seasonal dummies. The estimates are also reported in Table 5.1-5.9.

Table 5.1: OLS and IV Estimation for Industry 21

$$DPCM21 = a_0 + a_1 DPRS21 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS21_{t-j} + a_3 DPDT21 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT21_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS21 = a_0 + a_1 DRP21 + a_{2,t-j}\sum_{j=1}^{5} lagDRP21_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS21 = a_0 + a_1 DLPDP21 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP21_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			IV		
Coefficient	DPCM21	DS21	DLIRS21	DPCM21	DS21	DLIRS21
a_0	0.0005709 [0.24762]	0.0096639 [1.0374]	0.077184 [9.2589]***	0.0010908 [0.33209]	0.0098217 [1.0470]	0.080940 [7.6003]***
a_1	-0.10213 [-0.27599]	0.82249 [1.9075]*	-0.62672 [-1.2089]	-1.8307 [-0.74818]	0.87949 [1.5013]	-2.7351 [-1.0372]
$a_{2,t-j}$		-0.5738 [lag 3] [-1.3361]	-1.9186 [lag 1] [-3.8366]***		-0.57898 [lag 3] [-1.3432]	-2.0786 [lag 1] [-3.4135]***
		1.1738 [lag 4] [2.7125]***	-1.9694 [lag 5] [-3.5397]***		1.1825 [lag 4] [2.7059]***	-2.8078 [lag 5] [-2.3278]**
a_3	0.59969 [2.5754]**			2.2017 [2.8733]***		
a_5			-0.10686 [-9.3137]***			-0.10965 [-8.0204]***
a_6			-0.11744 [-10.0801]***			-0.11756 [-8.7466]***
a_7	-0.0038859 [-0.82362]		-0.061491 [-5.2702]***	-0.0087311 [-1.0521]		-0.060254 [-4.4489]***
F-Statistic	2.4829*	3.3170**	25.1486***	*NONE*	3.3101**	16.8259***
DW-Statistic	2.0814	2.4466	1.8248	1.9525	2.4448	2.1072
Wu-Hausman Statistic	0.22163	0.020289	0.89495			
<u>Joint Significance Test</u>						
F-Statistic		3.3170**	8.5820***			
Likelihood Ratio		9.8076**	23.6756***			
Lagrange Multiplier		9.0102**	19.3742***			
Wald-Statistic					8.5640**	19.3238***
Serial Correlation	4.4952	7.9282*	2.2786	6.5403	7.8508*	1.9321
Functional Form	0.20470	1.3164	0.54333	0.80012	0.82481	1.3328
Normality	234.9430***	1.4691	1.2346	0.51201	1.5023	1.2506
Heteroscedasticity	0.21218	0.0031409	5.7318**	0.57737	0.048519	0.0044383

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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.*
**NONE* – The F-Statistic in the case of the IV regression could become negative if the unrestricted IV models fits poorly, *NONE* indicates such a possibility, namely a negative F-Statistic.*
The above notes apply also to Table 5.2 – 5.9
<u>List of Instruments</u>:
DPCM21: a_0, DPFUC21, DUCP21 and S3
DS21: a_0, DPFUC21, DRP21(-3) and DRP21(-4)
DLIRS21: a_0, DUCP21, DLPDP21(-1), DLPDP21(-5), S1, S2 and S3

Table 5.2: OLS and IV Estimation for Industry 22

$$DPCM22 = a_0 + a_1 DPRS22 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS22_{t-j} + a_3 DPDT22 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT22_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS22 = a_0 + a_1 DRP22 + a_{2,t-j}\sum_{j=1}^{5} lagDRP22_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS22 = a_0 + a_1 DLPDP22 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP22_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			*IV*		
Coefficient	DPCM22	DS22	DLIRS22	DPCM22	DS22	DLIRS22
a_0	-0.010619 [-2.9777]***	-0.082952 [-2.8208]***	-0.092938 [-10.4111]***	-0.074777 [-0.24574]	-0.081791 [-2.6204]**	-0.090457 [-6.8404]***
a_1	-0.47599 [-5.8677]***	0.21076 [0.35704]	0.42004 [0.49077]	-1.7534 [-0.41441]	1.7224 [1.6975]*	5.7221 [0.43572]
a_3	2.6901 [2.7853]***			-55.3187 [-0.16142]		
a_5		0.28581 [6.9198]***	0.17336 [11.3825]***		0.30082 [6.7538]***	0.16100 [4.4141]***
a_6	0.041440 [4.9245]***	-0.12136 [-2.8940]***		0.14877 [0.36866]	-0.10748 [-2.3830]**	
a_7		0.24234 [5.8175]***	0.16577 [10.7262]***		0.23598 [5.3229]***	0.16901 [7.7495]***
F-Statistic	12.6928***	33.7094***	61.8503***	*NONE*	28.4787***	28.4540***
DW-Statistic	1.9977	2.4185	2.4607	2.1305	2.3234	2.4112
Wu-Hausman Statistic	0.73955	4.2941**	0.27926			
Serial Correlation	5.5551	9.7432**	4.5972	0.067682	4.9308	1.8157
Functional Form	0.058543	0.16134	0.039802	0.012766	0.36861	0.41319
Normality	0.63642	0.20651	0.27355	0.13855	0.73517	0.35801
Heteroscedasticity	3.7462*	0.97766	0.17403	0.088290	0.0086506	0.18196

List of Instruments:

DPCM221: a_0, DPFUC221, DUCP22 and S2
DS22: a_0, DPFUC221, S1, S2 and S3
DLIRS22: a_0, DUCP22, S1 and S3

Table 5.3: OLS and IV Estimation for Industry 23

$$DPCM23 = a_0 + a_1 DPRS23 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS23_{t-j} + a_3 DPDT23 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT23_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS23 = a_0 + a_1 DRP23 + a_{2,t-j}\sum_{j=1}^{5} lagDRP23_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS23 = a_0 + a_1 DLPDP23 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP23_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			IV		
Coefficient	DPCM23	DS23	DLIRS23	DPCM23	DS23	DLIRS23
a_0	-0.0001546 [-0.037860]	-0.058655 [-3.8634]***	-0.0088518 [-1.8016]*	0.0091001 [0.26450]	-0.057752 [-3.7825]***	-0.0067483 [-1.0628]
a_1	0.27959 [0.79298]	0.46527 [2.0251]**	0.023358 [0.040611]	3.1280 [0.25808]	0.33620 [1.2033]	-2.3783 [-0.71160]
$a_{2,t-j}$	0.64547 [lag5] [2.1369]**	-0.4058 [lag 1] [-1.8402]*	1.2105 [lag 5] [2.1002]**	4.0658 [lag5] [0.65701]	-0.38819 [lag 1] [-1.7469]*	1.4895 [lag 5] [1.9453]*
a_3	-0.62586 [-0.28579]			93.2804 [0.59407]		
a_5		0.11267 [4.2301]***			0.10858 [3.9949]***	
a_7		0.13145 [5.0107]]***	0.029497 [2.9381]***		0.13226 [5.0227]***	0.023155 [1.6026]
F-Statistic	1.5332	8.9834***	4.9609***	*NONE*	8.8507***	*NONE*
DW-Statistic	1.6615	2.2857	2.3876	2.2992	2.2618	2.3735
Wu-Hausman Statistic	0.68482	0.66739	0.71046			
<u>Joint Significance Test</u>						
F-Statistic	2.2834	3.2808**	2.2464			
Likelihood Ratio	4.7113	6.7736**	4.6379*			
Lagrange Multiplier	4.5218	6.3866**	4.4543			
Wald-Statistic				0.51375	3.8936	3.8857
Serial Correlation	9.9117**	1.4910	4.0673	0.34042	1.1980	2.0256
Functional Form	2.8165*	0.12074	0.22577	0.087129	0.47558	0.51992
Normality	79.3417***	0.55987	0.88226	0.23556	0.30323	0.26271
Heteroscedasticity	5.4078**	0.10350	1.1374	2.6391	0.75372	0.65325

List of Instruments:

DPCM23: a_0, DPFUC23, DPRS23(-5) and DUCP23
DS23: a_0, DPFUC23, DRP23(-1) S1 and S3
DLIRS23: a_0, DUCP23, DLPDP23(-5), and S3

Table 5.4: OLS and IV Estimation for Industry 24

$$DPCM24 = a_0 + a_1 DPRS24 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS24_{t-j} + a_3 DPDT24 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT24_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS24 = a_0 + a_1 DRP24 + a_{2,t-j}\sum_{j=1}^{5} lagDRP24_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS24 = a_0 + a_1 DLPDP24 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP24_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			*IV*		
Coefficient	DPCM24	DS24	DLIRS24	DPCM24	DS24	DLIRS24
a_0	-0.0006419	-0.086040	0.032474	0.0005559	-0.082029	0.026421
	[-0.21647]	[-2.7616]***	[4.0303]***	[0.015943]	[-2.5884]**	[2.0658]**
a_1	-0.27337	-0.29077	-0.53219	-5.8533	0.23688	0.89447
	[-1.3774]	[-0.53254]	[-0.99960]	[-0.94475]	[0.31008]	[0.38803]
a_3	3.4364			21.6747		
	[2.2041]**			[0.11029]		
a_5		0.10921	-0.066701		0.10131	-0.063977
		[2.4987]**	[-5.0784]***		[2.2613]**	[-4.3724]***
a_6		0.081737	-0.038614		0.083337	-0.039938
		[1.8704]*	[-2.8805]***		[1.8889]*	[-2.7669]***
a_7		0.12799			0.12175	
		[2.8994]***			[2.7068]***	
F-Statistic	2.4370*	2.4423	9.2712***	*NONE*	2.1698*	6.0571***
DW-Statistic	2.3135	2.8892	2.0455	3.0719	2.9253	2.3434
Wu-Hausman Statistic	0.67350	1.0121	0.45823			
Serial Correlation	3.1319	18.9438***	9.9568**	0.90917	21.0648***	11.2133**
Functional Form	0.029540	0.60823	1.1797	0.43011	0.27326	0.0021862
Normality	554.0085***	21.0491***	1.7939	1.4375	19.8911***	1.6812
Heteroscedasticity	1.2116	0.13156	0.54104	0.60681	0.027256	0.063721

List of Instruments:

DPCM24: a_0, DPFUC24, and DUCP24
DS24: a_0, DPFUC24, S1, S2 and S3
DLIRS24: a_0, DUCP24, S1 and S2

Table 5.5: OLS and IV Estimation for Industry 25

$$DPCM25 = a_0 + a_1 DPRS25 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS25_{t-j} + a_3 DPDT25 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT25_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS25 = a_0 + a_1 DRP25 + a_{2,t-j}\sum_{j=1}^{5} lagDRP25_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS25 = a_0 + a_1 DLPDP25 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP25_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			*IV*		
Coefficient	DPCM25	DS25	DLIRS25	DPCM25	DS25	DLIRS25
a_0	0.0032461	-0.053632	0.0099204	-0.016858	-0.055357	0.010035
	[0.86116]	[-3.8771]***	[1.7484]*	[-0.30348]	[-3.9044]***	[1.7622]*
a_1	0.12662	1.3926	-0.016041	-5.6653	1.2508	0.078835
	[0.71179]	[5.4229]***	[-0.10016]	[-0.39679]	[3.5499]***	[0.40330]
$a_{2,t-j}$		-0.98532 [lag 2]	0.39949 [lag 3]		-1.0025	0.4058
		[-3.9535]***	[2.3412]**		[lag 2]	[lag 3]
					[-3.9837]***	[2.3682]**
a_3	-0.04440			30.7097		
	[-0.069935]			[0.40428]		
a_5		0.14819	0.052537		0.15098	0.053078
		[6.4628]***	[5.5720]***		[6.4308]***	[5.5979]***
a_7		0.088181	-0.065832		0.089690	-0.065753
		[3.7351]***	[-6.7063]***		[3.7660]***	[-6.6754]***
F-Statistic	0.33818	27.7750***	28.7153***	*NONE*	27.5372***	28.4357***
DW-Statistic	2.2495	1.9655	2.0197	2.0371	1.9961	2.0039
Wu-Hausman Statistic	1.7432	0.34562	0.72761			
<u>Joint Significance Test</u>						
F-Statistic		25.5860***	2.7713*			
Likelihood Ratio		39.0538***	5.7730*			
Lagrange Multiplier		28.2713***	5.4903*			
Wald-Statistic					34.2388***	5.6580*
Serial Correlation	3.1120	4.6944	2.0424	0.23324	4.9855	2.3688
Functional Form	1.0425	11.1201***	2.4251	0.16845	2.7820*	2.5630
Normality	148.8963***	0.73859	101.3158***	0.025825	0.88994	105.5006***
Heteroscedasticity	0.25809	13.6234***	1.4363	0.00007275	14.6027***	1.4860

<u>List of Instruments:</u>

DPCM25: a_0, DPFUC25 and DUCP25
DS25: a_0, DPFUC25, DRP25(-2), S1 and S3
DLIRS25: a_0, DUCP25, DLPDP25(-3), S1 and S3

Table 5.6: OLS and IV Estimation for Industry 26

$$DPCM26 = a_0 + a_1 DPRS26 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS26_{t-j} + a_3 DPDT26 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT26_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS26 = a_0 + a_1 DRP26 + a_{2,t-j}\sum_{j=1}^{5} lagDRP26_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS26 = a_0 + a_1 DLPDP26 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP26_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			*IV*		
Coefficient	DPCM26	DS26	DLIRS26	DPCM26	DS26	DLIRS26
a_0	-0.00001679 [-0.0062441]	-0.023241 [-1.6128]	-0.0030771 [-0.54306]	0.059087 [0.13303]	-0.023227 [-1.6085]	-0.0027080 [-0.44291]
a_1	0.36204 [0.63378]	0.69409 [2.7043]***	0.46597 [0.68095]	97.3027 [-0.14343]	0.81417 [2.5422]**	-1.2302 [-0.20842]
$a_{2,t-j}$	1.0443 [lag 1] [1.8107]*	-0.57517 [lag 3] [-2.4845]**	-2.2715 [lag 3] [-3.2119]***	-71.7946 [lag 1] [-0.14054]	-0.58342 [lag 3] [-2.5109]**	-2.2594 [lag 3] [-3.0225]***
a_3	-1.3651 [-0.74178]			516.1766 [0.14115]		
$a_{4,t-j}$	-4.1014 [lag 1] [-2.2474]**			233.7875 [lag 1] [0.13944]		
a_5		0.060507 [2.4782]**			0.061161 [2.4975]**	
a_7		0.71987 [2.8712]***			0.071229 [2.8317]***	
F-Statistic	1.3240	5.7554***	5.3752***	*NONE*	5.6768***	2.0678
DW-Statistic	2.6321	2.0715	2.2524	1.5660	2.0442	2.2308
Wu-Hausman Statistic	2.1361	0.39306	0.091800			
Joint Significance Test						
F-Statistic	1.7054 [a_1 and a_2] 2.6053* [a3 and a4]	6.2677***	5.3752***			
Likelihood Ratio	3.6213 [a_1 and a_2] 5.4433* [a3 and a4]	12.3103***	10.3487***			
Lagrange Multiplier	3.5087 [a_1 and a_2] 5.1915* [a3 and a4]	11.0717***	9.4636***			
Wald-Statistic				0.022776 [a_1 and a_2] 0.021482 [a3 and a4]	11.6634***	9.2793***
Wald Test of Restriction(s)	2.9944* [a_3+a_4=0]			0.019779 [a_3+a_4=0]		
Serial Correlation	11.7089**	9.2566*	2.9690	0.022331	9.1570*	2.7143
Functional Form	0.19241	0.51904	0.19142	0.017584	0.018795	0.0038690
Normality	31.5057***	0.52496	0.11910	0.46385	0.36249	0.41648
Heteroscedasticity	1.0863	1.1730	0.017340	0.46986	0.0074885	0.0041226

List of Instruments:

DPCM26: a_0, DPFUC26, DPRS26(-1), DUCP26 and DPDT26(-1)
DS26: a_0, DPFUC26, DRP26(-3), S1 and S3
DLIRS26: a_0, DUCP26 and DLPDP26(-3)

Table 5.7: OLS and IV Estimation for Industry 27

$$DPCM27 = a_0 + a_1 DPRS27 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS27_{t-j} + a_3 DPDT27 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT27_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS27 = a_0 + a_1 DRP27 + a_{2,t-j}\sum_{j=1}^{5} lagDRP27_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS27 = a_0 + a_1 DLPDP27 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP27_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			*IV*		
Coefficient	DPCM27	DS27	DLIRS27	DPCM27	DS27	DLIRS27
a_0	-0.013700 [-2.9429]***	0.070569 [3.6990]***	-0.022128 [-3.1541]***	-0.22453 [-0.24526]	0.070551 [3.6974]***	-0.022212 [-3.1163]***
a_1	0.074678 [0.60621]	0.64693 [1.0581]	0.23044 [0.40580]	5.9829 [0.23742]	0.73081 [1.0231]	0.14674 [0.10917]
$a_{2,t-j}$			-1.0520 [lag 1] [-1.8161]*			-1.027 [lag 1] [-1.4918]
a_3	-0.91456 [-1.5429]			-63.0368 [-0.23546]		
a_5	0.014563 [2.3686]**			0.16836 [0.25258]		
a_6	0.025421 [3.4883]***	-0.17812 [-4.6026]***	0.056769 [3.9935]***	0.46949 [0.24309]	-0.17757 [-4.5789]***	0.057052 [3.8472]***
a_7	0.014109 [2.2902]**			0.12393 [0.25836]		
F-Statistic	2.5912**	11.7784***	6.7668***	*NONE*	11.7649***	6.7568***
DW-Statistic	2.1371	1.6024	2.2098	2.1990	1.6107	2.2041
Wu-Hausman Statistic	1.1314	0.050727	0.0044323			
Joint Significance Test						
F-Statistic			1.6577			
Likelihood Ratio			3.4584			
Lagrange Multiplier			3.3556			
Wald-Statistic						3.1608
Serial Correlation	3.5927	6.1098	2.2027	0.068129	6.0654	1.8859
Functional Form	0.26690	0.49623	1.6349	0.053533	0.28057	1.2071
Normality	198.0970***	3.1151	0.091120	1.1500	3.1731	0.11438
Heteroscedasticity	0.42504	1.13061	0.031071	0.0032191	1.5595	0.0073229

List of Instruments:

DPCM27: a_0, DPFUC27, DUCP27, S1, S2 and S3
DS27: a_0, DPFUC27 and S2
DLIRS27: a_0, DUCP27, DLPDP27(-1) and S2

Table 5.8: OLS and IV Estimation for Industry 28

$$DPCM28 = a_0 + a_1 DPRS28 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS28_{t-j} + a_3 DPDT28 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT28_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS28 = a_0 + a_1 DRP28 + a_{2,t-j}\sum_{j=1}^{5} lagDRP28_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS28 = a_0 + a_1 DLPDP28 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP28_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			IV		
Coefficient	DPCM28	DS28	DLIRS28	DPCM28	DS28	DLIRS28
a_0	-0.0053810 [-1.5615]	0.026227 [1.9278]*	-0.0059309 [-1.5325]	-1.8334 [-0.022705]	0.026347 [1.9348]*	-0.0015787 [-0.20060]
a_1	0.36014 [1.5916]	0.35478 [0.94248]	-0.75388 [-1.6505]	-239.6961 [-0.022560]	0.25995 [0.55144]	3.0177 [0.65430]
$a_{2,t-j}$	0.025000 [lag 4] [0.22549]	-0.94640 [lag 2] [-2.5558]*	0.86627 [lag 2] [1.9069]*	66.6128 [lag 4] [0.022638]	-0.94182 [lag 2] [-2.5402]**	-0.42112 [lag 2] [-0.24752]
a_3	-1.0518 [-1.6686]			132.4067 [0.022154]		
$a_{4,t-j}$	-0.14596 [lag 3] [-0.45669]			-122.153 [lag 3] [-0.022664]		
a_5	0.0037481 [0.64638]			2.8031 [0.022656]		
a_6	0.022583 [3.8524]***	-0.060938 [-2.1971]**	0.027346 [3.4171]***	2.6434 [0.022854]	-0.061977 [-2.2194]**	0.0092873 [0.37204]
F-Statistic	3.7793***	4.5255***	4.7354***	*NONE*	4.4990***	*NONE*
DW-Statistic	2.2056	2.8361	2.2317	2.4073	2.8172	2.2673
Wu-Hausman Statistic	0.45543	0.11018	1.5812			
Joint Significance Test						
F-Statistic	1.4258 [a_1 and a_2] 1.4809 [a3 and a4]	3.6006**	2.3804			
Likelihood Ratio	3.1615 [a_1 and a_2] 3.2803 [a3 and a4]	7.2618**	4.9031*			
Lagrange Multiplier	3.0754 [a_1 and a_2] 3.1877 [a3 and a4]	6.8183**	4.6981*			
Wald-Statistic				0.0005346 [a_1 and a_2] 0.0005377 [a3 and a4]	6.6095**	1.3189
Wald Test of Restriction(s)	2.8240* [a_3+a_4=0]			0.0007194 [a_3+a_4=0]		
Serial Correlation	3.2298	22.7811***	3.0479	0.0005891	21.8613***	1.6214
Functional Form	0.46810	2.2107	0.10398	0.0005851	3.1716*	0.22237
Normality	4.4401	0.12815	4.1493	1.1966	0.11044	1.5362
Heteroscedasticity	0.039707	0.028954	1.3588	2.2257	0.10438	9.3204***

List of Instruments:

DPCM28: a_0, DPFUC28, DPRS28(-4), DUCP28, DPDT28(-3), S1 and S2
DS28: a_0, DPFUC28, DRP28(-2) and S2
DLIRS28: a_0, DUCP28, DLPDP28(-2) and S2

Table 5.9: OLS and IV Estimation for Industry 29

$$DPCM29 = a_0 + a_1 DPRS29 + a_{2,t-j}\sum_{j=1}^{5} lagDPRS29_{t-j} + a_3 DPDT29 + a_{4,t-j}\sum_{j=1}^{5} lagDPDT29_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DS29 = a_0 + a_1 DRP29 + a_{2,t-j}\sum_{j=1}^{5} lagDRP29_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

$$DLIRS29 = a_0 + a_1 DLPDP29 + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP29_{t-j} + a_5 S1 + a_6 S2 + a_7 S3$$

	OLS			*IV*		
Coefficient	DPCM29	DS29	DLIRS29	DPCM29	DS29	DLIRS29
a_0	-0.0041049 [-1.3384]	-0.068654 [-2.5191]**	0.38645 [3.0756]***	0.40828 [0.024615]	-0.065520 [-2.3218]**	0.037830 [2.5933]**
a_1	-0.0087228 [-0.10298]	0.86789 [1.2981]	-0.63347 [-0.66367]	-119.8771 [-0.024964]	1.2572 [1.1461]	0.10340 [0.015525]
$a_{2,t-j}$	0.040311 [lag 1] [0.51633]			-13.8974 [lag 1] [-0.024939]		
	0.23148 [lag 3] [2.4472]**			-35.4232 [lag 3] [-0.024805]		
a_3	-0.78129 [-0.62179]			1734.3 [0.024912]		
a_5		0.074193 [1.6334]	-0.14570 [-6.8708]***		0.071795 [1.5648]	-0.14529 [-6.7162]***
a_6	0.020261 [2.7958]***		0.0031508 [0.14245]	-2.3373 [-0.024702]		-0.0002085 [-0.0055778]
a_7		0.24769 [5.2702]***			0.24291 [5.0252]***	
F-Statistic	1.9529	10.9591***	17.9004***	*NONE*	10.7772***	17.5049***
DW-Statistic	2.2950	2.1495	2.5114	2.0799	2.1405	2.5723
Wu-Hausman Statistic	0.35888	0.19940	0.012407			
Joint Significance Test						
F-Statistic	2.2548* [a_1 and a_2]					
Likelihood Ratio	7.0991* [a_1 and a_2]					
Lagrange Multiplier	6.6748* [a_1 and a_2]					
Wald-Statistic				0.0007375 [a_1 and a_2]		
Serial Correlation	4.3190	16.8729***	8.1204*	0.0007007	14.6473***	4.6926
Functional Form	0.19675	1.0672	1.7171	0.0006981	2.2803	0.69782
Normality	0.73013	0.55654	0.19832	1.2617	0.30402	0.34346
Heteroscedasticity	0.036399	0.77459	0.63774	0.25085	0.53107	0.48117

List of Instruments:

DPCM29: a_0, DPFUC29, DPRSS29(-1), DPRS29(-3), DUCP29 and S2

DS29: a_0, DPFUC29, S1 and S3

DLIRS29: a_0, DUCP29, S1 and S2

5.1.1 Industry 21: Food, Beverage and Tobacco Manufacturing

A Bertrand reaction is found for industry 21 with a positive coefficient of 0.59969 for the variable *DPDT21* using *OLS* estimation method. It is statistically significant at the 5 percent level. Although it is accompanied by an insignificant domestic producer share variable, the F-statistic indicates that the estimates are jointly significant at the 10 percent level. The Wu-Hausman test for exogeneity suggests the use of *OLS* as an estimation method is appropriate. Hence, there is further emphasis the reliability of these estimates. Out of the four diagnostic tests, attention is drawn to the normality test. It is statistically significant at the 1 percent level. No doubt that the estimates have to be treated with caution. However, with the inclusion of the lag structure, the normality test often fails.

The model also proves useful in explaining the two share structures. For domestic producer share equation, the price ratio is statistically significant at the 10 percent level. The lag 4 estimate of this variable is also statistically significant at the 1 percent level. This current and lag price ratio has a joint estimate of F-statistic 3.3170, which is significant at the 5 percent level. These *OLS* estimates are justified with the acceptation of the null hypothesis of the price ratio exogenous properties. The F-statistic is also statistically significant at the 5 percent level. Note that these estimates for the domestic producer share equation do suffer from residual serial correlation at the 10 percent level. As a result, these estimates should be interpreted with caution.

The *DLPDP21* and its lag variables, the three seasonal dummies and the constant term are significant at the 1 percent level of statistic for the budget share equation. The joint significance test is also significant at the 1 percent level. The current and the lag 1 and 5 of *DLPDP21* have a joint F-statistic of 8.5820, which is also significant at the 1 percent level. However the estimates for the budget share equation suffer from heteroscedasticity diagnostic according to the test.

A Bertrand reaction is also confirmed for the *DPCM21* equation, using the instrumental variable method of estimation for industry 21. The variable *DPDT21* has a positive coefficient of 2.2017 and is statistically significant at the 1 percent level. Statistically, the domestic producer share is not significant even at the 10 percent level, but it does impact negatively on the price-cost margin, as in the *OLS* estimation. These estimates are reliable, by not failing any of the diagnostic tests.

For the domestic producer share equation, two lags of variable *DRP21* are included in the equation using *IV* estimation. Lag 3 is statistically not significant, but lag 4 estimate is statistically significant at the 1 percent level of statistic. At the current level, *DRP21* is not statistically significant nor is the constant term. The F-statistic indicates that the included independent variables are jointly significant at the 5 percent level. This coincides with the Wald-statistic, which provides a

joint test of zero restrictions on the coefficients of the current and lags *DRP21*, which is also statistically significant at the 5 percent level. Note that the residual is diagnosed to be serially correlated at the 10% level. Hence, these estimates should be treated with caution.

The *IV* estimation for *DLIRS21* includes lag 1 and 5 periods, together with the current period of the *DLPDP21* variable. All the included variables are statistically significant except the current level of *DLPDP21*. This is reflected in the F-statistic being significant at the 1 percent level. To start with, the constant term is significant at the 1 percent level. Lag 1 and 5 of the *DLPDP21* are also significant at the 1 percent level and 5 percent, respectively. The budget share is statistically shown to be influenced by the seasonal dummies. All the 3 dummies are statistically significant at the 1 percent level. The Wald-statistic has a χ^2 of 19.3238, which is statistically significant at the 1 percent level. To conclude, industry 21 can be classified as having Bertrand reaction, as estimated by both the *OLS* and *IV* estimates.[53]

5.1.2 Industry 22: Textile, Clothing, Footwear and Leather Manufacturing

Industry 22 shows a Bertrand reaction, according to the *OLS* results. It has a positive coefficient of 2.6901 for the variable *DPDT22*, which is statistically significant at the 1 percent level. A t-ratio of –5.8677 for *DPRS22* is also significant at the 1 percent level. This is true also for the constant term and the seasonal dummy. The regression satisfies the exogeneity property, but suffers from heteroscedasticity at the 10 percent level.

The estimates of the *DS22* equation are suspect, with both the serial correlation and the Wu-Hausman statistic significant at the 5 percent level. The variable *DRP22* estimate is not significant statistically, while all the 3 included seasonal dummies and a constant are statistically at the 1 percent level.

As for the budget share equation, the constant term and 2 seasonal dummies are significant at the 1 percent level. The variable *DLPDP22* is not statistically significant in influencing the budget share. However, the joint restrictions on all the explanatory variables being zero yields a significant level of 1 percent. As a result, aside from the suspect equation *DS22* estimates, the textile, clothing, footwear and leather manufacturing industry seems to behave in a Bertrand reaction.

Despite the highly significant *OLS* estimates, the *IV* estimates have an opposite conclusion. They show that the industry 22 has a Cournot reaction. But the *IV* estimates are not significant even at the 10 percent level. Hence, these estimates cannot be taken very seriously.

The *IV* estimation for *DS22* equation yields satisfactory estimates. The variable *DRP22* is positive and significant at the 10 percent level that the variable *DRP22* positively influences the domestic producer share. The constant term and the 3 seasonal dummies are each highly statistically. Seasonal dummies 1 and 3 positively influence *DS22*, while dummy 2 is negative. These *IV* estimates satisfy the 4 diagnostic tests for the residual.

The budget share equation for industry 22 is influenced by the seasonal dummies. Both the positive dummies are significant at the 1 percent level. The negative coefficient of the constant term is also significant at the 1 percent level. However, the variable DLPDP22 is not statistically significant. These estimates are reliable in the sense that the residuals pass all the diagnostic tests.

5.1.3 Industry 23: Wood and Paper Product Manufacturing

In the *OLS* results for industry 23, the variable *DPDT23* has a negative coefficient of –0.62586. However, this coefficient is not significant at the 10 percent level. The current level of *DPRS23* is insignificant, but its lag 5 is significant at the 5 percent level. The joint significance test for these variables has a F-statistic of 2.2834, failing to achieve even the 10 percent significance level. However, these estimates should be treated with caution since the residual is serially correlated at the 5 percent level and failed the normality at the 1 percent level. The test for misspecification of functional form is also statistically significant at the 10 percent level and the heteroscedasticity test is rejected at the 1 percent level.

The structural model applies well to the domestic producer share equation for this industry. The current level of *DRP23* variable yields an estimate of 0.46527 and is statistically significant at the 5 percent level. This estimate is offset (-0.4058) by its lag 1 variable, which is significant at the 10 percent level. The joint

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[53] However, some of the estimates do not pass the diagnostic tests in one form or another.

significance of these variables is at the 5 percent level, with a F-statistic of 3.2808. This share is also estimated to be affected positively in two seasons. There is no evidence against the estimates are statistically being reliable, with the insignificance of Wu-Hausman and all 4 diagnostic tests.

For the budget share equation, the variable *DLPDP23* is insignificant but its lag 5 is significant at the 5 percent level. Out of the three joint significance tests, the two coefficients are only jointly significant at the 10 percent level of χ^2 of 4.6379 using the likelihood ratio statistic. The constant term is significant at the 1 percent level and the seasonal dummy is significant at the 1 percent level. These *OLS* estimates do not fail any of the diagnostic tests and the Wu-Hausman statistic indicates that the explanatory variables are all exogneous.

The *IV* estimation for *DPCM23* is poor. No explanatory variable is significant. The joint test of zero restrictions on the coefficients of *DPRS23* is also insignificant.

The variable *DRP23* at the current period is statistically insignificant in influencing the domestic producer share. The impact lagged one period is significant at the 10 percent level. However, the joint test of zero restrictions for *DPR* and its lag are insignificant. As in industry 22, the seasonal dummies influence this share equation. Both the included dummies are significant at the 1 percent level. This is true also for the constant term. These estimates are statistically reliable since none of the diagnostic tests are significant.

The regression results indicate that the current *DLPDP23* variable is insignificant. The impact of this variable on the budget share is lagged five periods is significant at the 10 percent level. These estimates are also reliable, since all the diagnostic tests are rejected.

5.1.4 Industry 24: Printing, Publishing and Recorded Media

The *DPDT* variable in industry 24 has an estimate of 3.4364 and is statistically significant at the 5 percent level, suggesting Bertrand reaction. Although the *DPRS24* and the constant term appear to be insignificant, the F-statistic is significant at the 10 percent level. Note that the normality test is rejected at the 1 percent significance level, suggesting caution in interpreting results of significance tests.

Domestic producer share for industry 24 is seasonally influenced. The S1, S2 and S3 seasonal dummies are statistically significant at the 5 percent, 10 percent and 1 percent level, respectively. Variable *DPR24* is insignificant, as is the F-statistic for joint impact of variables. These estimates should be treated with caution since the residuals are serially correlated at the 1 percent significance level and also the normality test fails.

The budget share equation is also influenced seasonally. Both S1 and S2 are statistically significant at the 1 percent level, as is true also for the constant term. Although *DLPDP24* is insignificant, this test might be biased since the serial correlation test is significant at the 5 percent level.

The *IV* estimation indicates that none of the explanatory variables for the price-cost margin equation are significant. As a comparison to the *OLS* estimates, the *IV* estimates for variable *DPDT24* has the same sign as the *OLS* estimates. For the domestic share variable, the *IV* estimation predicts that it has a inverse relationship with the *DRP24* variable, which is the same prediction as the *OLS* estimation. However, the insignificant statistics do not provide any confident results.

The variable *DPR24* is estimated not to affect the domestic producer share. Of the three included seasonal dummies, only the seasonal dummies are statistically significant. The constant term is also statistically significant at the 5 percent level. However, these *IV* estimates suffer from serial correlation and the normality test is rejected at the 1 percent level of significance.

For the budget share equation, the *IV* estimates also suffer from serial correlation at the 5 percent level. As a result, the estimates should be treated with caution. Nonetheless, the seasonal dummies are predicted to be statistically significant at the 1 percent level and the constant term is significant at the 5 percent.

5.1.5 Industry 25: Petroleum, Coal, Chemical and Associated Product Manufacturing

Variable *DPDT25* has a negative coefficient, which classifies industry 25 into Cournot type of behaviour. The domestic share variable has a direct relationship with the price-cost margin. However, neither of these estimates is significant at the 10 percent significance level. As a result, the Cournot reaction is not conclusive for industry 25. In fact, the normality test is significant at the 1 percent level, which makes the *OLS* test statistics unreliable.

All the *OLS* coefficient estimates for the domestic producer share equation are statistically significant at the 1 percent level. The current *DRP25* variable and its lag 2 have offsetting effect. The former has a positive coefficient, while the latter has a negative coefficient. The test of joint impact has a significance of F-statistic 25.5860, which is significant at the 1 percent level. Other variables included in the equation are the constant term and two seasonal dummies. Even though these are highly significance estimates, they suffer from a heteroscedasticity problem and from the misspecification of functional too.

The current level of *DLPDP25* is estimated not to have statistical significance impact on the budget share. It is affecting the budget share only after lag 3 periods. At lag 3, it is statistically significant at the 5 percent level. A joint test of significance on variable *DLPDP25* and its lag is significant at the 10 percent level, with a F-statistic of 2.7713. It is also estimated that the budget share depends on seasonality elements. Both S1 and S3 dummies are significant at the 1 percent level. The constant term is also significant, but at the 10 percent level. However, the hypothesis that the residuals are not normally distributed is rejected at the 1 percent significance level. As a conclusion, the model predicts well for both the two share equations, although they fail diagnostic tests in one form or another. The estimates from the price-cost margin equation tend to indicate that industry 25 follows a Cournot type of reaction, albeit without statistical significance at the usual level.

The *IV* estimates for the coefficient of the variable *DPDT25* are contradictory with the *OLS* estimates. It turns out that industry 25 has a Bertrand type of reaction for the *IV* estimation. However, this *IV* estimate is statistically insignificant. The sign of the variable *DPRS25* is also opposite in the two estimation methods. Variable *DPRS25* has an inverse relationship with price-cost margin using the *IV* estimation. Again, this estimate is insignificant. Overall, the reaction property of industry 25 is not conclusive.

All the included variables for the domestic share equation are statistically significant at the 1 percent level, using the *IV* estimation method. Variable *DRP25* and its lag 2 are also statistically significant at the 1 percent level for the joint significance test. Note that the test for heteroscedasticity is significant at the 1 percent level and the test for misspecification of the functional form is significant at the 10 percent level. As a result, these estimates should be treated with caution.

As an individual variable, only lag 3 of the variable *DLPDP25* in the budget share equation is significant at the 5 percent level as compared to the insignificant current level. Together these variables have a joint significance at the 10 percent level. Both the S1 and S3 dummies are significant at the 1 percent level. The constant term is also significant, but at the 10 percent level. A word of caution is that the residuals fail the normality diagnostic at the 1 percent level. Besides the diagnostic problems, the model works by picking up significant variables for the two share equations. One of the reasons why the budget share equation has poor estimates might due to poor instruments used.[54]

5.1.6 Industry 26: Non-Metallic Mineral Product Manufacturing

Both the variable *DPDT26* and its lag 1 counterpart have an estimated negative *OLS* coefficient. The negative coefficient on the current level of *DPDT26* indicates that industry 26 is behaving in a Cournot environment. Even though the current level of variable *DPDT26* is insignificant, its lag 1 variable is statistically significant at the 5 percent level. The joint significance test also rejects the zero restriction on these two coefficients and is statistically significant at the 10 percent level. Further, when imposing a zero restriction on the sum of the *DPDT26* and its lag 1 coefficients, it is significantly different from zero at the 10 percent level. This is shown by the Wald test, which has a statistic of 2.9944. As for variable *DPRS26*, the current level is statistically insignificant, but its lag 1 variable is significant at the 10 percent level. However, these variables are not jointly significant, given the F-statistic of 1.7054. All these results suffer from the serial correlation and lack of normality according to the diagnostic tests.

In the producer share equation, variable *DRP26* and its lag 3 are statistically significant at the 1 percent and 5 percent level, respectively. The lag 3 of *DRP26* has an offsetting effect by having a negative *OLS* coefficient of –0.57517. Combined these variables are also jointly significant at the 1 percent level, even with the offsetting effects. Seasonal dummies are also significant, but the constant term is not. The Wu-Hausman statistic indicates that the variables are exogenous, but the residuals exhibit significant serial correlation when the diagnostic test is applied.

The budget share for industry 26 does not seem to be influenced by seasonality. The current variable *DLPDP26* has a direct relationship with the budget share but this relationship is more than offset by its lag 3 variable by having a negative *OLS* coefficient of –2.2715. The current level of variable *DLPDP26* cannot be statistically proven significant, but its lag 3 is significant at the 1 percent level. A joint significance test indicates that they are jointly significant at the 1 percent level for both *DLPDP26* and its lag 3, even with the offsetting impact between the two variables. These estimates seem reliable, based on the diagnostic tests, and the Wu-Hausman statistic indicates that these variables are exogenous.

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[54] There might be a low correlation between the instruments and the explanatory variables.

The *IV* estimation for the price-cost margin seems suspicious with the large estimated coefficient for both *DPRS26* and *DRP26* variables. None of the included variables are statistically significant, despite that these estimates pass all the diagnostic tests.

For the domestic producer share equation, variable *DRP26* and its lag 3 variable are statistically significant at the 5 percent level. They have offsetting effects, with the current variable having a positive *IV* coefficient of 0.81417 and the lag 3 variable having a negative *IV* coefficient of –0.58342. They are also jointly significant at the 1 percent significance level. While interpreting these results, it should be noted that the residuals fail the serial correlation diagnostic test at the 10 percent level.

The budget share equation is predicted well by the model with *IV* estimation. The current level of variable *DLPDP26* has a negative relationship with the budget share. This relationship is further amplified by its lag 3 variable, which is significant at the 1 percent level. While both of these variables are jointly significant at the 1 percent level, the constant term is not significant. These estimates are reliable, without failing any diagnostic tests. As seen in other industries, the *IV* estimation of the price-cost margin equation seems to have poor results but both the share equations yield results that satisfy the diagnostic tests.

5.1.7 Industry 27: Metal Product Manufacturing

The variable *DPDT27* has an *OLS* estimate of –0.91456 for the price-cost margin equation. However, this estimate is not statistically significant. Hence, a Cournot reaction cannot be concluded for industry 27. The variable *DPRS27* is also insignificant, while there are significant seasonal dummies and the constant term. These results are subject to caution with the residuals not being normally distributed, according to the normality test.

Beside the constant term and the seasonal dummy that are significant at the 1 percent level, the variable *DRP27* is statistically insignificant for the domestic producer share equation. Overall, all the included variables have a F-statistic of 11.7784, which is statistically significant at the 1 percent level.

For the budget share equation, the constant term is significant at the 1 percent level. The S2 dummy also shares the same significance level. The significance level for the current *DLPDP27* variable is below 10 percent, but its lag 1 variable is significant at the 10 percent level. Although the joint test is insignificant for the combination of *DLPDP27* and its lag, the explanatory variables as a whole are statistically significant at the 1 percent level. These estimates satisfy all diagnostic tests and all explanatory variables are exogenous according to the Wu-Hausman test.

The *IV* estimation has the same prediction as the *OLS* estimate where industry 27 is having a Cournot reaction, since *DPDT27* variable has the negative sign. However, this estimate is insignificant, so it does not provide a reliable indication that industry 27 is behaving in a Cournot environment. All other included variables are also insignificant.

The constant term and the seasonal dummy are both statistically significant at the 1 percent level for the domestic producer share equation using *IV*. This share is not significantly affected by the *DRP27* variable. These estimates are reliable, with the F-statistic significant at the 1 percent level and none of the diagnostic tests significant. The same applies to the Wu-Hausman test.

In the budget share equation only the constant term and the seasonal dummy are statistically significant at the 1 percent level. Both *DLPDP27* and its lag 1 variable are statistically insignificant. As expected, the joint test of zero restrictions for the coefficients of *DLPDP27* and its lag 1 is statistically insignificant. Similarly to the domestic producer equation, the budget share estimates are reliable.

5.1.8 Industry 28: Machinery and Equipment Manufacturing

For industry 28, only S2 dummy is statistically significant at the 1 percent level for the price-cost margin equation using *OLS*. None of the other included variables are statistically significant. Even when tested jointly, these set of explanatory variables are not significant. However, when a zero restriction of the sum of *DPDT28* and its lag 3 coefficients is imposed, it is statistically significant at the 10 percent level. As a result, since the coefficients of *DPDT28* and its lag 3 add up to be –1.19776, it suggests that industry 28 is having a Cournot-type of reaction. Without failing any of the diagnostic tests make these estimates reliable.

The constant term is significant at the 10 percent level for the domestic producer share equation. Only lag 2 of the *DRP28* is significant at the 10 percent level. The combination of the current variable of *DRP28* and its lag 2 variable are jointly significant at the 5 percent level of significant. This share is also estimated to be affected by the seasonality. These estimates for the domestic share equation are suffering from the serial correlation at the 1 percent level. Hence, they should be treated with caution.

The S2 dummy is significant at the 1 percent significance level in the budget share equation. Neither the constant term nor the current variable *DLPDP28* are statistically significant. The lag 2 of *DLPDP28* variable is significant at the 10 percent level. The joint test of zero restrictions on both the coefficients of *DLPDP28* and its lag 2 variable is significant at the 10 percent level, using the Lagrange Multiplier statistic and the Likelihood Ratio statistic. But at this confidence interval, the F-statistic is not significant. Although the *OLS* estimates are inconclusive in indicating the reaction strategy of industry 28, the model seems to work well with the two share equations.

The results from the *IV* estimation are contradictory with the one by *OLS*. As the positive coefficient of the *DPDT28* suggests a Bertrand reaction, it contradicts with the *OLS* estimate. However, this *IV* estimate is insignificant, so the contradictory result is unreliable. The other variables are also insignificant, although, they are having the same sign as the *OLS* estimates, except the current value of *DPRS28*.

The *IV* estimation of the domestic producer share equation is similar with the *OLS* estimation, both in the magnitude of the coefficients and their sign. The constant term is significant at the 10 percent level. The current variable *DRP28* is insignificant, but its lag 2 variable is significant at the 5 percent level. These variables are jointly significant at the 5 percent level. Also, the seasonal dummy is also estimated to be significant at the 5 percent level. However, due to the significant serial correlation diagnostic, these estimates should be treated with caution.

Unlike its *OLS* counterpart, the *IV* estimates for the budget share equation yield unsatisfactory results. Neither the current variable *DLPDP28* nor its lag 2 are significant. Also, the included seasonal dummy and the constant term are insignificant. These significance statistics should be treated with caution, since the residuals fail the heteroscedasticity diagnostic test at the 1 percent significance level.

5.1.9 Industry 29: Other Manufacturing

Industry 29 shares the same fate as in industry 28 for the price-cost margin equation. The *OLS* estimate for the *DPDT29* coefficient indicates that industry 29 is having a Cournot reaction, but this estimate is not statistically significant. The current variable DPRS29 is insignificant, but its lag 3 variable is statistically significant at the 5 percent level. The *DPRS29* and its lag 3 variable are jointly significant at the 10 percent level. The constant term is insignificant, but the seasonal dummy S2 is significant at the 1 percent level.

For the domestic producer share equation, only the seasonal dummy S3 is significant at the 1 percent level. All other variables are statistically insignificant. Also, these estimates fail the serial correlation diagnostic test and should therefore be treated with caution.

Only the constant term and the seasonal dummy S1 are statistically significant at the 1 percent level in the budget share equation. Again, these estimates should be treated with caution, since they fail the serial correlation diagnostic test. As a conclusion, the model is not clearly applicable to industry 29. Perhaps this is due to its diversity in production structure.

The nature of this industry also seems to be causing a problem for the *IV* estimation. None of the included variables are statistically significant for the price-cost margin. Furthermore, it has a contradictory sign for the variable *DPDT29* as compared to the *OLS* estimate. All the *IV* estimates are having the opposite sign to those in the *OLS* estimates, except for the *DPRS29* variable.

Similarity is found for the domestic producer share equation, by comparing both the estimation methods. The constant term is significant at the 5 percent level using the *IV* estimation, while the seasonal dummy S3 is significant at the 1 percent level. All of the estimated coefficients provide the same sign as to the *OLS* estimates. In fact, *DRP29* is also insignificant for *IV* estimation. However, these estimates should be treated with care, since they suffers from the serial correlation at the 1 percent level.

The estimates for both the constant term and the seasonal dummy S1 in the budget share equation are statistically significant, at 5 percent for the former and 1 percent for the latter variable. This is similar to the *OLS* case. The coefficients for both have the same sign as in the *OLS* estimates. However, for the *DLPDP29* variable, the coefficient is estimated to be positive under *IV* estimation, while *OLS* suggests otherwise. The contradictory results also prevail for seasonal dummy S2. The *IV* estimates are more reliable since none of the diagnostic tests are significant.

5.2 Vector Autoregression and Cointegration

The two general methods for testing the existence of cointegrating vectors are the Engle and Granger (1987) and the Johansen (1988). The simplest method is the two-step regression-based test proposed by Engle and Granger. This method involves examining the residuals from the cointegrating regression and, in particular, testing the null hypothesis that assumes the residual series has a unit root against an alternative that the series is stationary. Engle and Granger examine the stationarity of the residuals from the cointegrating regression using Durbin-Watson, Dickey-Fuller and Augmented Dickey-Fuller statistics. They conclude that the augmented Dickey-Fuller test is to be preferred.

Johansen argues that the Engle and Granger procedure suffers from a number of deficiencies. In particular, the use of *OLS* to estimate a cointegration relationship for an N-dimensional vector identifies at most a single cointegrating vector, while the alternative Johansen method can identify up to N-1 distinct cointegrating vectors among a series of cointegrating vectors that exist within the system (MacDonald and Power, 1995, p.141). This is particularly pertinent when one moves away from the simple two-variable case.

In addition, large finite-sample biases can arise in static *OLS* estimates of cointegrating vectors or parameters. While estimates are super-consistent, Monte Carlo experiments suggest that a large number of observations may be necessary before the biases become small (Banerjee, Dolado, Hendry and Smith, 1986). In the absence of information on the data generation process, some method other than static regression may give superior estimates of the cointegrating vector or tests with higher powers. In particular, dynamic regressions may be more robust to a range of data-generation processes.

It is useful to consider an informal explanation for the existence of biases in static regressions. The effect of using static regressions to estimate the cointegrating slope is to allow the residual to capture all the dynamic adjustment terms. According to the super-consistency theorem, this is certainly permissible asymptotically. It is important to emphasize that the data set in this thesis is finite. The omission of the dynamics may then be justified asymptotically by observing that, as they are of a lower order of magnitude than the non-stationary terms in the regression, they may be ignored in the limit. Despite being of a lower order of magnitude, the omitted dynamics can matter considerably in determining biases even in fairly large samples (Banerjee, Dolado, Galbraith and Hendry, 1986).

Phillips and Hansen (1990) have argued that the performance of estimators of co-integrating vectors based on static regressions is adversely affected by the existence of second-order biases. Phillips and Hansen therefore recommend full-system maximum likelihood estimation of cointegrated systems. As an alternative to estimation of the full system, they propose correcting the single-equation estimates non-parametrically in order to obtain median-unbiased and asymptotically normal estimates. These recommended corrections, for simultaneity bias and residual autocorrelation, use expressions derived from the asymptotic distributions of the estimators although the corrections are made to estimators from finite samples. Phillips and Hansen show that these corrections work effectively in sample sizes as small as 50.

In attempting to overcome this deficiency, Johansen (1988) provides an alternative cointegration technique. The Johansen method relies on modelling the variables of interest using an autogregressive process. This provides estimates of all the cointegrating vectors that exist within a vector of variables. It also provides a test statistic for the number of cointegrating vectors that has an exact limiting distribution. According to MacDonald and Power (1995, p. 141), this test may therefore be viewed as more discerning in its ability to reject a false null hypothesis.

The estimates obtained from fully modified and full-information methods are asymptotically equivalent (Banerjee et al., 1993). Given that the sample size in this thesis is not particularly small and that simultaneous estimation is used, the Johansen procedure is adopted. Two models are proposed in testing for cointegration for the three equations used in the structural model presented in the previous section. In the first model (Model 1), the cointegration test is carryied out using only the variables in a single equation. An alternative model (Model 2) uses all the variables in the structural model to test for cointegration. Since the empirical model is a structural model, it is plausible to use all the variables in testing for cointegration. The main reason to test for cointegration among variables is to enable the establishment of a dynamic vector error correction model (*VECM*). The *VECM* may be interpreted as possessing a long-run equilibrium, although random shocks push the system away from equilibrium in the short-run.

5.3 Model 1: Cointegration Analysis

The cointegration analysis is carried out with and without trend, and a constant term is entered unrestricted in the each cointegration analysis. The same analysis strategy is performed with all the industries for both model 1 and model 2. Test statistics are based on the maximum eigenvalue and trace statistics. When these test statistics reject the null hypothesis, it is rejecting the hypothesis of no cointegrating vector.

5.3.1 Model 1: Cointegration Analysis for PCM, PRS and PDT

The cointegration analysis results for the price-cost margin equation are presented in Table 5.10. Based on to the *VAR* system reduction result for industry 21, the cointegration analysis is carried out with 5 lags used in the analysis.[55] Without the trend variable, the trace statistic suggests that there are possibly 2 cointegration relationships. As a result, two cointegrating vectors are used in modelling the vector error correction model.

For industry 22, there is evidence suggesting that *PCM22*, *PRS22* and *PDT22* are not cointegrated. Both the maximum eigenvalue statistic and the trace statistic are not able to reject the null hypothesis of no cointegrating vector, using 4 lags in the analysis. This conclusion is confirmed by the cointegration analyses using the trend and without the trend variable.

Both cointegration analyses, with and without trend variable, are unable to reject the null hypothesis for industry 23, using 5 lags in the analysis. As a result, *PCM23*, *PRS23* and *PDT23* are not cointegrated, within the limit of the critical values.

For industry 24, the cointegration analysis with a constant and a trend variable rejects the null hypothesis that there is no cointegrating vector. In fact, the analysis suggests that there is only 1 cointegrating vector. This is confirmed by both the maximum eigenvalue and the trace statistics with 5 percent significance value when the analysis is performed with a trend variable.

The cointegration analysis using 5 lags and a trend variable for industry 25 has theoretically conflicting results. Both the maximum eigenvalue and the trace statistics suggest there are more than 2 cointegrating vectors, which is theoretically unsound. The cointegration analysis without the trend variable does not suggest that the variables are cointegrated. As a conslusion, the statistics suggest that that the variables in industry 25 are not cointegrated.

Similar to industry 25, the statistics for industry 26 are not theoretically sound. When a trend is included in the analysis, the cointegration analysis suggests that there are more than 2 cointegrating vector. This might be due to the misspecification, since the analysis without the trend variable suggests that the variables are not cointegrated. Hence, the variables in industry 26 do not appear to be cointegrated.

Both the maximum eigenvalue and the trace statistics do not reject the null hypothesis of no cointegrating vector between the variables in industry 27. In fact, both analyses, with and without trend variable give congruent results, when using 3 lags in the analysis.

Industry 28 has the same situation as in industry 27. The statistics suggest that the variables are not cointegrated when using 3 lags in the cointegration analysis.

For industry 29, cointegration analysis with the trend variable suggests that the variables are not cointegrated. In fact, this is further confirmed by the analysis without a trend variable.

Table 5.10: Cointegration Test for Model 1 (PCM, PRS and PDT)

Variable	Order of *VAR*	H_0: rank = p	With Trend: Maximum Eigenvalue	95%	Trace	95%	Without Trend: Maximum Eigenvalue	95%	Trace	95%
PCM21		p==0	17.44	23.8	31.91	34.6	16.24	21.0	32.44*	29.7
PRS21	5	p<=1	13.24	16.9	14.47	18.2	15.97*	14.1	16.2*	15.4
PDT21		p<=2	1.232	3.7	1.232	3.7	0.2295	3.8	0.2295	3.8
PCM22		p==0	17.42	23.8	28.08	22.27	18.79	21.0	21.85	17.33
PRS22	4	p<=1	10.33	16.9	10.66	8.452	2.296	14.1	3.054	2.422
PDT22		p<=2	0.3227	3.7	0.3227	0.256	0.7579	3.8	0.7579	0.6011
PCM23		p==0	21.68	23.8	31.58	34.6	20.68	21.0	27.79	29.7
PRS23	5	p<=1	8.676	16.9	9.905	18.2	4.582	14.1	7.114	15.4
PDT23		p<=2	1.229	3.7	1.229	3.7	2.532	3.8	2.532	3.8
PCM24		p==0	27.82*	23.8	37.81*	34.6	9.37	21.0	16.72	29.7
PRS24	5	p<=1	8.69	16.9	9.989	18.2	7.05	14.1	7.35	15.4
PDT24		p<=2	1.299	3.7	1.299	3.7	0.2998	3.8	0.2998	3.8
PCM25		p==0	21.21	23.8	32.61	34.6	10.38	21.0	16.11	29.7
PRS25	5	p<=1	7.559	16.9	11.4	18.2	5.307	14.1	5.73	15.4
PDT25		p<=2	3.841*	3.7	3.841*	3.7	0.4236	3.8	0.4236	3.8
PCM26		p==0	10.03	23.8	22.76	34.6	11.87	21.0	19.29	29.7
PRS26	3	p<=1	7.546	16.9	12.73	18.2	5.994	14.1	7.421	15.4
PDT26		p<=2	5.184*	3.7	5.184*	3.7	1.427	3.8	1.427	3.8
PCM27		p==0	17.86	23.8	28.85	34.6	10.65	21.0	18.17	29.7
PRS27	3	p<=1	7.401	16.9	10.99	18.2	7.527	14.1	7.529	15.4
PDT27		p<=2	3.592	3.7	3.592	3.7	0.00166	3.8	0.00166	3.8
PCM28		p==0	21.52	23.8	30.52	34.6	11.11	21.0	15.63	29.7
PRS28	3	p<=1	6.457	16.9	9	18.2	4.514	14.1	4.519	15.4
PDT28		p<=2	2.543	3.7	2.543	3.7	0.005	3.8	0.005	3.8
PCM29		p==0	16.92	23.8	27.19	34.6	9.738	21.0	14.47	29.7
PRS29	5	p<=1	6.692	16.9	10.26	18.2	4.727	14.1	4.728	15.4
PDT29		p<=2	3.571	3.7	3.571	3.7	0.00049	3.8	0.00049	3.8

Note: * *indicates statistical significance at the 5 percent level*
** *indicates statistical significance at the 1 percent level*

[55] The *VAR* system reduction tests for Model 1 and Model 2 are presented in the appendix.

5.3.2 Model 1: Cointegration Analysis for LSD and LPFPD

The cointegration analysis results for the domestic producer share equation are presented in Table 5.11. For the domestic producer share equation, 4 lags in the *VAR* are used in the cointegration analysis for industry 21. The cointegration test result with trend variable indicates that *LSD21* and *LPFPD21* each have one cointegrating vector.[56] Both the maximum eigenvalue and the trace statistics reject the null hypothesis of no cointegrating vector at the 95 percent critical value. Although, the alternative cointegration test without a trend variable indicates that there is no cointegration relationship between the two variables concerned, a positive result will always be preferred since the exclusion of trend is unjustified.

For industry 22, the cointegration test results with the trend variable are conflicting. The maximum eigenvalue statistic is not able to reject the null hypothesis of zero cointegrating vector at the 95 percent critical value. On the other hand, the trace statistic suggests that there is at least one cointegrating vector exists between variables *LSD22* and *LPFPD22*. Since one of the statistics is indicating the existence of cointegration, it is justifiable that there exists an error correction mechanism.

Both the cointegration tests, with and without the trend variable, have a theoretically unsound result. When 5 lags are used in the analysis for industry 23, both tests suggest that there exist more than 1 cointegrating vectors. When an error correction model is being proposed for industry 23, it should be treated with caution.

For industry 24, the cointegration analysis with a trend variable does not conform with the theory, where only 1 cointegrating vector can exist for an equation with 2 variables. This suggests that the inclusion of a trend variable might not be appropriate. The cointegrating analysis without a trend indicates that there is no cointegrating relationship between the variables *LSD24* and *LPFPD24*.

For industry 25, the cointegration analysis with trend suggests that there are more than one cointegration relationship between *LSD25* and *LPFPD25*. This result is unreliable since it does not conform with the theory. As for the cointegration without the trend variable, the analysis suggests that there is no cointegrating vector exists. This result is preferred.

The maximum eigenvalue and the trace statistics indicate that *LSD26* and *LPFPD26* are not cointegrated, when industry 26 is analysed with a trend variable. The same results appear for the cointegration analysis without a trend as well.

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[56] Theoretically, with two variables in an equation, there can only exists one cointegrating vector.

The cointegration analysis without a trend variable is preferred, since the test with a trend suggests more than 1 cointegrating vector. Without the trend variable, the test statistics suggest that there is no cointegration relationship between *LSD27* and *LPFPD27*.

Similar to industry 27, the cointegrating analysis result for industry 28 is not theoretical sound when a trend is included. The alternative analysis, without a trend, suggests that the variables in industry 28 are not cointegrated.

Both the cointegration analyses suggest that there is no evidence of cointegration relationship between the variables in the industry 29. With this congruent result, there is no error correction mechanism for this industry.

Table 5.11: Cointegration Test for Model 1 (LSD and LPFPD)

Variable	Order of *VAR*	H_0: rank = p	With Trend				Without Trend			
			Maximum Eigen-value	95%	Trace	95%	Maximum Eigen-value	95%	Trace	95%
LSD21 LPFPD21	4	p==0 p<=1	22.15** 2.128	16.9 3.7	24.28** 2.128	18.2 3.7	4.997 0.0506	14.1 3.8	5.048 0.0506	15.4 3.8
LSD22 LPFPD22	5	p==0 p<=1	16.7 3.718	16.9 3.7	20.42* 3.718	18.2 3.7	4.864 0.00334	14.1 3.8	4.867 0.00334	15.4 3.8
LSD23 LPFPD23	5	p==0 p<=1	21.59** 10.16**	16.9 3.7	31.75** 10.16**	18.2 3.7	18.02* 9.39**	14.1 3.8	27.68** 7.771**	15.4 3.8
LSD24 LPFPD24	3	p==0 p<=1	34.23** 6.461*	16.9 3.7	40.69** 6.461*	18.2 3.7	9.815 3.147	14.1 3.8	12.96 3.147	15.4 3.8
LSD25 LPFPD25	5	p==0 p<=1	8.311 3.989*	16.9 3.7	12.3 3.989*	18.2 3.7	9.991 1.491	14.1 3.8	11.48 1.491	15.4 3.8
LSD26 LPFPD26	5	p==0 p<=1	9.801 1.843	16.9 3.7	11.64 1.843	18.2 3.7	8.705 0.4087	14.1 3.8	9.114 0.4087	15.4 3.8
LSD27 LPFPD27	5	p==0 p<=1	11.1 5.355*	16.9 3.7	16.45 5.355*	18.2 3.7	5.625 0.1614	14.1 3.8	5.787 0.1614	15.4 3.8
LSD28 LPFPD28	2	p==0 p<=1	21.29* 8.796**	16.9 3.7	30.09** 8.796**	18.2 3.7	10.45 1.124	14.1 3.8	11.58 1.124	15.4 3.8
LSD29 LPFPD29	5	p==0 p<=1	8.118 1.397	16.9 3.7	9.515 1.397	18.2 3.7	3.859 1.263	14.1 3.8	5.122 1.263	15.4 3.8

Note: * *indicates statistical significance at the 5 percent level*
** *indicates statistical significance at the 1 percent level*

5.3.3 Model 1: Cointegration Analysis for LIRS and LPDP

The cointegration analysis results for the budget share equation are presented in Table 5.12. For industry 21, the cointegration analysis without a trend suggests that there exists 1 cointegrating vector between *LIRS21* and *LPDP21*. The trace statistic rejects the null hypothesis at the 95 percent critical value. When the cointegration analysis includes the trend variable, the test results are not theoretically consistent, indicating more than one cointegrating vectors. Hence, these results are not taken into consideration.

A *VAR* of the order 4 is used in testing for cointegration in industry 22. When the analysis includes the trend variable, the results, by both the maximum eigenvalue and the trace statistics, indicate that there exists more than 1 cointegrating vector. These results are theoretically impossible. Hence, the alternative cointegration analysis is accepted. Without a trend, the test statistics suggest that there exists no cointegrating vector between the variables.

The test statistics are unable to reject the null hypothesis for industry 23 when 5 lags are included in the cointegration analysis. These statistics are estimated with the trend variable. Since the analysis results without a trend are spurious, it is concluded that the variable *LIRS23* and *LPDP23* are not cointegrated.

As indicated in the *VAR* system reduction for industry 24, 5 lags are appropriate to be included in the cointegration analysis. Both analyses, with and without a trend variable, suggest there is no cointegrating relationship between *LIRS24* and *LPDP24*.

For industry 25, the cointegration analysis without a trend variable is theoretically sound. With 5 lags are included in the analysis, both test statistics are 99 percent confident in rejecting the null hypothesis. Based on this result, we conclude that the variables in industry 25 are cointegrated. As indicated in the *VAR* system reduction result, the cointegration results should be treated with caution due to evidence of autocorrelation in the vector for the *VAR* system.

Both the cointegration analyses, with and without a trend variable, produce the same results of no cointegrating relation between variable *LIRS26* and *LPDP26*. Hence, an error correction model might be redundant for industry 26, since there is no justification that an error correcting mechanism exists.

Similarly, both the maximum eigenvalue and the trace statistics suggest that there is no cointegrating relationship between variable *LIRS27* and *LPDP27*. These results apply to both the cointegrating analyses, with and without a trend variable.

For industry 28, 4 lags are included in the cointegration analysis. Both the maximum eigenvalue and the trace statistics are such that there is 95 percent confidence in rejecting the null hypothesis, when the cointegration analysis is performed without a trend variable. As a result, the variables *LIRS28* and *LPDP28* are shown to be cointegrated.

The *VAR* of the order 4 is used for the cointegration analysis for industry 29. The test statistics suggest that there is no cointegrating relationship between the variables *LIRS29* and *LPDP29*. These results are shown by both the analyses, with and without a trend variable.

Table 5.12: Cointegration Test for Model 1 (LIRS and LPDP)

			With Trend				Without Trend			
Variable	Order of *VAR*	H_0: rank = p	Maximum Eigen-value	95%	Trace	95%	Maximum Eigen-value	95%	Trace	95%
LIRS21	5	p==0	15.89	16.9	25.46**	18.2	13.13	14.1	15.6*	15.4
LPDP21		p<=1	9.575**	3.7	9.575**	3.7	2.464	3.8	2.464	3.8
LIRS22	4	p==0	11.94	16.9	17.4	18.2	13.08	14.1	13.85	15.4
LPDP22		p<=1	5.468*	3.7	5.468*	3.7	0.7643	3.8	0.7643	3.8
LIRS23	5	p==0	8.314	16.9	9.804	18.2	9.064	14.1	13.57	15.4
LPDP23		p<=1	1.49	3.7	1.49	3.7	4.502*	3.8	4.502*	3.8
LIRS24	5	p==0	9.271	16.9	12.6	18.2	6.725	14.1	7.087	15.4
LPDP24		p<=1	3.331	3.7	3.331	3.7	0.3623	3.8	0.3623	3.8
LIRS25		p==0	16.54	16.9	20.39*	18.2	20.12**	14.1	22.66*	15.4
LPDP25	5	p<=1	3.842*	3.7	3.842*	3.7	2.535	3.8	* 2.535	3.8
LIRS26	5	p==0	8.428	16.9	9.94	18.2	4.829	14.1	7.18	15.4
LPDP26		p<=1	1.512	3.7	1.512	3.7	2.351	3.8	2.351	3.8
LIRS27		p==0	11.33	16.9	14.58	18.2	8.243	14.1	8.247	15.4
LPDP27	5	p<=1	3.259	3.7	3.259	3.7	0.003997	3.8	0.0039 97	3.8
LIRS28	4	p==0	15.98	16.9	17.92	18.2	18.39*	14.1	19.48*	15.4
LPDP28		p<=1	1.939	3.7	1.939	3.7	1.087	3.8	1.087	3.8
LIRS29	3	p==0	6.203	16.9	8.723	18.2	6.501	14.1	8.708	15.4
LPDP29		p<=1	2.52	3.7	2.52	3.7	2.207	3.8	2.207	3.8

Note: ** indicates statistical significance at the 5 percent level*
*** indicates statistical significance at the 1 percent level*

5.4 Model 2: Cointegration Analysis

The cointegration analysis for model 2 consists of all the variables in the structural model. In the price-cost margin equation, the cointegration analysis is performed on variables that appears in the equation and on those variables that are involved indirectly through the domestic share variable (*PRS*) and the product of the two shares (*PDT*) variable. The variables concerned are the *PCM*, *PRS*, *PDT*, *IRS*, *PDP* and *PFPD*.

The domestic producer share equation is linearly transformed for cointegration analysis purposes. The linearly transformed domestic producer share equation is shown in equation (5.7). The dependent variable is term *LSD* and the independent variable is term *LPFPD*. Since, Model 2 considers all the variables in the structural model, variable *LPFUC* is included in the cointegration analysis. The

LPFUC variable is the log of equation (5.15), where variable *PFUC* is used as the instrument for domestic producer share equation.

As in the budget share equation, the linearly transformed version of the industry share equation is shown in equation (5.11). The dependent variable is term *LIRS* and the independent variable is term *LPDP*. Variable *LUCP* is included in the cointegration analysis, where LUCP is the log of the instrument variable used for the budget share equation, namely, the log of variable in equation (5.16).

5.4.1 Model 2: Cointegration Analysis for PCM, PRS, PDT, IRS, PDP and PFPD

The test results are presented in Table 5.13. For industry 21, 4 lags in the *VAR* system are used in the analysis.[57] Without the trend variable, both the test statistics show that all the variables are cointegrated and there exist 2 cointegrating vectors are significant at the 1 percent level.

For industry 22, the test statistics suggest that there exist a cointegration relationship among the variables. This is based on the maximum eigenvalue that is statistically significant at the 5 percent level and at the 1 percent level for the trace statistic. These results are based on the analyses either with or without a trend variable. There is a mixed conclusion on whether there exists more than 1 cointegrating vector. With a trend variable, the trace statistic indicates that there exists more than 1 cointegrating vector, as opposed to just one cointegrating vector suggested by the maximum eigenvalue statistic. Since, it is not confident that there exists more than one cointegrating vector, the vector error correction model is specified using just one cointegrating vector.

Both the analyses, with and without a trend variable, coincide for industry 23. Tthe trace statistic indicates that there exists a cointegrating vector at the 5 percent significance level.

For industry 24, without a trend variable, the test statistic is theoretically sound, as compared to the analysis with a trend variable.[58] Both the maximum eigenvalue and the trace statistics indicate that the variables are cointegrated by one cointegrating vector at the 5 percent significance level.

Both the cointegration analyses produce the same results for industry 25. Both the test statistics are significant at the 1 percent level in rejecting the null

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[57] The *VAR* system reduction tests for Model 2 are presented in the Appendix.

hypothesis, with or without a trend variable. In fact, these statistics suggest that there are more than 2 cointegrating vectors.

The test statistics for cointegration analysis with a trend variable are disregarded due to the theoretical inconsistency for industry 26.[59] However, the analysis without a trend variable produces statistically sound results. Both the maximum eigenvalue and the trace statistics indicate that a single cointegrating relationship exists at the 1 percent significance level.

The test results for industry 27 are similar to that of industry 26. The cointegration analysis with a trend variable seems inappropriate. Without the trend variable, the trace statistics indicates that there are at least 2 cointegrating vectors. However, the maximum eigenvalue statistic only suggests that there is only 1 cointegrating vector at the 1 percent significant level. Since both the statistics confidently indicate that there is only 1 cointegrating vector, only one cointegrating vector is specified for the vector error correction model.

Cointegration analysis with the trend variable seems not to provide a correct statistical result for model 2 in industry 28. Based on the analysis without a trend variable, both the statistics suggest that the variables in industry 28 are cointegrated. In fact, the trace statistic suggests that there are at least 3 and possibly 4 cointegrating vectors. However, since there is no rejection by the maximum eigenvalue for more than one cointegrating vectors, it is concluded that only one cointegrating vector exists. Hence, the vector error correction model is specified using only one cointegrating vector.

Both the cointegration analyses, with and without a trend variable suggest that the variables in industry 29 are cointegrated. With a trend variable, both the test statistics suggests that there are possibly 2 cointegrating vectors. When it is analysed without a trend, only the maximum eigenvalue is suggesting 2 cointegrating vectors, while the trace statistic indicates zero cointegrating vector. Since both the statistics are consistent when a trend variable is included in the analysis, two cointegrating vectors are specified in the vector error correction model.

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[58] With a trend variable, both the test statistics suggest that there are more than 5 cointegrating vectors, with is theoretically impossible.

Table 5.13: Cointegration Test for Model 2 (PCM, PRS, PDT, IRS, PDP and PFPD)

			With Trend				Without Trend			
Variable	Order of *VAR*	H_0: rank = p	Maximum Eigen-value	95%	Trace	95%	Maximum Eigen-value	95%	Trace	95%
PCM21		p==0	46.58*	42.5	145.1**	104.9	47.56**	39.4	125.1**	94.2
PRS21		p<=1	40.48*	36.4	98.55**	77.7	39.43**	33.5	77.58**	68.5
PDT21		p<=2	24.15	30.3	58.07*	54.6	23.06	27.1	38.15	47.2
IRS21	4	p<=3	20.56	23.8	33.92	34.6	9.461	21.0	15.09	29.7
PDP21		p<=4	8.344	16.9	13.36	18.2	5.274	14.1	5.63	15.4
PFPD21		p<=5	5.015*	3.7	5.015*	3.7	0.3564	3.8	0.3564	3.8
PCM22		p==0	43.77*	42.5	132.4**	104.9	41.72*	39.4	118.2**	94.2
PRS22		p<=1	36.31	36.4	88.67**	77.7	29.96	33.5	76.51**	68.5
PDT22		p<=2	29.24	30.3	52.36	54.6	27.57*	27.1	46.55	47.2
IRS22	3	p<=3	12.46	23.8	23.12	34.6	13.12	21.0	18.98	29.7
PDP22		p<=4	10.64	16.9	10.65	18.2	5.601	14.1	5.852	15.4
PFPD22		p<=5	0.01211	3.7	0.01211	3.7	0.2513	3.8	0.2513	3.8
PCM23		p==0	35.16	42.5	112.6*	104.9	31.8	39.4	96.89*	94.2
PRS23		p<=1	28.26	36.4	77.47	77.7	29.17	33.5	65.09	68.5
PDT23		p<=2	22.37	30.3	49.21	54.6	15.41	27.1	35.92	47.2
IRS23	3	p<=3	14.41	23.8	26.84	34.6	11.85	21.0	20.51	29.7
PDP23		p<=4	10.82	16.9	12.43	18.2	6.184	14.1	8.665	15.4
PFPD23		p<=5	1.606	3.7	1.606	3.7	2.481	3.8	2.481	3.8
PCM24		p==0	45.37*	42.5	124.2**	104.9	41.86*	39.4	100.2*	94.2
PRS24		p<=1	40.63*	36.4	78.83*	77.7	20.49	33.5	58.35	68.5
PDT24		p<=2	18.24	30.3	38.2	54.6	18.51	27.1	37.86	47.2
IRS24	3	p<=3	9.667	23.8	19.97	34.6	12.13	21.0	19.35	29.7
PDP24		p<=4	6.325	16.9	10.3	18.2	6.455	14.1	7.22	15.4
PFPD24		p<=5	3.974*	3.7	3.974*	3.7	0.7647	3.8	0.7647	3.8
PCM25		p==0	64.45**	42.5	157**	104.9	64.44**	39.4	144.1**	94.2
PRS25		p<=1	48.77**	36.4	92.54**	77.7	40.5**	33.5	79.64**	68.5
PDT25		p<=2	22.29	30.3	43.77	54.6	17.29	27.1	39.14	47.2
IRS25	4	p<=3	11.54	23.8	21.48	34.6	15.51	21.0	21.85	29.7
PDP25		p<=4	7.756	16.9	9.936	18.2	5.378	14.1	6.342	15.4
PFPD25		p<=5	2.18	3.7	2.18	3.7	0.9636	3.8	0.9636	3.8
PCM26		p==0	44.67*	42.5	129.5**	104.9	45.84**	39.4	112.6**	94.2
PRS26		p<=1	31.07	36.4	84.84*	77.7	22.65	33.5	66.76	68.5
PDT26		p<=2	19.11	30.3	53.77	54.6	18.65	27.1	44.11	47.2
IRS26	4	p<=3	17.48	23.8	34.67*	34.6	15.06	21.0	25.47	29.7
PDP26		p<=4	10.07	16.9	17.18	18.2	9.316	14.1	10.41	15.4
PFPD26		p<=5	7.11**	3.7	7.11*	3.7	1.095	3.8	1.095	3.8
PCM27		p==0	63.82**	42.5	180.5**	104.9	55.14**	39.4	130**	94.2
PRS27		p<=1	54.8**	36.4	116.7**	77.7	29.88	33.5	74.85*	68.5
PDT27		p<=2	26.03	30.3	61.87**	54.6	25.06	27.1	44.98	47.2
IRS27	4	p<=3	23.19	23.8	35.84*	34.6	13.14	21.0	19.91	29.7
PDP27		p<=4	6.933	16.9	12.66	18.2	6.604	14.1	6.774	15.4
PFPD27		p<=5	5.724*	3.7	5.724	3.7	0.1697	3.8	0.1697	3.8
PCM28		p==0	60.47**	42.5	163.5**	104.9	45.72**	39.4	133.9**	94.2
PRS28		p<=1	40.87*	36.4	103**	77.7	29.39	33.5	88.15**	68.5
PDT28		p<=2	23.23	30.3	62.17**	54.6	25.87	27.1	58.77**	47.2
IRS28	3	p<=3	18	23.8	38.93*	34.6	20.86	21.0	32.89*	29.7
PDP28		p<=4	14.64	16.9	20.93*	18.2	11.87	14.1	12.03	15.4
PFPD28		p<=5	6.292*	3.7	6.292	3.7	0.1555	3.8	0.1555	3.8
PCM29		p==0	61.08**	42.5	140.1**	104.9	49.2**	39.4	109.1	94.2
PRS29		p<=1	45.98**	36.4	79.05*	77.7	36.57*	33.5	59.87	68.5
PDT29		p<=2	17.06	30.3	33.06	54.6	9.247	27.1	23.3	47.2
IRS29	3	p<=3	8.397	23.8	16	34.6	7.056	21.0	14.05	29.7
PDP29		p<=4	5.193	16.9	7.603	18.2	4.438	14.1	6.994	15.4
PFPD29		p<=5	2.41	3.7	2.41	3.7	2.556	3.8	2.556	3.8

Note: * *indicates statistical significance at the 5 percent level*
** *indicates statistical significance at the 1 percent level*

[59] With a trend variable, the tests statistics suggest that there are more than 5 cointegrating vectors.

5.4.2 Model 2: Cointegration Analysis for LSD, LPFPD and LPFUC

The cointegration analysis for the *LSD*, *LPFPD* and *LPFUC* vairables are presented in Table 5.14. For industry 21, the test results suggest that there exists at least one, possible two cointegrating vectors, when the test is carried out with a trend variable. These test results are confirmed by the maximum eigenvalue and the trace statistic, both is significant at the 5 percent level. Hence, the vector error correction model is specified using two cointegrating vectors.

In industry 22, the cointegration test suggests that the *LSD22*, *LPFPD22* and *LPFUC22* variables are cointegrated, with or without the trend variable. However, with the trend variable, the test results are contradictory. Hence, the cointegration test without a trend variable is preferred and the error correction model is justified.

The test results for industry 23 indicate that the variables are cointegrated for the test with or without a trend variable. With the trend variable, the maximum eigenvalue and the trace statistics are significant at the 5 percent level. Without the trend variable, the maximum eigenvalue statistic is significant at the 5 percent level, while the trace statistic is significant at the 1 percent test statistic. The vector error correction model is specified using the cointegrating vector from the cointegration analysis without the trend variable.

For industry 24, even though the test with and without a trend variable suggest that the variables are cointegrated, the test statistic without the trend variable is preferred. This is due to the theoretically unsound results of the test with a trend variable that suggest more than 2 cointegrating vectors exist. It is significant at the 1 percent level for both the maximum eigenvalue and the trace statistics without a trend variable that there is a cointegrating vector. In the specification, the cointegrating vector used is from the analsysis without the trend variable.

The cointegration test for industry 25 suggests that all three variables are not cointegrated. This is confirmed by both test with or without the trend variable and also by each of the maximum eigenvalue and the trace statistics.

In industry 26, the cointegration test statistics suggest that no cointegrating vector exists between the *LSD26*, *LPFPD26* and *LPFUC26* variables. This is confirmed by the test statistic with or without the trend variable.

For industry 27, the cointegration test with a trend variable suggests that the variables are cointegrated. This is only confirmed by the trace statistic, which is significant at the 5 percent level. Even though the maximum eigenvalue and the trace statistics suggest there are more than 2 cointegrating vector, it is theoretically unsound, and is not taken seriously. Since the cointegration analysis with the trend variable is inconsistent with theory, the cointegration analysis without a trend variable is preferred. Without the trend variable, the cointegration analysis indicates that there is zero cointegrating vector. Hence, there is no justification for a long-run equilibrium.

There is no evidence of cointegrating vector for industry 28, when the cointegration test is carried out without a trend variable. However, with a trend variable, the maximum eigenvalue and the trace statistics are significant at the 5 and 1 percent level, respectively. The significant test statistics that suggest there are possibly more than 2 cointegrating vectors are not taken seriously. Since the cointegration analysis with a trend variable is theoretically inconsistent, the results from the alternative analysis, without the trend variable, is preferred.

For industry 29, there is no evidence of cointegrating vector when the test is carried out with or without a trend variable. Hence, it is concluded that the *LSD29*, *LPFPD29* and *LPFUC29* variables are not cointegrated.

Table 5.14: Cointegration Test for Model 2 (LSD, LPFPD and LPFUC)

Variable	Order of *VAR*	H0: rank = p	With Trend: Maximum Eigen-value	95%	Trace	95%	Without Trend: Maximum Eigen-value	95%	Trace	95%
LSD21		p==0	26.18*	23.8	47.78**	34.6	18.61	21.0	23.72	29.7
LPFPD21	5	p<=1	18.23*	16.9	21.6*	18.2	5.107	14.1	5.111	15.4
LPFUC21		p<=2	3.37	3.7	3.37	3.7	0.004915	3.8	0.004915	3.8
LSD22		p==0	28.61*	23.8	43.94**	34.6	24.06*	21.0	32.18*	29.7
LPFPD22	5	p<=1	10.64	16.9	15.34	18.2	7.636	14.1	8.114	15.4
LPFUC22		p<=2	4.699*	3.7	4.699*	3.7	0.4779	3.8	0.4779	3.8
LSD23		p==0	24.24*	23.8	39.02*	34.6	22.16*	21.0	35.86**	29.7
LPFPD23	5	p<=1	11.78	16.9	14.79	18.2	11.87	14.1	13.7	15.4
LPFUC23		p<=2	3.005	3.7	3.005	3.7	1.826	3.8	1.826	3.8
LSD24		p==0	41.48**	23.8	60.03**	34.6	33.64**	21.0	42.78**	29.7
LPFPD24	3	p<=1	12.22	16.9	18.54*	18.2	7.609	14.1	9.14	15.4
LPFUC24		p<=2	6.32*	3.7	6.32*	3.7	1.531	3.8	1.531	3.8
LSD25		p==0	12.23	23.8	22.62	34.6	13.75	21.0	24.48	29.7
LPFPD25	4	p<=1	8.758	16.9	10.38	18.2	9.626	14.1	10.73	15.4
LPFUC25		p<=2	1.627	3.7	1.627	3.7	1.107	3.8	1.107	3.8
LSD26		p==0	20.64	23.8	30.11	34.6	13.84	21.0	17.52	29.7
LPFPD26	5	p<=1	8.911	16.9	9.464	18.2	3.376	14.1	3.678	15.4
LPFUC26		p<=2	0.5537	3.7	0.5537	3.7	0.3024	3.8	0.3024	3.8
LSD27		p==0	19.21	23.8	39.52*	34.6	17.34	21.0	23.68	29.7
LPFPD27	3	p<=1	14.25	16.9	20.3*	18.2	6.336	14.1	6.339	15.4
LPFUC27		p<=2	6.051*	3.7	6.051*	3.7	0.002843	3.8	0.002843	3.8
LSD28		p==0	23.92*	23.8	44.45**	34.6	15.69	21.0	26.24	29.7
LPFPD28	4	p<=1	15.33	16.9	20.53*	18.2	10.11	14.1	10.56	15.4
LPFUC28		p<=2	5.206*	3.7	5.206*	3.7	0.4426	3.8	0.4426	3.8
LSD29		p==0	12.02	23.8	22.15	34.6	7.569	21.0	13.73	29.7
LPFPD29	4	p<=1	6.957	16.9	10.13	18.2	4.97	14.1	6.156	15.4
LPFUC29		p<=2	3.172	3.7	3.172	3.7	1.186	3.8	1.186	3.8

Note: * *indicates statistical significance at the 5 percent level*
** *indicates statistical significance at the 1 percent level*

5.4.3 Model 2: Cointegration Analysis for LIRS, LPDP and LUCP

The cointegration analysis for the *LIRS*, *LPDP* and *LUCP* variables are presented in Table 5.15. For industry 21, the trace statistic with a trend variable is significant at the 1 percent and 5 percent level, suggesting that there is 1 and possibly 2 cointegrating vectors, respectively. Although, the test statistics also suggest there are possibly more than 2 cointegrating vectors, this result is not taken seriously. It is also confirmed by the test without a trend variable, which suggests there exists 1 cointegrating vector. The vector error correction model is specified using one cointegrating vector from the cointegration analysis without the trend variable.

There is no evidence of cointegrating vector for industry 22. With or without a trend variable, the tests indicate that there are no significant statistics. Hence, it is concluded that there is no cointegrating vector between the variables.

For industry 23, the cointegration test without a trend variable suggests that there are more than 2 cointegrating vectors. However, this is theoretically unsound. Furthermore, there is no significant test statistic with a trend that suggests the existence of a cointegrating relationship. Hence, the variables in industry 23 are concluded as not cointegrated.

The cointegration test statistics with a trend variable suggest that there are more than 2 cointegrating vectors, which is not taken seriously, for industry 24. In fact, there is no evidence of any cointegrating vector when the hypothesis is testing for zero cointegrating vector. It is concluded that there is no cointegrating relationship between the variables in industry 24.

For industry 25, there is no evidence of cointegrating vector when the test is carried out with a trend variable. However, it is significant at the 1 percent level that there is at least 1 cointegrating vector, when testing without a trend variable. In fact, there are possibly more than two cointegrating vectors, which is theoretically incorrect. Hence the analysis result from the analysis with a trend variable is preferred.

There no evidence of any cointegrating vector existing for industry 26, testing with or without trend variable. Hence, the variable *LIRS26*, *LPDP26* and *LUCP26* are concluded as not cointegrated.

There is evidence of cointegrating relationships between the variables in industry 27 when testing with a trend variable. However, this result suggesting more than 2 cointegrating vectors is not theoretically sound. Without a trend variable, there is no evidence of cointegrating relationship. Hence, it is concluded that there is no cointegrating relationship between the variables in industry 27.

For industry 28, the cointegration test with or without trend shows evidence of one cointegrating vector. With the trend variable, the trace statistic is significant at the 5 percent level. Without the trend variable, the maximum eigenvalue and the trace statistics are significant at the 5 percent level. As a result, the variables in industry 28 are cointegrated. The vector error correction model is specified using the one cointegrating vector from the analysis without the trend variable.

There is no evidence of cointegrating relationship between the variables in industry 29. Each of the tests, with or without the trend variable, suggests that there is no cointegrating vector. Hence, the variables in industry 29 are concluded as not cointegrated.

Table 5.15: Cointegration Test for Model 2 (LIRS, LPDP and LUCP)

Variable	Order of *VAR*	H_0: rank = p	With Trend: Maximum Eigen-value	95%	Trace	95%	Without Trend: Maximum Eigen-value	95%	Trace	95%
LIRS21		p==0	21.61	23.8	44.61**	34.6	21.34*	21.0	31.86*	29.7
LPDP21	5	p<=1	13.1	16.9	23*	18.2	10.17	14.1	10.52	15.4
LUCP21		p<=2	9.901**	3.7	9.901**	3.7	0.3503	3.8	0.3503	3.8
LIRS22		p==0	14.15	23.8	27.31	34.6	15.89	21.0	20.66	29.7
LPDP22	4	p<=1	10.66	16.9	13.17	18.2	3.909	14.1	4.768	15.4
LUCP22		p<=2	2.51	3.7	2.51	3.7	0.8596	3.8	0.8596	3.8
LIRS23		p==0	15.06	23.8	23.26	34.6	16.63	21.0	26.99	29.7
LPDP23	4	p<=1	6.511	16.9	8.204	18.2	6.543	14.1	10.36	15.4
LUCP23		p<=2	1.693	3.7	1.693	3.7	3.817*	3.8	3.817*	3.8
LIRS24		p==0	13.07	23.8	30.96	34.6	11.59	21.0	24.07	29.7
LPDP24	5	p<=1	11.32	16.9	17.89	18.2	9.778	14.1	12.48	15.4
LUCP24		p<=2	6.574*	3.7	6.574**	3.7	2.7	3.8	2.7	3.8
LIRS25		p==0	18.25	23.8	33.36	34.6	18.18	21.0	35.87**	29.7
LPDP25	4	p<=1	14.63	16.9	15.1	18.2	12.41	14.1	17.68*	15.4
LUCP25		p<=2	0.4723	3.7	0.4723	3.7	5.274*	3.8	5.274*	3.8
LIRS26		p==0	18.81	23.8	27.53	34.6	8.196	21.0	14.51	29.7
LPDP26	5	p<=1	7.896	16.9	8.726	18.2	4.074	14.1	6.317	15.4
LUCP26		p<=2	0.8302	3.7	0.8302	3.7	2.243	3.8	2.243	3.8
LIRS27		p==0	17.45	23.8	34.19	34.6	13.18	21.0	20.33	29.7
LPDP27	5	p<=1	12.95	16.9	16.76	18.2	7.055	14.1	7.155	15.4
LUCP27		p<=2	3.786*	3.7	3.786*	3.7	0.09968	3.8	0.09968	3.8
LIRS28		p==0	21.59	23.8	38.53*	34.6	25.56*	21.0	32.96*	29.7
LPDP28	5	p<=1	13.42	16.9	16.95	18.2	6.791	14.1	7.404	15.4
LUCP28		p<=2	3.524	3.7	3.524	3.7	0.6133	3.8	0.6133	3.8
LIRS29		p==0	17.55	23.8	27.09	34.6	11.93	21.0	21.61	29.7
LPDP29	3	p<=1	6.342	16.9	9.537	18.2	6.439	14.1	9.675	15.4
LUCP29		p<=2	3.195	3.7	3.195	3.7	3.236	3.8	3.236	3.8

Note: * *indicates statistical significance at the 5 percent level*
** *indicates statistical significance at the 1 percent level*

5.5 Vector Error Correction Model for Model 1

This thesis applies the error correction model based on the Johansen method. This method is known as the vector error correction model (*VECM*). In Model 1 for the price-cost margin equation, according to the cointegration analysis discussed earlier, only industry 21 and 24 are cointegrated. The cointegrating vector used as the error-correction mechanism in the price-cost margin equation is termed $ECM11_i$ and $ECM12_i$. The former is the first error-correcting mechanism and the second is the second error-correcting mechanism, if there are two terms. The subscript *i* is used to indcate the different industries.

From the cointegration analysis of Model 1 for the domestic producer share equation, the results demonstrate that the variables in industry 21 and 22 are cointegrated. The cointegrating vector used as the error-correction mechanism in the domestic producer share equation is termed $E11_i$ and $E12_i$ if there is a second error-correcting mechanism.

For the budget share equation, the variables in industry 21, 25 and 28 are cointegrated. The cointegrating vector used as the error-correction mechanism in the budget share equation is termed $R11_i$ and $R12_i$ is there is a second error-correcting mechanism.

5.5.1 Model 1: Vector Error Correction Model for Price-Cost Margin Equation

The results for the vector error correction model are presented in Table 5.16. For industry 21, the *VECM* is specified with two error correction mechanisms. These terms are the cointegrating vectors obtained from the cointegration analysis. The first error correction mechanism is significant at the 5 percent level of statistic, with a negative coefficient of 0.19065. The second error correction mechanism turns out to be not statistically significant. However, the joint test of zero restrictions on these two coefficients is significant at the 10 percent level, with and F-statistic of 3.1111. With the significant of this joint F-test, the price-cost margin equation for industry 21 is concluded as having a long-run equilibrium adjustment. This long-run equilibrium model has a positive coefficient of 0.59983 for the *DPDT* variable and it is significant at the 5 percent. A positive coefficient suggests that industry 21 has Bertrand-type reactions in the long run. The constant term is also significant at the 5 percent level. However, the *DPRS* variable is not statistically significant. Note that these results fail the normality and heteroscedasticity diagnostics. Hence, when interpreting the results should caution be used.

The error correction mechanism in industry 24 is not significant. Even though the cointegration analysis suggests that the variables specified in the price-cost margin equation for industry 24 are cointegrated, the single equation estimation of the price-cost margin as the dependent variable might not have long-term adjustment with variable *DPRS* and *DPDT*. If this is the case, one can use the *OLS* or the *IV* estimation to specify the price-cost margin equation for industry 24. Even though there is an insignificant error correction mechanism, the *DPRS* and the *DPDT* variables are both significant at the 5 percent level. The included seasonal dummy is also significant at the 5 percent level. However, these significance levels should be interpreted with care, since the residuals fail the normality and the heteroscedasticity diagnostics. By also failing the functional form diagnostic, the estimated coefficients are unreliable.

Table 5.16: Vector Error Correction Model for Price-Cost Margin for Model 1

$$DPCM_I = a_0 + a_1 DPRS_I + a_2 DPDT_I + + a_3 S1 + a_4 S2 + a_5 S3 + a_6 ECM11_I + a_7 ECM12_I$$

Coefficient	DPCM21	DPCM24
a_0	-0.41756 [-2.0918]**	0.048072 [1.1008]
a_1	0.29332 [0.79082]	-0.39369 [-2.0059]**
a_2	0.59983 [2.4726]**	3.7768 [2.4536]**
a_5		-0.014707 [-2.1479]**
a_6	-0.19065 [-2.3462]**	0.022109 [1.0373]
a_7	0.22644 [1.1010]	
F-Statistic	3.4028**	2.5500**
DW-Statistic	1.9276	2.2874
Joint Significance Test		
F-Statistic	3.1111* [a_6 and a_7]	
Likelihood Ratio	6.4424** [a_6 and a_7]	
Lagrange Multiplier	6.0917** [a_6 and a_7]	
Serial Correlation	2.5104	5.2414
Functional Form	0.53794	9.1803***
Normality	152.5893***	411.4975***
Heteroscedasticity	3.8717**	17.6660***

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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.*

5.5.2 Model 1: Vector Error Correction Model for Domestic Producer Share Equation

The results of the vector error correction model for the domestic producer share equation are presented in Table 5.17. There is no evidence of a long-run equilibrium for the domestic producer share equation in industry 21. This is indicated by the insignificant coefficient of the error correction mechanism, *E121*. Without failing any of the diagnostic tests, the estimates are reliable. Since the cointegration analysis suggests that the variables in the domestic producer share equation are cointegrated, this insignificant error correction mechanism for the specific domestic producer share equation shows that the dependent variable, *DS*, is not adjusting towards the long-run equilibrium. In other word, the error correction mechanism can be viewed as exogenous. In fact, the variable *DRP* must be adjusting towards the long-run equilibrium, instead, for the *DS* and *DRP* variables to be cointegrated. Since there is no long-run relationship, the domestic producer share equation can be estimated using the *OLS* or the *IV* methods.

For industry 22, there is no indication of a long-run equilibrium model for the domestic producer share equation. The error correction mechanism is not significant in this domestic producer share specification. The explanation for the insignificant error correction mechanism, even though there is evidence of cointegrating relationship, is that the cointegrating vector will be significant for either one or both the specification of *DS* as the dependent variable or *DRP* as the dependent variable. In this case, the specification for *DS* results in insignificant error correction mechanism, meaning that *DS* is not adjusting towards the long-run equilibrium, but *DRP* is. Since there is no long-run equilibrium model, the coefficients are not taken seriously. Even so, the coefficient estimates are not reliable by failing the serial correlation and the functional form diagnostics.

Table 5.17: Vector Error Correction Model for Domestic Producer Share for Model 1

$$DS_i = a_0 + a_1 DRP_i + a_{2,t-j} \sum_{j=1}^{5} lagDRP_{i,t-j} + a_3 S1 + a_4 S2 + a_5 S3 + a_6 E11_i + a_7 E12_i$$

Coefficient	DS21	DS22
a_0	-0.053180 [-0.51898]	-0.098673 [-2.8806]***
a_1	0.84881 [2.0124]**	0.33352 [0.54953]
$a_{2,t-j}$	1.0707 [lag 4] [2.5694]**	
a_3		0.28219 [6.7877]***
a_4	-0.045694 [-2.1642]**	-0.11860 [-2.8154]***
a_5		0.23573 [5.5629]***
a_6	-0.030880 [-0.73369]	-0.038780 [-0.89963]
a_7		
F-Statistic	3.4415**	27.0305***
DW-Statistic	2.3579	2.3654
Joint Significance Test		
F-Statistic	4.7451**	
Likelihood Ratio	9.5552***	
Lagrange Multiplier	8.7972**	
Serial Correlation	4.8931	8.9273*
Functional Form	0.17779	2.9654*
Normality	2.2180	0.11998
Heteroscedasticity	0.19285	0.22803

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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.*

5.5.3 Model 1: Vector Error Correction Model for Budget Share Equation

The results for the vector error correction model for the budget share equation using Model 1 are presented in Table 5.18. For industry 21, there is evidence of a long-run equilibrium model for the budget share equation. The error correction mechanism is significant at the 5 percent level. The included variables for the budget share specification are the *DLPDP* variable and its lag 5 together with a constant and a seasonal dummy. The current *DLPDP* variable is not significant but its lag 5 is significant at the 10 percent level. Jointly, these variables are not significant. The constant term is significant at the 5 percent and the seasonal dummy is significant at the 1 percent level. However, by failing the serial correlation and the normality diagnostics, these estimated coefficients and its significance statistics need to be treated with caution.

Industry 25 is the next industry that evidenced cointegrating relationship between *LIRS* and *LPDP* variables. The specification of the long-run equilibrium model includes the *DLPDP* and its lag 3 variables, together with a constant and two seasonal dummies. The current *DLPDP* variable demonstrates that there is no impact on the budget share, but its lag 3 variable is significant. This lag variable is significant at that 5 percent level. When tested together, the *DLPDP* and its lag lie just outside the 10 percent significant level. Hence, it is not significant using the normal significance level. The included seasonal dummies are both significant at the 1 percent level, while the constant term is not significant. The test statistic indicates that the error correction mechanism for industry 25 is not significant. Consequently, there is no justification of a long-run equilibrium model for the budget share equation in industry 25. A word of caution is that the statistical significance of the estimates is untrustworthy, since the normality diagnostic is significant at the 1 percent level.

For industry 28, a long-run adjustment is not evident in the *VECM* specification for the budget share equation. This is suggested by the insignificant *R1128* variable. The other included variables in this long-run equilibrium specification are the *DLPDP* and its lag 2 variables, together with a constant term and a seasonal dummy. The *DLPDP* and its lag 2 variables are each significant at the 10 percent level and the seasonal dummy is significant at the 1 percent level. The *DLPDP* and its lag 2 are also jointly significant at the 10 percent level. However, these significance levels should be treated with caution, since the equation fails the normality diagnostic. As a conclusion, there is no justification for a long-run equilibrium model, so the budget share equation for industry 28 can be estimated using the *OLS* or *IV* estimation method.

Table 5.18: Vector Error Correction Model for Budget Share for Model 1

$$DLIRS_i = a_0 + a_1 DLPDP_i + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP_{i,t-j} + a_3 S1 + a_4 S2 + a_5 S3 + a_6 R11_i + a_7 R12_i$$

Coefficient	DLIRS21	DLIRS25	DLIRS28
a_0	-0.34572 [-2.4210]**	0.029977 [0.59167]	-0.027493 [-0.70406]
a_1	0.17361 [0.20586	0.019334 [0.10492]	-0.88380 [-1.7130]*
$a_{2,t-j}$	-1.5525 [lag 5] [-1.7285]*	0.38386 [lag 3] [2.1755]**	0.90712 [lag 2] [1.9586]*
a_3		0.052577 [5.5306]***	
a_4	-0.056371 [-3.6702]***		0.027383 [3.3992]***
a_5		-0.065857 [-6.6542]***	
a_6	-0.19963 [-2.5407]**	0.011279 [0.39841]	-0.017209 [-0.55495]
F-Statistic	6.3070***	22.6324***	3.5822**
DW-Statistic	2.1382	2.0441	2.1981
<u>Joint Significance Test</u>			
F-Statistic	1.9190	2.3909	2.4767*
Likelihood Ratio	4.0589	5.1085*	5.1864*
Lagrange Multiplier	3.9178	4.8863*	4.9574*
Serial Correlation	16.8124***	2.0016	3.3640
Functional Form	0.85363	2.3288	0.0001631
Normality	6.9393**	101.3379***	5.0953*
Heteroscedasticity	2.4139	1.6610	0.98854

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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.*

5.6 Vector Error Correction Model for Model 2

In Model 2, according to the cointegration analysis discussed earlier, all nine industries evident cointegrating relationship among variable *PCM*, *PRS*, *PDT*, *IRS*, *PDP* and *PFPD* for the price-cost margin equation. The cointegrating vectors used as the error-correction mechanism in the price-cost margin equation for Model 2 are termed $ECM21_i$ and $ECM22_i$ if there exists a second error-correcting mechanism.

From the cointegration analysis of Model 2 for the domestic producer share equation, the results demonstrate that the variables in industry 21, 22, 23 and 24 are cointegrated. The cointegrating vector used as the error-correction mechanism in the domestic producer share equation is termed $E21_i$ and $E22_i$ if there is a second error-correcting mechanism.

For the budget share equation, the variables in industry 21, 25 and 28 are cointegrated. The cointegrating vector used as the error correction mechanism in the budget share equation is termed $R21_i$. There is only 1 cointegrating vector for each of industry 21, 25 and 28. Hence, there is only 1 error-correction term being specified for the budget share equation in Model 2.

5.6.1 Model 2: Vector Error Correction Model for Price-Cost Margin Equation

Table 5.19a-c shows the results for the vector error correction model for the price-cost margin using Model 2. The cointegration analysis for the price-cost margin equation in industry 21 suggests that there exist two cointegrating vectors. Consequently, two error-correcting mechanisms are specified in modelling the *VECM*. The first term is not significant, but the second term is significant at the 10 percent level. A joint significance test suggests that they are not significantly different from zero, with a F-statistic of 2.1927. Hence, there is no long-term adjustment of the price-cost margin towards its independent variables specified in the equation. Despite the insignificant error-correcting term, the *DPDT* and its lag 1 variables are significant, where the former is significant at the 2 percent and the latter is significant at the 10 percent. Together, they are jointly significant at the 1 percent level, with a positive F-statistic of 5.5443. Since the sum of the *DPDT* and its lag 1 coefficients is positive, suggesting that industry 21 is having a Bertrand-type conjecture. However, when the sum of these coefficients is tested on zero restriction, it is not significant. Hence, the Bertrand-type conjecture cannot be confirmed. Even so, this result cannot be justified without the error-correcting terms being significant. Furthermore, by failing the normality diagnostic, the confidence levels are not reliable.

For industry 22, it is statistically significant that there is a long-run adjusting mechanism of the price-cost margin towards the variables specified in the *VECM*. This is evident in the significant error-correcting term at the 5 percent level. The current *DPRS* variable is not significant, but its lag 1 variable is significant at the 10 percent level. These two variables are jointly significant at the 5 percent level. The variable *DPDT* and its lag 1 are specified in the *VECM*. Despite the insignificant current *DPDT* variable, its lag 1 variable is significant at the 10 percent level. These coefficients sum up to be −1.5071, suggesting a Cournot-type conjecture. The joint test for the *DPDT* and its lag 1 coefficients have a F-statistic of 3.5502, which is significant at the 5 percent level. But when a restriction is imposed on the sum of these coefficients, it is insignificantly different from zero. Hence, the Cournot-type conjecture cannot be confirmed. However, the residuals are diagnosed to be serially correlated, which makes the estimated coefficients untrustworthy.

The error-correcting term for industry 23 is not significant. Even though the variables are analysed to be cointegrated. However, the price-cost margin variable is not correcting towards the long-run equilibrium. Hence, there is no justification for an error correction model for the price-cost margin equation. Further, failing the functional form, normality and the heteroscedasticity diagnostics makes the estimates and the significance level unreliable.

In industry 24, the price-cost margin equation shows evidence of a long-run equilibrium model. The error-correcting term is significant at the 5 percent level. In this long-run model, the current *DPRS* variable is statistically significant at the 1 percent level while its lag 5 is not significant. Jointly, the current and the lag 5 *DPRS* variables are significant at the 5 percent level. For variable *DPDT*, the current variable is positively related to the price-cost margin at a 1 percent significant level, which gives indication of a Bertrand behaviour. Its lag 5 variable is not significant. When the sum of the *DPDT* and its lag 5 coefficients is tested, it is significantly different from zero at the 1 percent level, with a Wald statistic of 9.6624. The normal F-test is also significant at the 1 percent level, with a F-statistic of 6.5751. Furthermore, the constant term and the seasonal dummy are also significant each at the 5 percent level. However, by failing the functional form, normality and the heteroscedasticity diagnostics, this set of results should be treated with caution.

The long-run model of the price-cost margin equation for industry 25 suggests that this industry is behaving in a Cournot type of oligopolistic behaviour. This is evident from the significant current *DPDT* and its lag 2 variables, which both have a negative coefficient. The joint test of zero restrictions on these two coefficients has a F-statistic of 2.4514, which is significant at the 10 percent level. Further, the sum of the *DPDT* and its lag 2 coefficients is significantly different from zero at the 5 percent level. The long-run model is justified by the two error-correcting terms. The first term is not significant, but the second term is significant at the 5 percent level. When tested jointly, these error-correcting terms have a F-statistic of 2.9578, which is significant at the 10 percent level. However, the significance statistics are worrying, since the residuals fail the normality diagnostic.

For industry 26, the long-run model for price-cost margin equation is specified with *DPRS* and *DPDT*, each with current and lag 1 variables. For variable *DPRS*, the current level seems not to affect the price-cost margin, but the lag 1 variable does. The lag 1 *DPRS* variable is positively related to price-cost margin and is significant at the 5 percent level. The current *DPDT* variable is also not significant in affecting the price-cost margin, but its lag 1 variable has a negative impact and is significant at the 1 percent level. Since the sum of the coefficients for *DPDT* and its lag 1 is negative, this suggests a Cournot behaviour. The joint test for variable *DPDT* and its lag 1 is significant and the sum of the coefficients is also significant at the 10 percent level. The error-correcting term is not significant. Hence there is no justification of a long-run adjustment process of the price-cost margin towards the included variables. This set of results fails the serial correlation, normality and heteroscedasticity diagnostics, resulting in an unreliable estimates and test statistics.

In industry 27, the current *DPDT* and lag 1 variables, each has a negative coefficient. This gives an indication of a Cournot type of behaviour among the manufacturers in industry 26. These variables are also jointly significant at the 10 percent level, with a F-statistic of 2.8968 and the sum of these coefficients are significantly different from zero at the 5 percent level, with a Wald statistic of 5.1321. Apart from this, the price-cost margin seems to be affected by seasonality. All three included seasonal dummies are significant and all contribute positively to the price-cost margin. This set of results can be thought as the long-run equilibrium estimates, since the error-correcting term is significant. However, the significance level is questionable, since the residuals fail the normality diagnostic.

The price-cost margin equation performs well for industry 28. All the included variables are significant. To begin with, the constant term is significant at the 1 percent level. The variable *DPRS* is significant at the 10 percent level. The variable *DPDT* has a negative coefficient of 1.0113 that is significant at the 10 percent level. With this significant negative coefficient, within industry 28 is said to have Cournot–

type conjectures. The price-cost margin also affected by the seasonality, suggested by the two significant seasonal dummies, each at 1 percent level. This set of results represents the long-run equilibrium results with the significant error-correcting term at 1 percent level. By not failing any of the diagnostic tests, this set of results is reliable.

For industry 29, there is no evidence of a long-run equilibrium model. There are two error-correcting terms and neither is significant. Even tested jointly, the F-statistic is not significant either. Without failing any of the diagnostic tests, this set of results is reliable. Hence, there is no long-run equilibrium model for the price-cost margin in industry 29.

Table 5.19a: Vector Error Correction Model for Price-Cost Margin for Model 2

$$DPCM_I = a_0 + a_1 DPRS_I + a_{2,t-j}\sum_{j=1}^{5} lagDPRS_{I_{t-j}} + a_3 DPDT_I + a_{4,t-j}\sum_{j=1}^{5} lagDPDT_{I_{t-j}} + a_5 S1 + a_6 S2 + a_7 S3 + a_8 ECM21_I + a_9 ECM22_I$$

Coefficient	DPCM21	DPCM22	DPCM23
a_0	-4.3091 [-2.0717]**	0.29453 [2.1598]**	-2.2293 [-1.1973
a_1	-0.21956 [-0.48004]	-0.24319 [-1.3138]	0.10851 [0.31226
$a_{2,t-j}$	0.54310 [lag 1] [1.2629]	0.39286 [lag 1] [1.7889]*	0.78155 [lag 5] [2.6667]***
a_3	0.83009 [3.1324]***	1.7159 [0.97044]	-0.67498 [-0.31694]
$a_{4,t-j}$	-0.52558 [lag 1] [-1.8775]*	-3.2230 [lag 1] [-1.7356]*	
a_6			0.024567 [2.4725]**
a_8	0.0010771 [0.060254]	-0.053633 [-2.1531]**	0.0052298 [1.1943]
a_9	4.8504 [1.7370]*		
F-Statistic	2.0182*	3.2028**	2.3392*
DW-Statistic	1.9723	1.9509	1.6854
Joint Significance Test			
F-Statistic	0.88232 [a_1 and a_2] 5.5443*** [a_3 and a_4] 2.1927 [a_8 and a_9]	4.8819** [a_1 and a_2] 3.5502** [a_3 and a_4]	3.7101** [a_1 and a_2]
Likelihood Ratio	1.9770 [a_1 and a_2] 11.4173*** [a_3 and a_4] 4.7921* [a_8 and a_9]	9.9846*** [a_1 and a_2] 7.4297** [a_3 and a_4]	7.7427** [a_1 and a_2]
Lagrange Multiplier	1.9431 [a_1 and a_2] 10.3465*** [a_3 and a_4] 4.5962* [a_8 and a_9]	9.1590*** [a_1 and a_2] 6.9658** [a_3 and a_4]	7.2399** [a_1 and a_2]
Wald Test of Restriction(s)	0.83172 [$a_3+a_4=0$]	0.23520 [$a_3+a_4=0$]	
Serial Correlation	2.9547	16.4219***	6.7143
Functional Form	0.23397	0.020487	12.5982***
Normality	196.1741***	0.26788	52.2361***
Heteroscedasticity	1.1166	0.18556	11.6374***

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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 5.19b: Vector Error Correction Model for Price-Cost Margin for Model 2

$$DPCM_t = a_0 + a_1 DPRS_t + a_{2,t-j}\sum_{j=1}^{5} lagDPRS_{t,t-j} + a_3 DPDT_t + a_{4,t-j}\sum_{j=1}^{5} lagDPDT_{t,t-j} + a_5 S1 + a_6 S2 + a_7 S3 + a_8 ECM21_{i,t-1} + a_9 ECM22_{t,t-1}$$

Coefficient	DPCM24	DPCM25	DPCM26
a_0	1.3009 [2.2193]**	3.3905 [1.7723]*	1.4770 [0.66996]
a_1	-0.62389 [-2.8453]***	0.19073 [0.74202]	0.29959 [0.49575]
$a_{2,t-j}$	-0.29445 [lag 5] [-1.4715]	0.21813 [lag 1] [0.87744]	1.4018 [lag 1] [2.3631]**
a_3	6.4861 [3.6065]***	-1.8159 [-1.7967]*	-1.0210 [-0.53065]
$a_{4,t-j}$	1.7406 [lag 5] [1.0724]	-1.1693 [lag 2] [-1.9448]*	-5.0736 [lag 1] [-2.7446]***
a_6	0.017530 [2.3758]**		0.015538 [2.3687]**
a_7		0.024204 [-1.6158]	
a_8	-0.21657 [-2.2263]**	0.0008441 [0.054109]	0.024720 [0.67163]
a_9		-4.5663 [-2.4022]**	
F-Statistic	3.0761**	1.5522	1.9150*
DW-Statistic	1.9216	2.5391	2.6263
<u>Joint Significance Test</u>			
F-Statistic	4.0943** [a_1 and a_2] 6.5751*** [a_3 and a_4]	0.62332 [a_1 and a_2] 2.4514* [a_3 and a_4] 2.9573* [a_8 and a_9]	3.0844* [a_1 and a_2] 4.1043** [a_3 and a_4]
Likelihood Ratio	8.6450** [a_1 and a_2] 13.3090*** [a_3 and a_4]	1.4320 [a_1 and a_2] 5.4357* [a_3 and a_4] 6.4967** [a_8 and a_9]	6.6312** [a_1 and a_2] 8.6645** [a_3 and a_4]
Lagrange Multiplier	8.0219** [a_1 and a_2] 11.8694*** [a_3 and a_4]	1.4142 [a_1 and a_2] 5.1845* [a_3 and a_4] 6.1402** [a_8 and a_9]	6.2600** [a_1 and a_2] 8.0381** [a_3 and a_4]
Wald Test of Restriction(s)	9.6624*** [$a_3+a_4=0$]	4.6668** [$a_3+a_4=0$]	3.5760* [$a_3+a_4=0$]
Serial Correlation	1.9289	7.2788	11.9227**
Functional Form	16.3606***	0.12756	0.64464
Normality	395.3667***	50.1409***	34.4718***
Heteroscedasticity	21.0150***	0.0007199	3.4629*

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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 5.19c: Vector Error Correction Model for Price-Cost Margin for Model 2

$$DPCM_I = a_0 + a_1 DPRS_I + a_{2,t-j}\sum_{j=1}^{5} lagDPRS_{I,t-j} + a_3 DPDT_I + a_{4,t-j}\sum_{j=1}^{5} lagDPDT_{I,t-j} + a_5 S1 + a_6 S2 + a_7 S3$$
$$+ a_8 ECM21_{I,t-1} + a_9 ECM22_{I,t-1}$$

Coefficient	DPCM27	DPCM28	DPCM29
a_0	0.089192 [2.5516]**	0.94456 [3.6503]***	-0.055375 [-0.10268]
a_1	0.066108 [0.55780]	0.35868 [1.9013]*	0.013384 [0.16290
$a_{2,t-j}$			0.19475 [lag 3] [2.3300]**
a_3	-0.72593 [-1.2747]	-1.0113 [-1.8397]*	-0.95003 [-0.79571]
$a_{4,t-j}$	-0.95944 [lag 1] [-2.0809]**		
a_5	0.013223 [2.2873]**		
a_6	0.023837 [3.4608]***	0.018938 [3.7335]***	0.017222 [2.4028]**
a_7	0.021170 [3.0223]***	0.013131 [2.9680]***	
a_8	-0.22542 [-2.9906]***	-0.38047 [-3.6792]***	-0.011932 [-0.85167]
a_9			-0.0085772 [-0.010902]
F-Statistic	3.4109***	9.7082***	1.6336
DW-Statistic	1.8792	1.6884	2.2692
Joint Significance Test			
F-Statistic	2.8968* [a_3 and a_4]		2.7875* [a_1 and a_2] 0.39424 [a_8 and a_9]
Likelihood Ratio	6.3699** [a_3 and a_4]		6.0256** [a_1 and a_2] 0.89185 [a_8 and a_9]
Lagrange Multiplier	6.0268** [a_3 and a_4]		5.7180* [a_1 and a_2] 0.88491 [a_8 and a_9]
Wald Test of Restriction(s)	5.1321** [a_3+a_4=0]		
Serial Correlation	2.1654	3.2398	3.9744
Functional Form	0.0038415	0.41276	0.14333
Normality	149.1915***	1.2176	2.2291
Heteroscedasticity	0.71582	0.18272	1.2216

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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.*

5.6.2 Model 2: Vector Error Correction Model for Domestic Producer Share Equation

Table 5.20 gives the summary results for the vector error correction model for the domestic producer share equation using model 2. The domestic producer share equation performs well for industry 21. The current and the lag 3 of variable *DRP* are each significant at the 5 percent level, while the lag 1 and 4 variable are each significant at the 10 percent level. When these variables are tested jointly for zero restrictions on their coefficients, the F-statistic is 2.6044 and is significant at the 5 percent level. These results are verified as the long-run equilibrium estimates, since the two error-correcting terms are each significant. The first term is significant at the 10 percent level, while the second term is significant at the 5 percent level. These error-correcting terms are also jointly significant at the 10 percent level. Most importantly, this set of results did not fail any of the diagnostic tests, makes the estimates as well as the significance level reliable.

For industry 22, the estimates suggest that the domestic producer share is affected by the seasonality element. All three seasonal dummies are statistically significant at the 1 percent level. The included constant term is also significant, but at the 5 percent level. The *DRP* estimate is not significant, showing that *DRP* is not contributing to the share. However, the error-correcting term is not significant, suggesting there is no long-run adjusting process. Hence, for industry 22, the domestic producer share equation can be estimated using the *OLS* or the *IV* method. Note that, when interpreting the estimated coefficient, it should be interpreted with the caution due to failing the serial correlation diagnostic.

Industry 23 is another industry that indicates a long-run equilibrium model exists for the domestic producer share equation. The error-correcting term is significant at the 10 percent level. The contribution of variable DRP to this share is positive and is significant at the 5 percent level. Seasonality elements are also estimated to be affecting positively to the share. The two included seasonal dummies are each significant at the 1 percent level. Even the constant term for this industry is significant at the 5 percent level. Without failing the diagnostic tests, these results are reliable.

For industry 24, the variable *DRP* does not have a significant coefficient. These are long-run estimates since the error-correcting term is significant at the 1 percent level. The included seasonal dummy is contributing positively to the share and is significant at the 5 percent level. The constant term is also significant, but at the 1 percent level. Since the residuals fail the heteroscedasticity diagnostic, these significance levels should be interpreted with care.

Table 5.20: Vector Error Correction Model for Domestic Producer Share for Model 2

$$DS_i = a_0 + a_1 DRP_i + a_{2,t-j}\sum_{j=1}^{5} lagDRP_{i,t-j} + a_3 S1 + a_4 S2 + a_5 S3 + a_6 E21_i + a_7 E22_i$$

Coefficient	DS21	DS22	DS23	DS24
a_0	-0.40486 [-2.2603]**	-0.081094 [-2.1580]**	-0.30592 [-2.2604]**	-1.3778 [-7.6209]***
a_1	0.99828 [2.1949]**	0.21094 [0.35391]	0.57167 [2.3401]**	0.2937 [1.5471]
$a_{2,t-j}$	-0.90563 [lag 1] [-1.7955]*			
	-1.1822 [lag 3] [-2.4269]**			
	0.85338 [lag 4] [1.7732]*			
	-0.69593 [lag 5] [-1.4926]			
a_3		0.28542 [6.7981]***	0.098840 [3.7131]***	
a_4		-0.12174 [-2.8576]***		
a_5		0.24209 [5.7401]***	0.11674 [4.3738]***	0.061712 [2.3555]**
a_6	0.062889 [1.7359]*	0.0005188 [0.080667]	-0.16586 [-1.8583]*	-0.96072 [-7.5259]***
a_7	0.34970 [2.3314]**			
F-Statistic	2.4230**	26.4536***	9.0099***	20.7350***
DW-Statistic	2.2185	2.4170	2.0934	1.9227
Joint Significance Test				
F-Statistic	2.6044** [a_1 and a_2] 2.7522* [a_6 and a_7]			
Likelihood Ratio	13.4331** [a_1 and a_2] 6.0682** [a_6 and a_7]			
Lagrange Multiplier	11.9675** [a_1 and a_2] 5.7564* [a_6 and a_7]			
Serial Correlation	4.6784	9.6513**	0.56085	3.0930
Functional Form	2.1231	0.0065457	0.048489	2.3196
Normality	1.0236	0.19398	0.80412	3.7871
Heteroscedasticity	0.45813	0.94759	2.1172	7.8831***

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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.*

5.6.3 Model 2: Vector Error Correction Model for Budget Share Equation

The results for the vector error correction model for the budget share equation are presented in Table 5.21. For industry 21, there is evidence of a long-run equilibrium for the budget share equation. This is indicated by the significant error-correcting term at the 5 percent level with a t-ratio of –2.5027. In this long-run model, the budget share equation is specified with *DLPDP* and its lags 4 and 5 variables. The current and the lag 4 of variable *DLPDP* are not significant, but the lag 5 is significant at the 5 percent level. The current *DLPDP* has a negative impact, this negative impact seems to be more prominent after 1 year, since the lag 5 is significant and has a bigger coefficient. When *DLPDP* and its lag variables are tested jointly, they are significant at the 10 percent level. Three seasonal dummies are also included in the estimation, with each significant at the 1 percent level. These positive results do not fail any of the diagnostic tests, making them reliable.

The next industry that exhibits cointegrated variables for the budget share equation is industry 28. The current *DLPDP* and its lag 2 variables are specified in this equation. It is not convincing that the current *DLPDP* has an impact on the budget share, but its lag 2 variable does. This is shown by the statistically significant estimates. However, no significance is suggested when the coefficients for the current *DLPDP* and its lag 2 are jointly tested for zero restrictions. This budget share equation also includes a seasonal dummy and this dummy is significant at the 1 percent level. Since the residuals fail the normality test, the significance statistics are untrustworthy.

Table 5.21: Vector Error Correction Model for Budget Share for Model 2

$$DLIRS_i = a_0 + a_1 DLPDP_i + a_{2,t-j}\sum_{j=1}^{5} lagDLPDP_{i,t-j} + a_3 S1 + a_4 S2 + a_5 S3 + a_6 R21_i + a_7 R22_i$$

Coefficient	DLIRS21	DLIRS25	DLIRS28
a_0	-0.028151 [-0.67399]	0.013196 [0.32683]	0.016918 [0.54691]
a_1	-0.64289 [-1.1396]	0.090624 [0.50135]	-0.55754 [-1.0537]
$a_{2,t-j}$	0.73762 [lag 4] [1.2378] -1.4579 [lag 5] [-2.3580]**	0.36738 [lag 3] [2.1729]**	0.86454 [lag 2] [1.8951]*
a_3	-0.10766 [8.6790]***	0.064663 [5.9571]***	
a_4	-0.11717 [-9.2965]***	0.023513 [2.1158]**	0.027695 [3.4402]***
a_5	-0.060647 [-4.8079]***	-0.053677 [-4.8129]***	
a_6	-0.066100 [-2.5027]**	0.0090235 [0.38472]	0.017665 [0.74454]
F-Statistic	17.5792***	20.9346***	3.6603**
DW-Statistic	1.9398	2.0413	2.3018
Joint Significance Test			
F-Statistic	2.7072* [a_1 and a_2]	2.5301* [a_1 and a_2]	1.9250 [a_1 and a_2]
Likelihood Ratio	8.7416** [a_1 and a_2]	5.4950* [a_1 and a_2]	4.0712 [a_1 and a_2]
Lagrange Multiplier	8.1043** [a_1 and a_2]	5.2385* [a_1 and a_2]	3.9292 [a_1 and a_2]
Serial Correlation	4.3116	1.8846	2.7580
Functional Form	0.50407	1.8726	0.018462
Normality	1.6896	76.8037***	4.7092*
Heteroscedasticity	2.4704	1.2348	1.2899

Note: *57 observations used for estimation from 1986Q1 to 2000Q1*
t-ratios are in parentheses.
Serial correlation test is based on the Lagrange multiplier test of residual serial correlation.
Test for misspecification of functional form is based on the Ramsey's RESET test using the square of the fitted values.
Normality test is based on a test of skewness and kurtosis of residuals.
Test for heteroscedasticity is based on the regression of squared residuals on squared fitted values.
** 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.*

5.7 Summary and Implications

The model of consumer demand and oligopoly pricing proposed in this thesis leads to an econometric specification with an industry price-cost margin equation and two revenue share equations. The three equations are estimated as a simultaneous system using *OLS* and *IV* methods as the preliminary estimation strategies. Further, the cointegration analysis is performed to each of the three equations. Two models of cointegration analyses are proposed. The vector error correction model is carried out for those industries where the variables are shown to be cointegrated. The summary of the industry's reaction are reported in Table. 5.22.

Table 5.22: Summary of Industry's Reaction

Industry	OLS	IV	VECM1	VECM2
21	Bertrand_{C}	Bertrand	Bertrand_{CD}	Bertrand_{WC}
22	Bertrand_{D}	-	-	Cournot_{WA}
23	-	-	-	-
24	Bertrand_{C}	-	Bertrand_{BCD}	Bertrand_{BCD}
25	-	-	-	Cournot_{C}
26	Cournot_{AC}	-	-	Cournot_{ACD}
27	-	-	-	Cournot_{C}
28	Cournot	-	-	Cournot
29	-	-	-	-

Note: *A – Failed serial correlation diagnostic*
B – Failed functional form diagnostic
C – Failed normality diagnostic
D – Failed heteroscedasticity diagnostic
W – Insignificant Wald test of restriction

The regression results show that industry 21 is classified as having Bertrand-type conjectures using the *IV* method of estimation. Without failing any of the diagnostic tests, IV estimates seem to be the appropriate estimation method for industry 21. Further, the *VECM1* and *VECM2* both indicate that industry 21 has Bertrand-type conjectures. However, each of the *VECM* failed the diagnostic test in one way or another. This argues against the possibility of a long-run equilibrium model for industry 21.

For industry 28, the regression results using *OLS* estimation method suggest that the producers of machinery and equipment manufacturing are behaving in a Cournot-type of conjecture. This quantity reaction is also confirmed by the *VECM2*. Without failing any of the diagnostic tests for each estimation strategy, the estimates from the *OLS* are reliable as the short-run estimates, while Model 2 of the *VECM* gives the long-run equilibrium model.

For other industries, even though the estimation of the price-cost margin equation provides estimates that are consistent with the either Bertrand or Cournot behaviour, these estimates fail the diagnostic tests in one way or another. These results do not provide reliable estimates or significance level, but by viewing Table 5.22, the results indicate that industries that produces consumer products are generally sensitive to price movements. The classification of industry 21 to 24 is more proximate to consumer products as compared to higher industrial numbering. Only estimation results from *VECM2* in industry 22 suggesting a Cournot-type conjecture. The regression results for industry 25 to 28 suggesting quantity reaction sensitivity. This is in line with the nature of the products produce by these industries, which are heavy industrial manufacturing products. There are no significant estimates that can classify industry 29 into either Bertrand or Cournot reactions. Since industry 29 contains the residual productions that cannot be classified into any industrial classification, the nature of this industry is mixed. The structural model is not able to identify the oligopolistic nature of this industry.

5.7.1 Derivation of Parameter Estimates

To provide the estimates for the various elasticities, first, the parameters that appear in these elasticity equations have to be determined. From equation (5.5):

$$(5.42)\quad c_1 = 1 - \sigma$$

and c_1 is the coefficient for variable $DLPDP_i$ in the first difference equation for the budget share (5.13).[60] From equation (5.42), the substitution elasticity between the *m* consumption goods, σ, is given as,

$$(5.43)\quad \sigma = 1 - c_1$$

From equation (5.4), the elasticity of substitution between domestically produced and imported composite goods is given as:

[60] c_1 is the sum of the current and lag(s) estimates, if lag structure appears in the estimated equation.

$$(5.44) \quad \sigma_{df,i} = 1 - b_1$$

b_1 is the coefficient for DRP_i that appears in estimating equation for the first difference of the domestic producer share equation in (5.9).[61]

The estimates of substitution elasticities are reported in Table 5.23. The utility tree has been constructed so that goods substitute better the higher the level of disaggregation. For example, a different brand of a same product substitutes better than different products. As a consequence, the substitution elasticity between the *m* consumption goods has to be greater or equal zero and is less than the elasticity of substitution between domestically produced and imported composite goods. From Table 5.23, industry 23, 25 and 28 fulfils this ranking requirement. However, a negative elasticity of substitution between *m* consumption goods appears in industry 23, which violates the *Tree Principle* outlined in Chapter 3.

The *Proximity Principle* is a stronger form of the principle of ordering of substitutes. Imposition of the stronger assumption ensures that the ordering according to the degree of potential competition from producers of substitutes is independent of the market shares obtained by an industry or by the domestic suppliers in that industry. When this principle holds, the potential competition from domestic firms producing different products is less strong that the potential competition from foreign producers of the same product. Industry 28 satisfies this principle by having $\frac{\sigma}{1 - IRS_{28}} < \sigma_{df,28}$.

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[61] b_1 is the sum of the current and lag(s) estimates, if lag structure appears in the estimated equation.

Table 5.23: Estimates of Parameters from Consumer Model

Industry	σ	$\sigma_{df,i}$
21	8.6215 [IV]	1.9321 [VECM2]
22	*	-0.7224 [IV]
23	-0.233858 [OLS]	0.42833 [VECM2]
24	*	*
25	0.541996 [VECM2]^{C}	0.59272 [OLS]^{BD}
26	2.80553 [OLS]	0.88108 [OLS]^{A}
27	*	*
28	0.88761 [OLS]	1.59162 [OLS]^{A}
29	*	*

Note: *A – Failed serial correlation diagnostic*
B – Failed functional form diagnostic
C – Failed normality diagnostic
D – Failed heteroscedasticity diagnostic
** No significant estimate*
VECM1 and VECM2 represents vector error correction for model 1 and 2, respectively.

5.7.2 Derivation of Elasticity of Import Demand

Two types of elasticity of import demand are provided. Those indicated as "partial" include only the direct effect of import price as estimated. Those indicated as "total" include indirect effects that occur through changes in domestic price and the industry price, but exclude any impact occurring through changes in the aggregate price index for all manufacturing. There is no direct effect of import price on domestic price in the model. However, changes in import prices affect revenue shares, which in turn affect the price-cost margin in the regression. Solving for domestic price from price-cost margin yields an expression in terms of domestic cost and the price-cost margin.

The general elasticity of import demand is derived from the solution for $c_{d,i}$ is given in

$$(3.22) \quad c_{d,i} = \beta_i \left(\frac{p_{d,i}}{p_i} \right)^{-\sigma_{df,i}} c_i$$

Substitute the solution for c_i given in

$$(3.13) \quad c_i = \alpha_i \left(\frac{p_i}{p} \right)^{-\sigma} y$$

gives the expression:

$$(5.17) \quad c_{d,i} = \beta_i \, \alpha_i y \left[p^{\sigma} \; p_i^{\sigma_{df,i}-\sigma} \; p_{d,i}^{-\sigma_{df,i}} \right]$$

The derivative of $c_{d,i}$ is given as:

$$(5.18) \quad dc_{d,i} = \left[\frac{\delta c_{d,i}}{\delta p} dp + \frac{\delta c_{d,i}}{\delta p_i} dp_i + \frac{\delta c_{d,i}}{\delta p_{d,i}} dp_{d,i} \right]$$

The underlying structural model provides the possibility of finding the derivatives of $\frac{\delta c_{d,i}}{\delta p_{f,i}}$ and also the $\frac{\delta c_{d,i}}{\delta p_{d,i}}$. This facilitates the calculation of the elasticity of import demand and also the elasticity of demand.

The elasticity of import demand is given as:

$$(5.19) \quad \frac{dc_{d,i}}{dp_{f,i}} \frac{p_{f,i}}{c_{d,i}} = \left[\frac{\delta c_{d,i}}{\delta p} \frac{dp}{dp_{f,i}} + \frac{\delta c_{d,i}}{\delta p_i} \frac{dp_i}{dp_{f,i}} + \frac{\delta c_{d,i}}{\delta p_{d,i}} \frac{dp_{d,i}}{dp_{f,i}} \right] \left[\frac{p_{f,i}}{c_{d,i}} \right]$$

Note that the equation (5.19) gives the share elasticity of import demand, since $c_{d,i}$ is the share of domestic consumption of good i. It is possible to have two versions of this elasticity of import demand. The domestic price, $p_{d,i}$ can be assumed not affected by the foreign price, $p_{f,i}$, to yield the partial version of the import elasticity. Alternatively, it can be assumed that the foreign price affects the domestic price by affecting the share of consumption of good i, which in turn affects the price-cost margin that will affect the domestic price. In either case, it is assumed that both the domestic and foreign prices are not significant in affecting the general price. Hence, the elasticity of import demand is reduced from equation (5.19) to

$$(5.20)\quad \frac{dc_{d,i}}{dp_{f,i}}\frac{p_{f,i}}{c_{d,i}} = \beta_i\,\alpha_i\,y\left[\frac{\delta c_{d,i}}{\delta p_i}\frac{dp_i}{dp_{f,i}} + \frac{\delta c_{d,i}}{\delta p_{d,i}}\frac{dp_{d,i}}{dp_{f,i}}\right]\left[\frac{p_{f,i}}{c_{d,i}}\right]$$

5.7.2.1 Derivation of Partial Elasticity of Import Demand

The simpler version of the elasticity of import is expressed by:

$$(5.21)\quad \frac{dc_{d,i}}{dp_{f,i}}\frac{p_{f,i}}{c_{d,i}} = \left[\frac{\delta c_{d,i}}{\delta p_i}\frac{dp_i}{dp_{f,i}}\right]\left[\frac{p_{f,i}}{c_{d,i}}\right]$$

where

$$(5.22)\quad \frac{\delta c_{d,i}}{\delta p_i} = (\sigma_{df,i} - \sigma)\left[p_i^{\sigma_{df,i}-\sigma-1}\ p_{d,i}^{-\sigma_{df,i}}\ p^{\sigma}\right](\beta_i\,\alpha_i\,y)$$

From the consistent price index given in:

$$(3.24)\quad p_i \equiv \left[\beta_i p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}},$$

The differentiation of p_i with respect to $p_{f,i}$ can then be expressed as:

$$(5.23)\quad \frac{dp_i}{dp_{f,i}} = \left[\beta_i p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}-1}\left[(1-\beta_i)\,p_{f,i}^{-\sigma_{df,i}}\right]$$

From the expression (5.21), the partial version of the elasticity of import demand is then:

$$\frac{dc_{d,i}}{dp_{f,i}}\frac{p_{f,i}}{c_{d,i}} = \beta_i\ \alpha_i\ y\left[\left(\sigma_{df,i}-\sigma\right)p_i^{\sigma_{df,i}-\sigma-1}\ p_{d,i}^{-\sigma_{df,i}}\ p^{\sigma}\right]\times$$

$$(5.24)\qquad \left(\left[\beta_i p_{d,i}^{1-\sigma_{df,i}}+(1-\beta_i)p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}-1}\right)\times$$

$$\left[(1-\beta_i)p_{f,i}^{-\sigma_{df,i}}\right]\times$$

$$\left(\frac{p_{f,i}}{\beta_i\ \alpha_i\ y\left[p^{\sigma}\ p_i^{\sigma_{df,i}-\sigma}\ p_{d,i}^{-\sigma_{df,i}}\right]}\right)$$

Crossing out the terms, the elasticity of import demand, with the domestic price assumed constant, is expressed by:

$$(5.25)\qquad \varepsilon_{f1} = \left(\sigma_{df,i}-\sigma\right)\left(1-\beta_i\right)\left(\frac{p_{f,i}}{p_i}\right)^{1-\sigma_{df,i}}$$

5.7.2.2 Derived of Total Elasticity of Import Demand

A more complex elasticity of import demand, ε_{f2}, can be estimated through the structural model proposed in this thesis. When the foreign price affects the domestic price through the channel of domestic consumption share and the price-cost margin, the elasticity of import demand is given as:

$$(5.20)\qquad \frac{dc_{d,i}}{dp_{f,i}}\frac{p_{f,i}}{c_{d,i}} = \left[\frac{\delta c_{d,i}}{\delta p_i}\frac{dp_i}{dp_{f,i}}+\frac{\delta c_{d,i}}{\delta p_{d,i}}\frac{dp_{d,i}}{dp_{f,i}}\right]\left[\frac{p_{f,i}}{c_{d,i}}\right]$$

where

$$(5.26)\qquad \frac{dc_{d,i}}{dp_{d,i}} = \left[\frac{\delta c_{d,i}}{\delta p_{d,i}}+\frac{\delta c_{d,i}}{\delta p_i}\frac{dp_i}{dp_{d,i}}\right]$$

This gives the elasticity of import demand in equation (5.20) as:

(5.27) $$\frac{dc_{d,i}}{dp_{f,i}}\frac{p_{f,i}}{c_{d,i}}=\left[\frac{\delta c_{d,i}}{\delta p_i}\frac{dp_i}{dp_{f,i}}+\frac{\delta c_{d,i}}{\delta p_{d,i}}\frac{dp_{d,i}}{dp_{f,i}}+\frac{\delta c_{d,i}}{\delta p_i}\frac{dp_i}{dp_{d,i}}\frac{dp_{d,i}}{dp_{f,i}}\right]\left[\frac{p_{f,i}}{c_{d,i}}\right]$$

where $\frac{\delta c_{d,i}}{\delta p_i}$ is given in equation (5.22) and $\frac{dp_i}{dp_{f,i}}$ is given in equation (5.23). And from equation (3.22),

(5.28) $$\frac{\delta c_{d,i}}{\delta p_{d,i}}=\left(-\sigma_{df,i}\right)\left[p_i^{\sigma_{df,i}-\sigma}\ p_{d,i}^{-\sigma_{df,i}-1}\ p^{\sigma}\right]\left(\beta_i\ \alpha_i\ y\right)$$

The effect of foreign price on domestic price is given as:

(5.29) $$\frac{dp_{d,i}}{dp_{f,i}}=\frac{\delta p_{d,i}}{\delta PCM_i}\frac{\delta PCM_i}{\delta c_{d,i}}\frac{\delta c_{d,i}}{\delta p_{f,i}}$$

From the econometric specification in Chapter 3, the price-cost margin is given as:

(3.67) $$PCM_i\equiv\frac{\overline{p}_{d,i}-SMC_i}{\overline{p}_{d,i}}$$

This in turn gives the specification for the domestic price as:

(5.30) $$\overline{p}_{d,i}=\frac{-SMC_i}{\left[PCM_i-1\right]}$$

and the derivative of $\frac{\delta p_{d,i}}{\delta PCM_i}$ that appears in equation (5.29), can be obtained from equation (5.30) as:

(5.31) $$\frac{\delta p_{d,i}}{\delta PCM_i}=SMC_i\ \left[PCM_i-1\right]^{-2}$$

The differentiation of the price-cost margin with respect to the share of consumption, $c_{d,i}$ that appears in equation (5.29), can be obtained directly from the estimation of:

$$(3.68)\quad PCM_i = \omega_{0,i} + \omega_{1,i}PRS_i + \omega_{2,i}PDT_i$$

or

$$(3.71)\quad PCM_i = \delta_{0,i} + \delta_{1,i}PRS_i + \delta_{2,i}PDT_i$$

The variable PRS_i is the domestic producer share of the industry, which is the share of the consumption, locally. Since PDT_i is the product of PRS_i and the budget share of the industry, IRS_i given in equation (3.74), this provides the derivatives:

$$(5.32)\quad \frac{\delta PCM_i}{\delta c_{d,i}} = a_{1,i} + a_{2,i}\ IRS_i$$

where $a_{x,i}$ is either $\varpi_{x,i}$ *or* $\delta_{x,i}$, and $x = 1$ and 2.[62]

The effects of foreign price on domestic consumption share can be obtained from the derivatives given in equation (5.22) and (5.23):

$$(5.33)\quad \frac{dc_{d,i}}{dp_{f,i}} = (\sigma_{df,i} - \sigma)\left[p^{\sigma}\ p_i^{\sigma_{df,i}-\sigma-1}\ p_{d,i}^{-\sigma_{df,i}}\right](\beta_i\ \alpha_i\ y)\times \left[\beta_i p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}-1}\left[(1-\beta_i)p_{f,i}^{-\sigma_{df,i}}\right]$$

which can be written as:

$$(5.34)\quad \frac{dc_{d,i}}{dp_{f,i}} = (1-\beta_i)\left[\frac{p_{f,i}^{-\sigma_{df,i}}}{p_i^{1-\sigma_{df,i}}}\right](\sigma_{df,i} - \sigma)\times c_{d,i}$$

where $c_{d,i}$ is given in equation (5.17).

The derivative $\frac{dp_i}{dp_{d,i}}$ is obtained from the consistent price index given in equation (3.24),

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[62] If there is lag structure of $a_{x,i}$, the sum of the coefficient is used for the calculation of the total elasticity of import demand.

(5.35) $$\frac{dp_i}{dp_{d,i}} = \left[\beta_i\; p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)\, p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}-1} \left[\beta_i\; p_{d,i}^{-\sigma_{df,i}}\right]$$

By substitution equation (5.22), (5.23), (5.28), (5.29), (5.31), (5.32) (5.34) and (5.35) into equation (5.27) gives the following of total elasticity of import demand expression:

(5.36)
$$\varepsilon_{f2} = \left\{ \frac{ \begin{bmatrix} \left(\sigma_{df,i}-\sigma\right)\left(p^{\sigma}\; p_i^{\sigma_{df,i}-1}\; p_{d,i}^{-\sigma_{df,i}}\right)(\beta_i\; \alpha_i\; y) \\ \left(\beta_i\; p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)\, p_{f,i}^{1-\sigma_{df,i}}\right)^{\frac{1}{1-\sigma_{df,i}}-1} \left((1-\beta_i)\, p_{f,i}^{-\sigma_{df,i}}\right) \end{bmatrix} + \begin{bmatrix} \left(-\sigma_{df,i}\right)\left(p^{\sigma}\; p_i^{\sigma_{df,i}-\sigma}\; p_{d,i}^{-\sigma_{df,i}-1}\right)(\beta_i\; \alpha_i\; y)\left(\frac{SMC_i}{(PCM_i-1)^2}\right) \\ \left(a_{1,i}+a_{2,i}\; IRS_i\right)\left(\sigma_{df,i}-\sigma\right)(1-\beta_i)\left(\frac{p_{f,i}^{-\sigma_{df,i}}}{p_i^{1-\sigma_{df,i}}}\right)\times c_{d,i} \end{bmatrix} + }{ \begin{bmatrix} \left(\sigma_{df,i}-\sigma\right)\left(p^{\sigma}\; p_i^{\sigma_{df,i}-\sigma-1}\; p_{d,i}^{-\sigma_{df,i}}\right)(\beta_i\; \alpha_i\; y) \\ \left(\beta_i\; p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)\, p_{f,i}^{1-\sigma_{df,i}}\right)^{\frac{1}{1-\sigma_{df,i}}-1} \\ \left(\beta_i\; p_{d,i}^{-\sigma_{df,i}}\right)\left(\frac{SMC_i}{(PCM_i-1)^2}\right)\left(a_{1,i}+a_{2,i}\; IRS_i\right) \\ \left(\sigma_{df,i}-\sigma\right)(1-\beta_i)\left(\frac{p_{f,i}^{-\sigma_{df,i}}}{p_i^{1-\sigma_{df,i}}}\right) \end{bmatrix} } \right\} \times \left[\frac{p_{f,i}}{c_{d,i}}\right]$$

After crossing out the common terms, equation (5.36) becomes

(5.37)
$$\varepsilon_{f2} = \left(\sigma_{df,i}-\sigma\right)(1-\beta_i)\left(\frac{p_{f,i}^{1-\sigma_{df,i}}}{p_i}\right)\times \begin{bmatrix} p_i^{\sigma_{df,i}} + \left(-\sigma_{df,i}\right)\left(\frac{p_i^{\sigma_{df,i}-1}}{p_{d,i}}\right)\left(\frac{SMC_i}{(PCM_i-1)^2}\right)\left(a_{1,i}+a_{2,i}\; IRS_i\right)\times c_{d,i} + \\ \left(\sigma_{df,i}-\sigma\right)(\beta_i)\left(\frac{p_i^{\sigma_{df,i}}}{p_{d,i}}\right)\left(\frac{SMC_i}{(PCM_i-1)^2}\right)\left(a_{1,i}+a_{2,i}\; IRS_i\right) \end{bmatrix}$$

5.7.3 Derivation of Elasticity of Demand

The elasticity of demand can also be obtained in the same fashion as the elasticity of import demand:

$$(5.38)\quad \frac{\delta c_{d,i}}{\delta p_{d,i}}\frac{p_{d,i}}{c_{d,i}} = \left[\frac{\delta c_{d,i}}{\delta p_i}\frac{dp_i}{dp_{d,i}} + \frac{\delta c_{d,i}}{\delta p_{d,i}}\right]\left[\frac{p_{d,i}}{c_{d,i}}\right]$$

$\frac{\delta c_{d,i}}{\delta p_i}$ is given in equation (5.22) and $\frac{\delta c_{d,i}}{\delta p_{d,i}}$ is given in equation (5.28) and

$$(5.39)\quad \frac{dp_i}{dp_{d,i}} = \left[\beta_i\, p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)\, p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}-1}\left[\beta_i\, p_{d,i}^{-\sigma_{df,i}}\right]$$

By substituting equation (5.22), (5.39), (5.28) and (5.17) into (5.38), the elasticity of demand is as below:

$$(5.40)\quad \varepsilon_d = \beta_i\,\alpha_i\, y\left\{\begin{matrix}(\sigma_{df,i}-\sigma)\left(p_i^{\sigma_{df,i}-\sigma-1}\, p_{d,i}^{-\sigma_{df,i}}\, p^{\sigma}\right)\times \\ \left[\beta_i\, p_{d,i}^{1-\sigma_{df,i}} + (1-\beta_i)\, p_{f,i}^{1-\sigma_{df,i}}\right]^{\frac{1}{1-\sigma_{df,i}}-1}\left[\beta_i\, p_{d,i}^{-\sigma_{df,i}}\right]+ \\ (-\sigma_{df,i})\left(p_i^{\sigma_{df,i}-\sigma}\, p_{d,i}^{-\sigma_{df,i}-1}\, p^{\sigma}\right)\end{matrix}\right\}\times \frac{p_{d,i}}{\beta_i\,\alpha_i\, y\left[p^{\sigma}\, p_i^{\sigma_{df,i}-\sigma}\, p_{d,i}^{-\sigma_{df,i}}\right]}$$

Crossing out the common terms leaves,

$$(5.41)\quad \varepsilon_d = (\sigma_{df,i}-\sigma)\,\beta_i\left(\frac{p_{d,i}}{p_i}\right)^{1-\sigma_{df,i}} - \sigma_{df,i}$$

The β_i in the various elasticities give the share of domestic product in industry sales when foreign and domestic prices are equal. A reasonable approximation is therefore the mean share of domestic product in industry sales.

For the price index of prices charged by all domestic producers of i, $p_{d,i}$, the foreign price index faced by domestic producers of i, $p_{f,i}$, and price index that incorporating all domestic and all foreign producers of i, p_i, the mean value is used for the estimation of the various elasticities.

Estimates of the mean for the domestic producer share of the industry, the budget share of the industry and the price-cost margin are used in the derivation of the total elasticity of import demand.[63]

When the mean of the domestic producer price index and the price-cost margin are determined, the short-run marginal cost can be calculated from equation (3.67), where:

$$(5.45) \quad SMC_i = \overline{p}_{d,i}\left(1 - PCM_i\right)$$

Hence, the short-run marginal cost is also an estimate of the mean value.

The parameters used to calculate the various elasticities are presented in Table 5.24.

Table 5.24: Parameters Used to Calculate Various Elasticities

Parameters	Industry 21	23	25	26	28
σ	8.6215 [IV]	-0.233858 [OLS]	0.541996 [VECM2]	2.80553 [OLS]	0.88761 [OLS]
$\sigma_{df,i}$	1.9321 [VECM2]	0.42833 [VECM2]	0.59272 [OLS]	0.88108 [OLS]	1.59162 [OLS]
β_i	0226018	0.067106	0.165589	0.054434	0.189385
p_i	101.03731	101.03731	101.03731	101.03731	101.03731
$p_{d,i}$	103.58889	102.25657	102.11998	102.13333	100.44108
$p_{f,i}$	106.03477	101.83292	100.78906	108.15297	108.47625
$c_{d,i}$	0.91305	0.81825	0.68413	0.90273	0.44331
IRS_i	0.16587	0.06695	0.16650	0.05219	0.29241
SMC_i	77.26508	74.98348	81.25373	72.97817	75.69959
$a_{1,i}$, $a_{2,i}$	IV	VECM2	VECM2	VECM2	VECM2

The estimates of the various elasticities are reported in Table 5.25.

Table 5.25: Derived Elasticity Estimates

Industry	ε_{f1}	ε_{f2}	ε_{d}
21	-4.9497	-19.8132	-3.4093
22	*	*	*
23	0.6205	0.6505	0.0191
24	*	*	*
25	0.0423	0.0423	-0.5843
26	-1.8345	-1.8343	-0.9860
27	*	*	*
28	0.5472	0.5533	-1.4578
29	*	*	*

* No significant estimates are obtained for σ and $\sigma_{df,i}$ for industry 22, 24, 27 and 29. Hence, no elasticity estimates are provided.

[63] The composite of domestic goods, $c_{d,i}$, is approximate to the domestic producer share of the industry, assuming no storage opportunity.

Chapter 6: Conclusions and Implications

The literature on the behaviour of international trade flows has been largely centred on single-equation studies. Advances in estimation techniques have been the central focus in the literature, but little has been achieved in improving the specification of the trade flow model in terms of theoretical basis. Even up to the present time, the prevailing empirical studies of import demand are mostly based on single-equation modelling and little attention has been paid to the theoretical structure of the model. Furthermore, the use of a single-equation also has the disadvantage of ignoring the interaction of the supply and the demand sides.

Import demand structural modelling often assumes a perfect competitive environment. Introduction of an imperfectly competitive environment into modelling import demand can provide new insights into trade behaviour. The existing studies on this departure from perfect competition mainly stresses product differentiation, where the firms have some degree of market power. The inclusion of other forms of mperfect competition in the international trade flows model provides further insights that help fill the cavity within the perfect competitive models.

In particular, the use of conjectural variation permits us to model firm's behaviour under imperfect competition. The inclusion of firm's conjectures in trade modelling provides for interaction among competitors. Different assumptions on the conjecture parameters give different type of outcomes in the imperfectly competitive framework. Hence, many different models can be analysed within the same unifying framework. Furthermore, the use of a conjectural variation parameter provides a straightforward meaning to the degree of competition in an industry.

This thesis presents a model of consumer demand and oligopoly pricing that leads to an econometric specification for empirical research. The theory of consumer behaviour along with the production theory provides the base for the model. The econometric specification consists of an industry price-cost margin equation and two revenue share equations. One revenue share equation is for the division of revenues between domestic product and imports within an industry and the other for the industry share of total manufacturing revenues in the domestic market. Firms are assumed to behave in a non-collusive oligopoly environment, which leads to a specification of the price-cost margin equation. The econometric specification of the price-cost margin is able to distinguish the type of oligopoly behaviour, namely Cournot or Bertrand behaviour. This is done through differentiating the pattern of estimated coefficients in the industry price-cost margin.

The three equations are estimated as a simultaneous system for each of the broadly defined Australian manufacturing industries classified under the two-digit level of the *Australian and New Zealand Standard Industrial Classification*. The time series is quarterly data covering the period from the third quarter of 1984 to the first quarter of 2000. At this level of aggregation, sharp differences generally exist between products across classifications, but products contained within the classifications may be poor substitutes or even complements. The regression results are then used to derive estimates of the parameters of the underlying consumer demand model, as well as estimates of two versions of elasticity of import demand and one estimate for the elasticity of demand for domestic producer. The results are also used for distinguishing different oligopoly reactions among firms.

Using maximising behaviour by consumers and imperfectly competitive producers to derive an econometric specification is a distinguishing feature of the thesis. The set of variables included and the functional form of the estimating equations is dictated by maximisation over assumed preference and production functions. Consistency with maximising behaviour over the assumed functions imposes restrictions on the values of estimated coefficients that can be evaluated using test statistics from estimation results. The objective is to provide a coherent theoretical basis for empirical research.

The price-cost margin equation for both Cournot and Bertrand conjectural equilibrium can be estimated using a single equation. The single price-cost margin equation and the two share equations constitute an interdependent system for estimation purposes. $p_{d,i}$ 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, giving the simultaneity property of the model.

All constructed data are checked for unit root property prior estimation. The estimation process is carried out with the *OLS* and *IV* (instrumental variables) estimations. To justify the validity of the *OLS* estimates, the Wu-Hausman test for exogeneity is performed. In almost all of the regressions, the Wu-Hausman statistic is not able to reject the null hypothesis of exogeneity, with the exception to the domestic producer share of the Textile, Clothing, Footwear and Leather manufacturing. Hence, the *OLS* results for domestic producer share in this industry are treated with caution.

The results from the *OLS* estimation suggest that firms in Food, Beverage and Tobacco manufacturing, Textile, Clothing, Footwear and Leather manufacturing, and Printing, Publishing and Recorded Media manufacturing use price conjectures in determining their maximising behaviour. The products of these industries are closer to consumer product in nature. Hence, the suggested use of a Bertrand type of conjecture conforms to the industrial nature of these products. With the higher industrial numbering, Non-Metallic Mineral Product manufacturing, and Machinery and Equipment manufacturing, are found to exhibit behaviour consistent with the Cournot type of conjecture. The suggestion of a quantity reaction by the regression is again in line with the product's nature.

The *IV* estimates are consistent with the Bertrand-type of conjecture for Food, Beverage and Tobacco manufacturing. However, no consistency is found for any other industry using *IV* estimation. As a result, *OLS* estimation produces more positive results for the proposed structural model.

In order to distinguish the existence of any long-run equilibrium, cointegration analysis is performed. The cointegration technique follows the Johansen procedure. Two models are proposed in testing for cointegration for the three simultaneous equations in the structural model. In the first model (Model 1), the cointegration test is carried out using only the variables in each equation separately. An alternative model (Model 2) is to use all the variables in the structural model to test for cointegration. Since the empirical model is a structural model, it is plausible to use all the variables in testing for cointegration. The main reason to test for cointegration among variables is to determine whether it is valid to estimate a dynamic vector error correction model (*VECM*).

For Model 1, the *VECM1* produces similar conjecture as in the *OLS* and *IV* estimations. Food, Beverage and Tobacco manufacturing, and Printing, Publishing and Recorded Media manufacturing, each has a Bertrand-type of conjectures according to *VECM1*.

The *VECM2* results show a conflicting result regarding the reaction for Textile, Clothing, Footwear and Leather industry, as compared to the *OLS* estimates. The results from *VECM2* show a Cournot-type of conjecture, which is inconsistent in reflecting the nature of the product. Apart from this 'abnormality', the *VECM2* produces the most positive results that are consistent with the nature of the products. Food, Beverage and Tobacco manufacturing, and Printing, Publishing and Recorded Media manufacturing results are each consistent with Bertrand type of conjecture, while Petroleum, Coal, Chemical and Associated Product manufacturing, Non-Metallic Mineral Product manufacturing, Metal Product manufacturing, and Machinery and Equipment manufacturing results are each consistent with Cournot type of conjecture.

In comparing both the *VECM* estimations, the *VECM2* produces better results. Since *VECM2* is based on cointegration analysis that incorporates the full set of variables in the structural model, it incorporates the dynamics within the structural model. As a result, *VECM2* has a conceptual edge over *VECM1*. Industries for which cointegration analysis based on Model 1 does not indicate cointegration relationship between variables might be caused by the failure to allow for interaction dynamics among variables.

Overall, by using the same structural equations for each industry, the proposed model is able to identify the nature of the oligopoly reaction within an industry. Different reactions appear in the regression results, indicating the ability of the structural model in identifying interactions of firms within the industry. That four estimation strategies produced similar results amplifies the appropriateness of the model.

Foreign competition impacts on the domestic economy in the model through the price of imports. The regression results for the domestic producer revenue share provide estimates of the direct impact of import price on the division of an industry's domestic sales revenues between domestic and foreign producers. There is no direct effect of import price on industry's share of total revenues. However, the import price affects domestic price through the channel of domestic consumption share and the price-cost margin. Solving for domestic price from the price-cost margin yields an expression in terms of domestic cost and the price-cost margin.

Table 5.25 presents estimates of import demand elasticities with respect to import price and domestic price calculated for each of the industries for which regression results are statistically significant. Two types of elasticity of import demand are listed. Those indicated as "partial" include only the direct effect of import price on domestic consumption share. This is calculated from the derivatives of domestic consumption share on the import price index as well as on the price index that incorporates all domestic and all foreign price within an industry. Estimates of the "total" impact of import price on the share of domestic consumption are found by adding the impact of import price on domestic price. This impact is not a direct derivative within the structural model, but can be obtained indirectly through the channel of domestic consumption share and the price-cost margin. It is assumed that neither the domestic nor foreign prices are significant in affecting the changes in aggregate domestic price level.

The estimated impacts of import price vary substantially across the industries. This suggests that industries may be characterised as having differing degrees of sensitivity to international influences. Thus, failure to estimate at the most disaggregated possible might produce biased estimates.

There is a clear rank ordering of sensitivity of partial import demand elasticity, with Food, Beverage and Tobacco, and Non-metallic Mineral Product manufacturing being most sensitive, while Wood and Paper Product, and Machinery and Equipment manufacturing are less sensitive, followed by Petroleum, Coal, Chemical and Associated Product manufacturing being the least sensitive.

Import share and quantity are similarly ordered in terms of sensitivity as long as a negative elasticity is treated as showing more sensitivity than a positive elasticity. Yet, the rank ordering of the elasticities does not match the rank ordering according to the mean value of the domestic producer share in industry revenues.[64] This suggests that the use of domestic or import share as a measure of sensitivity to international influences may not always be appropriate. Food, Beverage and Tobacco manufacturing and Non-Metallic Mineral Product manufacturing have the highest mean value of the domestic producer share in industry revenues, while the producers of Wood and Paper Product and Petroleum, Coal, Chemical and Associated Product have a lesser mean value followed by the least domestic share by Machinery and Equipment manufacturing.

There is no great difference between the partial and total elasticity of import demand in terms of magnitude. The additional effects of the impact of import price to domestic price are minimal. This shows that when import price affects the domestic consumption share, the changes do not have a great impact on the price-cost margin. Hence, they do not have a substantial impact on the domestic price. Only for the Food, Beverage and Tobacco manufacturing industry, the effect of import price has quite a substantial impact on domestic price. This is shown by the difference in magnitude between the partial and total elasticity of import demand, namely, 4.9497 and 19.8132, respectively.

Athukorala and Menon (1995) model the demand for imports as dependent on relative price, domestic economic activity and a measure of general scarcity of domestic supplies. Import functions are estimated for total manufactured imports as well as for the 2-digit classification under the Manufacturing Division of the Australian Standard Industrial Classification. Even though, the industrial classification is different from the present data set used in this thesis, a comparison is still possible, since the classifications are similar at the two-digit industrial classification.

The ranking of sensitivity of import price reported in Table 5.25 is different compared to the one by Authukorala and Menon (1988, 1995). Chemicals industry

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[64] The mean value for the domestic producer share is reported in Table 5.24.

achieved a high 2.10 from their study. A comparison of the similar industry shows a much smaller sensitivity, namely, 0.0423 for the Petroleum, Coal and Chemical manufacturing. However, Authukorala and Menon (1995) exclude Petroleum products (ASIC 227 and 278). Even so, in Authukorala and Menon (1988), the price elasticity, which includes petroleum and coal products, is 2.24.

The Non-Metallic Mineral industry has a price elasticity of 0.43 from the previous study. This thesis shows that the 'equivalent' industry has an elasticity registered at 1.845, more than double the value of the previous study.

The Food, Beverage and Tobacco industry has the greatest variance as compared to Athukorala and Menon (1988).[65] In this thesis, this industry is the most elastic industry, achieving an elasticity value at 4.9497, as compared to the low elasticity of 0.52 in the previous study.

On the lower end, Machinery and Other Equipment registered a price elasticity of 0.37 from the study by Authokorala and Menon (1995). This lower end ranking is similar to the result from this thesis. Machinery and Equipment industry is the second lowest in as shown from Table 5.25. However, the magnitude of the elasticity is not greatly different. This thesis provides a value of 0.5472.

The results from Authokorala and Menon (1988, 1995) are used only as a benchmark value for the elasticity in disaggregated level. The data for their study only cover the period from 1981 to 1988 (1988) and from 1981 to 1991 (1995). This data set is substantially smaller as compared to the one used in this thesis. Moreover, the use of the levels data with the findings of non-stationary of the variables in Autholorala and Menon (1995), casts doubt on the reliability of the estimates. Also of concern is the validity of the single-equation estimates from a theoretical standpoint.

Despite great care taken in applying the models to the data set in this thesis, we still face some intrinsic limitations imposed by the data series, model and estimation procedures. Working on the sample period of sixty-three quarters limits the exploration of the dynamics of the data series. This is especially true in applying the Augmented Dickey-Fuller test to such small samples, which makes the test less robust. The price-cost margin appears to have a unit root in all industries, reflecting a shortcoming since it is not sensible from a theoretical standpoint for a variable with a finite range of values to be non-stationary.

The demand model considers only consumer demand in the domestic market. In practice, the sources of aggregate demand are investment, intermediate

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[65] Since Food, Beverages and Tobacco industry is not analysed in Athukorala and Menon (1995), a comparison is carried out with an earlier study.

and export demand too. This points out the possibility of misspecification due to eliminating other demand specifications from the model. In particular, not incorporating exports in the model might cause biases in the estimates, since shocks that alter the composition of demand alter the elasticities perceived by firms and hence their mark-ups.

Further, the estimates are exposed to diagnostic criticism. This cast particular doubt on the estimation results for particular industries. However, the calculations of elasticities of import demand and elasticity of demand are provided despite the existence of the poor diagnostics.

Within the limitations mentioned, our results are meant to illustrate the potential gains from empirical work employing econometric specifications with a coherent theoretical basis. Substantial further work is required in determining whether estimation results are robust to alternative modelling of preferences, technology and competitive behaviour. In particular, the assumption of constant consumption parameters and industry behaviour through time is a very strong one, particularly for an empirical analysis on the period of 1983 to 2000.

If the proposed model is established, substantial work can be carried out in analysing the effects of trade on the welfare of the consumer. The parameters of the elasticity of substitution permit such an analysis. Furthermore, incorporating the effects of intra-industry trade into the model might prove useful as a further research opportunity. This might require venturing into longer time series and more disaggregated data series. Hopefully, this thesis has provided some guidance to further research, as well as indicating some of the limitations of standard empirical practices.

Appendix for Chapter 5

A5.1 Model 1: *VAR* System Reduction

For Model 1, the cointegration test is carried out for the price-cost margin equation, to the budget share of the industry, and the domestic producer share of the industry. For price-cost margin equation, the null hypothesis is testing the three variables, namely the PCM_i, PRS_i and PDT_i are not cointegrated against the alternative hypothesis of cointegration.

As for the two shares equation, they are more complex due to its non-linearity in the equation.[66] As a consequence, these two share equations are linearly transformed.[67] For the domestic producer share of the industry, the linearisation process is as follows:

$$(5.6)\quad PRS_i^{-1} - 1 = b_0 (PFPD_i)^{b_1}$$

The time subscript is dropped in equation (5.6). Take the logarithmic of equation (5.6) gives,

$$(5.7)\quad ln\left[PRS_{i,t}^{-1} - 1\right] = lnb_0 + b_1 ln\left[PFPD_{i,t}\right]$$

which can be written as:

$$(5.15)\quad LSD_i = log(b_0) + b_1 LPFPD_i$$

where

$$(5.16)\quad \begin{aligned} LSD_i &= log\left(PRS_i^{-1} - 1\right) \\ LPFPD_i &= log\left(PFPD_i\right) \end{aligned}$$

For the budget share of the industry, it is linearly transformed from equation (3.74) by taking the logarithmic of both side of the equation. This gives,

[66] There is no congruent technique in testing for cointegration in a non-linear equation.
[67] Correct process, which can then be differenced for Chapter 5.

$$(5.17)\quad LIRS_i = log(\alpha_i) + (1-\sigma)LPDP_i$$

where

$$(5.18)\quad \begin{aligned} LIRS_i &= log(IRS_i) \\ LPDP_i &= log(PDP_i) \end{aligned}$$

A general *VAR* (vector autoregressive) system is constructed consisting of 5 lags of each variable. The *VAR* is then "tested down" by dropping one lag and calculating a F-statistic for the exclusion of the lag.[68] This process is continued until 1 lag in the order of *VAR*. The F-statistic provides a test of the joint significance of reducing the lag in the system. Thus, the null hypothesis is to accept that all the coefficients of the deleted lag length equal zero. For example, rejecting the null hypothesis using the F-statistic from lag length 5 to lag length 4 means rejecting the null that all the coefficients of the lag length 5 are zero. As a result, the F-statistic is a test criteria in choosing the order of *VAR.* The chosen *VAR* structure is then checked for adequacy in terms of autocorrelation. The *Akaike* (*AIC*), *Schwarz* (*SC*) and *Hannan-Quinn* (*HQ*) information criteria are also taken in to consideration in choosing the order of *VAR* system. In some industries, conflicting results might occur between criteria. Priority is given to autocorrelation and the F-statistic, since estimating a *VAR* that suffers from autocorrelation problem will result in spurious estimates.

A5.1.1 Model 1: *VAR* System Reduction – Price-Cost Margin Equation

The tests of *VAR* system reduction results for the price-cost margin equation are presented in Table A5.1a-i for Model 1. For industry 21, the chosen lag length in *VAR* is 5 lags. Even though autocorrelation problem is evident for variable *PDT21*, the system vector does not appear to have autocorrelation problem. Lag 5 in the *VAR* also shows significance at the 5 percent level of test statistic and both *SC* and *HQ* criteria support this lag length by giving the smallest values, although *AIC* criterion suggests otherwise.

4 lags in the *VAR* are chosen for industry 22, despite the insignificant of the F-statistic. The F-statistic is statistically significant at the 1 percent level for 3 lags in

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[68] The F-statistic is also refer to as the F-test.

the system, but this vector suffers from autocorrelation at the 5 percent level. In fact, lag length 4 is also the preferred lag length under *SC* and *AIC* criterion.

Lag length 5 is significant at the 5 percent level of F-statistic, without indication of an autocorrelation problem in industry 23. Both *SC* and *HQ* criteria give the lowest statistic, hence supporting the use of 5 lags in the *VAR* for industry 23 in testing for cointegration.

For industry 24, the F-statistic criterion gives little basis for choosing the lag length in *VAR*. None of the system reductions are significant except for the system reducing from lag length 5 to lag length 1, which is statistically significant at the 5 percent level. Based on *SC* and *HQ* criterion, lag length 5 is chosen without any autocorrelation problem in the individual variables or in the vector.

Lag length 5 is statistically significant at the 5 percent level, and both *SC* and *HQ* criteria indicate that lag length 5 is the proper lag length in the *VAR* for industry 25. At this lag length, there is no evidence of an autocorrelation problem for the individual variables or for the reduction vector.

The reduction from lag 3 to lag 2 is statistically significant at the 1 percent level for industry 26. Hence, the null hypothesis of all coefficienst in lag length 3 equal zero is rejected. At lag length 3, autocorrelation is not evident. Also, the *HQ* criterion supports this lag length.

For industry 27, the chosen lag length is 3 due to statistically significance at the 5 percent level and no evidence of any autocorrelation problem. However, both the *SC* and *HQ* criteria choose lag length 5 and the *AIC* criteria choses lag length 4. Priority is given to the F-statistic, and lag length 3 is clear from any autocorrelation problem.

Industry 28 provides a similar situation as in industry 27. Both the *SC* and *HQ* criteria choose lag length 5 and the *AIC* criterion chooses lag length 4. But both these lag lengths are insignificant in the reducing process and show autocorrelation. As a result, lag 3 is chosen. This order of *VAR* indicates that is it significant at the 5 percent level and autocorrelation is not evident.

Lag length 5 is chosen for industry 29. The F-statistic is insignificant from reducing lag length from 5 to 4. However, lag length 5 does not show evidence of autocorrelation and *SC* criterion indicates that it is the proper lag length in the *VAR*.[69]

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[69] Industry 29 appears to be one of the industry without clear indication of which lag length is appropriate. However, due to the autocorrelation criterion, lag length 5 is chosen.

Table A5.1a: Test of *VAR* System Reduction 5-1 for industry 21

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM21	PRS21	PDT21	Vector
5	2.4902*	1.7320*	2.3622**	2.1825**	-27.796	-28.122	-28.846	0.55015	0.70236	2.8934*	1.205
4		0.90389	2.0968**	1.8944*	-27.402	-27.923	-29.082	1.3002	1.0829	2.971*	1.5305
3			3.3523**	2.4117**	-27.364	-28.079	-28.674	1.3378	1.8273	2.3014	1.4124
2				1.3225	-26.920	-27.911	-29.375	1.4984	1.3555	4.3733**	2.1908**
1					-26.805	-27.911	-29.375	1.1059	1.0361	4.0291**	1.8137**

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1b: Test of *VAR* System Reduction 5-1 industry 22

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM22	PRS22	PDT22	Vector
5	1.3625	1.5137	2.2171**	3.1616**	-26.040	-26.366	-27.090	2.2828	1.9144	0.54395	1.2731
4		1.6338	2.5884**	3.6780**	-26.203	-26.723	-27.883	1.4485	2.0076	0.33303	1.4095
3			3.4452**	4.5406	-26.179	-26.894	-27.489	1.203	2.4933	0.37208	1.7665*
2				5.0040**	-25.875	-26.786	-27.816	7.2992**	2.0717	0.21607	2.1218**
1					-25.541	-26.647	-28.111	6.9469**	3.4697*	0.48215	2.6508**

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1c: Test of *VAR* System Reduction 5-1 industry 23

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM23	PRS23	PDT23	Vector
5	2.0478*	1.6202	1.7163*	1.6133*	-27.474	-27.800	-28.524	2.2567	4.1091**	1.5195	1.1587
4		1.1255	1.4536	1.3745	-27.052	-27.572	-28.732	3.3194*	2.7072*	1.2708	1.4041
3			1.7769	1.4895	-26.753	-27.469	-28.063	1.5519	2.4587	1.2375	1.3881
2				1.1568	-26.353	-27.263	-28.293	1.2072	3.8878**	0.1918	1.4799
1					-26.154	-27.260	-28.724	2.303	3.891**	0.26777	1.4515

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1d: Test of *VAR* System Reduction 5-1 industry 24

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM24	PRS24	PDT24	Vector
5	1.9352	1.6353	1.5587	1.6318*	-28.317	-28.642	-29.367	0.5003	1.3328	2.2729	0.74876
4		1.2667	1.2939	1.4423	-27.984	-28.505	-29.664	2.076	0.76483	0.979	0.94797
3			1.3043	1.5071	-27.602	-28.317	-28.912	1.0378	3.9314**	0.23035	1.0945
2				1.6875	-27.228	-28.139	-29.169	0.40692	3.0687	1.6681	1.3939
1					-27.008	-28.114	-29.578	0.3795	3.4178*	1.5852	1.4109

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1e: Test of *VAR* System Reduction 5-1 industry 25

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM25	PRS25	PDT25	Vector
5	2.1838*	1.5248	1.7877*	1.7415*	-24.791	-25.116	-25.841	1.8151	0.99737	0.69639	1.329
4		0.81605	1.4784	1.4797	-24.411	-24.932	-26.091	1.5302	1.485	1.2345	1.6592*
3			2.1825*	1.8372*	-24.182	-24.898	-25.492	0.98694	2.5759	0.80625	1.7554*
2				1.4064	-23.721	-24.631	-25.661	0.5257	1.5094	1.9021	1.6174*
1					-23.548	-24.654	-26.118	1.3709	1.554	3.0761*	1.8435**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1f: Test of *VAR* System Reduction 5-1 industry 26

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM26	PRS26	PDT26	Vector
5	0.4744	1.0104	1.8433*	2.1265**	-29.813	-30.138	-30.862	1.2163	0.65034	0.55442	0.77801
4		1.6142	2.6348**	2.7857**	-29.627	-30.148	-31.307	1.6578	0.42108	0.24486	0.6766
3			3.5606**	3.2559**	-29.621	-30.337	-30.931	0.57883	1.8044	0.82627	0.79775
2				2.6010**	-29.314	-30.225	-31.254	3.8705**	1.7862	2.1776	1.4651
1					-28.791	-29.897	-31.361	1.2963	0.99066	0.82496	1.9966**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1g: Test of *VAR* System Reduction 5-1 industry 27

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM27	PRS27	PDT27	Vector
5	1.3025	1.2255	1.5060	1.3910	-25.821	-26.147	-26.871	1.7517	1.1248	1.2009	0.87305
4		1.1303	1.5783	1.3933	-25.365	-25.885	-27.045	1.0297	1.0748	1.0831	1.3311
3			2.0223*	1.5146	-25.108	-25.824	-26.418	1.0105	1.0935	0.87118	1.0983
2				0.95961	-24.709	-25.620	-26.649	0.10818	3.8981**	4.159**	1.3121
1					-24.362	-25.468	-26.932	0.04123	2.6076*	1.7053	1.4417

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1h: Test of *VAR* System Reduction 5-1 industry 28

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM28	PRS28	PDT28	Vector
V	1.6901	1.2153	1.5573	1.5678	-26.669	-26.995	-27.719	4.3895**	0.83435	0.72051	1.3079
4		0.71517	1.4279	1.4608	-26.298	-26.818	-27.978	2.461	0.37633	1.11	1.7562*
3			2.1977*	1.8723*	-26.071	-26.787	-27.381	2.1221	0.90976	0.65627	1.2512
2				1.4570	-25.590	-26.500	-27.530	1.6952	2.1814	2.2854	1.6431*
1					-25.321	-26.427	-27.891	3.1166*	3.89**	3.786**	1.6786*

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.1i: Test of *VAR* System Reduction 5-1 industry 29

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								PCM29	PRS29	PDT29	Vector
5	0.59008	1.6616	1.9636**	2.5322**	-26.924	-27.249	-27.974	0.9380	2.2459	0.1174	0.61666
4		2.8469**	2.7396**	3.2819**	-26.897	-27.417	-28.577	0.1008	2.8044*	0.2406	0.77049
3			2.3849*	3.1469**	-26.702	-27.418	-28.012	0.3551	0.6574	1.8161	1.2332
2				3.6535**	-26.615	-27.526	-28.556	0.6273	4.2381**	2.6105*	1.7617*
1					-26.118	-27.224	-28.688	0.6049	3.0169	0.61344	2.4361**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

A5.1.2 Model 1: *VAR* System Reduction – Domestic Producer Share of the Industry

For thedomestic producer share of the industry, the tests of *VAR* system reduction results are presented in Table A5.2a-i. For industry 21, the test indicats that lag 4 is the lag length appropriate to test for cointegration. The F-statistic is statistically significant at the 5 percent level and there is no evidence that an autocorrelation problem exists. The *HQ* criterion also picks this lag length.

5 lags in the *VAR* are appropriate in testing for cointegration for industry 22. There is no autocorrelation for this lag length and the F-statistic is statistically significant at the 5 percent level. The *SC* criterion also suggests lag length 5 as the proper lag length.

The test of *VAR* system reduction from lag 5 to lag 4 shows statistically significant at the 5 percent level of the F-statistic for industry 23. At lag length 5, there is no autocorrelation problem and the *SC* criterion also picks this lag length as the appropriate one.

The F-statistic is statistically significant at the 5 percent level when the system is reduced from lag length 3 to lag length 2 for industry 24. Conflicting results from the three *SC*, *HQ* and *AIC* criteria is not given priority, since at lag length 3 there is no evidence of an autocorrelation problem.

For industry 25, lag length 5 is the appropriate lag length for cointegration test purposes. Although it is not statistically significant, it is the only lag length that does not show evidence of autocorrelation.

The reduction test from lag length 5 to 3 for industry 26 is statistically significant at the 5 percent level. This lag length shows no evidence of an autocorrelation problem and is picked by the *SC* and *HQ* criterias as the appropriate lag length to use for cointegration test purposes.

For industry 27, none of the system reduction tests are statistically significant. However, the *SC* and *HQ* criteria indicate that the lag length 5 is appropriate and it there is no evidence of an autocorrelation problem.

The F-test for industry 28 is statistically significant at the 5 percent level for the system reducing from lag length 2 to lag length1. At the lag length there is no evidence of an autocorrelation problem, although none of the *SC*, *HQ* and *AIC* criteria agree with this lag length.

None of the tests of *VAR* system reduction are statistically significant for industry 29. In this case, priority is given to the three criteria, *SC*, *HQ* and *AIC*. Of these three criterions, *SC* and *HQ* indicate lag length 5 is appropriate. Although the variable *LPFPD29* is statistically significant at the 1 percent level test for autocorrelation, the vector is clear from an autocorrelation problem. Hence, lag length 5 is chosen for cointegration test purposes.

Table A5.2a: Test of *VAR* system Reduction 5-1 for industry 21

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD21	LPFPD21	Vector
5	0.64073	1.5537	1.2598	1.8354*	-12.660	-12.834	-13.220	1.1952	0.16431	0.52197
4		2.5050*	1.5937	2.2683*	-12.634	-12.895	-13.474	1.8064	0.10546	0.75088
3			0.64281	2.0254	-12.406	-12.753	-13.526	0.38011	0.61397	1.3884
2				2.4565*	-12.329	-12.762	-13.729	1.3373	0.6609	1.6264
1					-12.105	-12.625	-13.785	0.69868	3.0386*	1.8022*

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2b: Test of *VAR* system Reduction 5-1 for industry 22

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD22	LPFPD22	Vector
5	2.7501*	3.3335**	3.33698**	3.6230**	-10.835	-11.009	-11.395	2.1086	1.8216	1.2887
4		3.6455**	3.4247**	3.6426**	-10.807	-11.068	-11.648	2.2857	1.7157	1.3393
3			2.8916*	3.2864**	-10.751	-11.098	-11.871	3.7879**	1.2241	2.1321*
2				3.4269*	-10.759	-11.193	-12.159	4.6196**	0.54543	2.8647**
1					-10.709	-11.230	-12.390	3.3469**	1.2191	2.9736**

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2c: Test of *VAR* system Reduction 5-1 for industry 23

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD23	LPFPD23	Vector
5	3.2702*	1.7237	1.9811*	2.2419**	-10.604	-10.778	-11.164	1.6309	0.94903	0.76886
4		0.16168	1.2189	1.7319	-10.526	-10.787	-11.367	2.0282	0.96502	0.963
3			2.3567	2.6061*	-10.430	-10.777	-11.550	2.2176	0.86771	0.88059
2				2.7113*	-10.164	-10.598	-11.564	4.3752**	0.47603	1.2792
1					-10.155	-10.676	-11.835	5.0627**	2.0201	1.7684*

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2d: Test of *VAR* system Reduction 5-1 for industry 24

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD24	LPFPD24	Vector
5	0.56750	0.84024	1.4347	1.2655	-11.604	-11.778	-12.164	1.9325	0.57255	0.79836
4		1.1338	1.9033	1.5263	-11.380	-11.640	-12.220	1.4804	0.24425	0.55511
3			2.6583*	1.7131	-11.306	-11.653	-12.426	1.5613	0.11227	0.77711
2				0.72105	-11.120	-11.554	-12.520	2.486	0.69769	1.0404
1					-10.890	-11.410	-12.570	2.4371	0.64766	1.2269

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2e: Test of *VAR* system Reduction 5-1 for industry 25

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD25	LPFPD25	Vector
5	2.2078	2.6574*	3.4049**	2.8877**	-11.012	-11.185	-11.572	0.64222	1.3498	1.5868
4		2.9550*	3.8078**	2.9621**	-10.812	-11.072	-11.652	2.5756	2.2691	2.0805*
3			4.3161**	2.7465**	-10.856	-11.203	-11.976	4.6024**	1.7766	2.8303**
2				1.0415	-10.813	-11.247	-12.213	7.921**	1.1351	3.2921**
1					-10.720	-11.241	-12.401	2.2977	0.36633	1.9763*

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2f: Test of *VAR* system Reduction 5-1 for industry 26

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD26	LPFPD26	Vector
5	1.1879	2.4207*	1.6989	1.4521	-11.169	-11.342	-11.729	1.6367	1.4262	1.2831
4		3.6245**	1.9389	1.5279	-10.940	-11.200	-11.780	0.68281	3.5915*	1.3133
3			0.22876	0.43323	-10.678	-11.025	-11.789	2.3609	0.62963	2.2015*
2				0.65759	-10.685	-11.119	-12.085	1.5367	0.35532	1.5383
1					-10.508	-11.028	-12.188	1.5538	0.94088	1.4347

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2g: Test of *VAR* system Reduction 5-1 for industry 27

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD27	LPFPD27	Vector
5	1.2721	1.3036	1.2278	1.0005	-11.054	-11.228	-11.614	1.7251	2.0696	1.6458
4		1.3198	1.1919	0.89951	-10.798	-11.059	-11.638	2.8441*	1.8074	1.6346
3			1.0503	0.68046	-10.602	-10.949	-11.722	2.1482	1.0201	1.3855
2				0.31002	-10.431	-10.865	-11.832	1.8262	0.93418	1.1703
1					-10.261	-10.782	-11.942	1.899	0.9081	0.90204

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2h: Test of *VAR* system Reduction 5-1 for industry 28

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD28	LPFPD28	Vector
5	1.8443	2.0482*	1.4351	1.8493*	-11.619	-11.793	-12.179	0.67181	1.812	1.564
4		2.1740	1.1879	1.7868	-11.557	-11.818	-12.397	1.4996	1.5217	2.053*
3			0.19254	1.5203	-11.293	-11.640	-12.413	3.1153*	0.5198	2.3818**
2				2.9412*	-11.190	-11.624	-12.590	2.2892	0.39203	1.0554
1					-11.067	-11.588	-12.748	5.151**	0.30286	1.7401

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.2i: Test of *VAR* system Reduction 5-1 for industry 29

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LSD29	LPFPD29	Vector
5	1.5992	1.9286	1.3299	1.3454	-10.736	-10.910	-11.297	0.78222	4.6772**	1.4672
4		2.2019	1.1655	1.2295	-10.559	-10.819	-11.399	2.1517	1.8061	1.5744
3			0.12300	0.70849	-10.289	-10.636	-11.409	3.8812**	1.3009	1.3614
2				1.3401	-10.188	-10.622	-11.588	3.6594*	0.71931	1.4459
1					-10.045	-10.566	-11.725	3.312*	0.91021	1.3685

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

A5.1.3 Model 1: *VAR* System Reduction – Budget Share of the Industry

As for the budget share of the industry equation, the tests of *VAR* system reduction are presented in Table A5.3a-i. The test result for industry 21 indicates that lag length 5 is appropriate lag length to test for cointegration, with the statistically significant F-test at the 1 percent level. At this lag length, there is no indication of autocorrelation.

Even though the F-statistic indicates that lag length 4 in industry 22 is not statistically significant when it is reduced to 3 lags in the system, it is statistically significant at the 1 percent level when it is reduced to 1 lag in the system. With 4 lags in the system, there is no indication of any autocorrelation problem for eith the individual test or the test as a vector. In fact, the *SC* criterion suggests lag length 4 is the appropriate one.

For industry 23, none of the F-tests for system reduction are statistically significant. In order to choose the appropriate lag length, *SC*, *HQ* and *AIC* criteria are used. The *SC* and *HQ* criteriaindicate lag length 5 is appropriate and at this lag length there is no indication of any autocorrelation problem. Hence, 5 lags in the system is used to test for cointegration.

For industry 24, 26 and 28, the *SC* and *HQ* criteria indicate 5 lags in the system as the appropriate lag length. Although for industry 24, at this lag length, the variable *LIRS24* shows autocorrelation at the 5 percent level, the autocorrelation test as a vector is not significant. As a result, lag length 5 is used for the cointegration test purposes. Industry 26 and 28 show no evidence of any autocorrelation problem.[70]

Industry 25 shows evidence of autocorrelation in the vector at all 5. The F-test is statistically significant at the 1 percent level and *SC* criterion indicates lag length 5 is appropriate.[71]

The chosen lag length for cointegration test purposes is 5 lags system for industry 27. It is statistically significant at the 5 percent level of F-statistic and is indicated by the *SC* criterion.

The F-test indicates that lag length 3 is significant at the 5 percent level. However, the variable *LIRS29* is statistically significant at the 5 percent level for autocorrelation test. As a result, lag length 4 is preferred for not having evidence of

[70] Only the best cointegration results will be shown.
[71] Since lag length 5 suffers from the vector autocorrelation, the cointegration test should be treated with caution.

autocorrelation. The F-test is statistically significant at the 5 percent level reducing the system to 2 lags from 4 lags.

Table A5.3a: Test of *VAR* system Reduction 5-1 for industry 21

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS21	LPDP21	Vector
5	4.2377**	2.725**	5.1796**	4.2350**	-15.037	-15.211	-15.597	1.2602	0.19142	1.4275
4		3.0825*	4.9663**	3.7214**	-14.829	-15.090	-15.669	3.441*	0.98726	1.604
3			6.3134**	3.7242**	-15.008	-15.355	-16.128	2.5944*	1.9424	2.667**
2				0.93930	-14.974	-15.408	-16.374	10.227**	1.9681	4.1365**
1					-15.039	-15.560	-16.720	7.0338**	1.8487	3.6358**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3b: Test of *VAR* system Reduction 5-1 for industry 22

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS22	LPDP22	Vector
5	1.9838	1.4861	1.8054	3.8070**	-14.874	-15.047	-15.434	1.3145	1.0895	1.6142
4		0.94861	1.6473	4.2373**	-15.196	-15.456	-16.036	1.2122	1.7384	1.5103
3			2.3509	5.8940**	-15.099	-15.446	-16.220	2.2187	0.71859	1.6339
2				8.9623**	-14.899	-15.332	-16.299	4.4041**	0.80252	1.5956
1					-14.787	-15.308	-16.468	13.753**	0.39809	3.6958**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3c: Test of *VAR* system Reduction 5-1 for industry 23

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS23	LPDP23	Vector
5	0.55476	0.50101	0.83547	0.72788	-16.228	-16.401	-16.788	1.1453	0.93584	1.7304
4		0.45590	0.99467	0.80076	-15.980	-16.240	-16.820	0.42775	0.16292	1.0218
3			1.5683	0.99529	-15.824	-16.171	-16.944	0.60984	0.38089	0.92923
2				0.41311	-15.582	-16.016	-16.983	1.0635	1.43	0.65165
1					-15.351	-15.872	-17.031	0.99872	0.33747	0.66613

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3d: Test of *VAR* system Reduction 5-1 for industry 24

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS24	LPDP24	Vector
5	0.77471	1.1214	1.0816	1.3224	-14.948	-15.122	-15.508	3.5826*	0.32745	1.6067
4		1.4822	1.2470	1.5195	-14.821	-15.081	-15.661	1.9641	0.25733	0.83192
3			0.99218	1.5084	-14.620	-14.9667	-15.740	1.6892	0.56948	1.3875
2				2.0253	-14.463	-14.896	-15.863	1.9349	0.74879	1.0826
1					-14.250	-14.771	-15.930	1.8272	1.5664	1.3852

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3e: Test of *VAR* system Reduction 5-1 for industry 25

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS25	LPDP25	Vector
5	3.8428**	2.3070*	3.5216**	3.1316**	-13.230	-13.404	-13.790	1.8944	1.1528	2.3046**
4		0.68798	2.9983**	2.5821**	-13.065	-13.326	-13.905	6.1566**	1.4944	3.0198**
3			5.3771**	3.5747**	-13.182	-13.529	-14.302	5.7119**	1.0439	2.3775**
2				1.5127	-12.960	-13.394	-14.360	7.7369**	0.4352	2.8817**
1					-12.995	-13.516	-14.675	7.5245**	0.38851	2.5003**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3f: Test of *VAR* system Reduction 5-1 for industry 26

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS26	LPDP26	Vector
5	0.91675	1.2921	1.0364	0.86922	-15.440	-15.614	-16.000	0.83445	0.70167	0.59255
4		1.6734	1.1002	0.85641	-15.189	-15.449	-16.029	0.94633	0.46777	1.131
3			0.51287	0.43592	-14.950	-15.297	-16.070	2.5113	0.23944	0.92465
2				0.36596	-14.808	-15.242	-16.208	1.1714	0.2183	1.0567
1					-14.608	-15.128	-16.288	0.5884	0.4243	1.1382

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3g: Test of *VAR* system Reduction 5-1 for industry 27

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS27	LPDP27	Vector
5	3.0635*	1.9189	1.7485	2.2445**	-14.631	-14.804	-15.191	0.90344	1.7986	1.0956
4		0.71191	1.0029	1.8124	-14.603	-14.863	-15.443	0.56475	1.1737	1.2688
3			1.3093	2.3908*	-14.427	-14.774	-15.547	0.82617	0.9091	1.3229
2				3.4307*	-14.207	-14.641	-15.607	1.714	0.73065	1.2788
1					-14.182	-14.703	-15.862	2.0869	3.4032*	2.1429*

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3h: Test of *VAR* system Reduction 5-1 for industry 28

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS28	LPDP28	Vector
5	1.7043	1.0302	1.3357	1.3231	-16.798	-16.971	-17.358	0.82963	1.849	0.83086
4		0.34574	1.1179	1.1613	-17.612	-16.873	-17.452	1.1833	2.084	1.1089
3			1.9419	1.6121	-16.485	-16.832	-17.605	1.0323	2.2511	1.0678
2				1.2367	-16.234	-16.668	-17.634	1.3264	1.3894	1.5464
1					-16.100	-16.621	-17.780	1.4195	0.58501	1.247

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.3i: Test of *VAR* system Reduction 5-1 for industry 29

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation		
								LIRS29	LPDP29	Vector
5	0.94877	1.1127	1.8379	1.5148	-14.123	-14.297	-14.683	2.0297	1.6103	1.4676
4		1.2794	2.2875*	1.7072	-13.882	-14.142	-14.722	2.4257	0.79403	1.2312
3			3.2584*	1.8995	-13.851	-14.198	-14.972	2.9665*	0.66323	1.632
2				0.49652	-13.677	-14.111	-15.078	3.0106*	1.3122	1.6882
1					-13.480	-14.000	-15.160	4.5419**	0.91388	1.4919

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

A5.2 Model 2: *VAR* System Reduction

The variables in the model are tested as a group for cointegration. Since the model is a structural model, using all the variables in the structural model in testing for cointegration is plausible. The system reduction in the price-cost margin equation consists of 6 variables. Variable *PRS* and *PDT* are involved directly in the price-cost margin specification, while variable *IRS*, *PDP* and *PFPD* are involved indirectly through variable *PRS* and *PDT*. As in Model 1, the *VAR* system reduction starts from 5 lags for each variable and is tested down to 1 lag in the *VAR*. Due to the degrees of freedom constraint, lower order of *VAR* model will be preferred if the order of *VAR* is significant, using the F-test, and does not show evidence of autocorrelation.

In Model 2 for the domestic producer share equation, the system consists of 3 variables, namely, the *LSD*, *LPFPD* and *LPFUC*. The *LSD* variable is the dependent variable and *LPFPD* is the independent variable in equation (5.7).

$$(5.7) \quad ln\left[PRS_{i,t}^{-1} - 1\right] = lnb_0 + b_1 ln\left[PFPD_{i,t}\right]$$

Since the variable *PFUC* is used as an instrument for the domestic producer share equation, this variable is included in the *VAR* system. Variable *PFUC* is given in:

$$(5.15) \quad PFUC = \frac{PF}{UC}$$

The variable *LPFUC* is the log of the *PFUC* variable. The *VAR* system is then proceed with the usual reduction manner.

In the budget share equation, the *VAR* system consists of variable *LIRS*, *LPDP* and *LUCP*. The *LIRS* is the dependent variable, while the *LPDP* variable is the independent variable, in equation (5.11) below.

$$(5.11) \quad ln\left[IRS_{i,t}\right] = ln\alpha_i + (1-\sigma) ln\left[PDP_{i,t}\right]$$

The instrument used for the budget share equation estimation is the variable *UCP*.

$$(5.16)\quad UCP = \frac{UC}{P}$$

The log of the variable *UCP*, namely the *LUCP*, is used in the budget share *VAR* system for model 2. The *VAR* system is then tested down to choose the appropriate lag length for the cointegration analysis purposes.

A5.2.1 Model 2: *VAR* System Reduction for PCM, PRS, PDT, IRS, PDP and PFPD

The results for variable *PCM, PRS, PDT, IRS, PDP* and *PFPD* are presented in Table A5.4a-i.For industry 21, lag length 4 is chosen, even though the residuals for variables *PRS21* and *PFPD21* show evidence of autocorrelation with a statistical significance of 10 percent level. As a vector, 4 lags in the *VAR* system is clear from this problem. All the lower order of *VAR*, show evidence of vector autocorrelation. The three criterions, namely the *SC*, *HQ* and *AIC* are of little aid in choosing the lag length for model 2, since the priority is given to the degree of freedom constraint.

The reduction from lag length 3 to 1 is statistically significant at the 10 percent level, yet the reduction from 2 lags in the *VAR* to just one lag is not statistically significant for industry 22. In fact, lag length 3 shows no evidence of autocorrelation for both the individual variables and the vector form. As a result, the *VAR* system of order 3 is chosen to test for cointegration.

The order of 3 *VAR* system is appropriate in testing for cointegration in industry 23, as indicated by the F-test in the system reduction from lag length 3 to lag length 2. Even though the variable *IRS23* shows evidence of autocorrelation at the 10 percent level, the autocorrelation diagnostic for lag length 3 as a vector is statistically insignificant.

For industry 24, the F-test is only found to be significant from the lag length 3 to reduce to 1 lag in the *VAR*. At lag length 3, there is no evidence of autocorrelation. As a result, the *VAR* system of the order 3 is use to test for cointegration property.

Both lag length 5 and 4 are statistically significant at the 10 percent for industry 25. With the degrees of freedom constraint, lag length 4 should be preferred. However,it is unable to provide satisfactory diagnostic test for autocorrelation as a vector for 4 lags in the *VAR*. As a result, lag length 5 will be chosen. In fact, order of 5 in the *VAR* shows no evidence of vector autocorrelation, unlike to all other lag lengths.

The system reductions from lag length 4 to 2 and from lag length 4 to 1 are statistically significant at the 10 percent level for industry 26. As a vector, the lag length 4 is clear from autocorrelation, although all the individual variables are diagnosed with autocorrelation, except for variable PCM26. Since all other lag lengths show evidence of vector autocorrelation, lag length 4 is preferred.

For industry 27, the F-test for lag length 4 is statistically significant at the 10 percent level. At this lag length, the autocorrelation diagnostic is insignificant as compared to all other lower lag lengths. Hence, lag length 4 is appropriate to use in testing for cointegration.

The F-test indicates that lag length 3 is statistically significant at the 10 percent level for industry 28. Furthermore, all other lag length show evidence of autocorrelation for the vector form, except lag length 3.[72] As a result, lag length 3 is chosen as the lag length in testing for cointegration.

The last but not least, for industry 29, the *VAR* system of order 3 is statistically significant at the 10 percent level. All the individual variables are clear from the autocorrelation as in the vector. These estimates suggest that lag length 3 is the appropriate lag length for the *VAR* system.

[72] It is statistically insufficient to provide an autocorrelation diagnostic for 4 lags in the *VAR* as a vector.

Table A5.4a: Test of *VAR* system Reduction 5-1 industry 21 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	1.5807*	1.6929**	1.6784**	1.6505**	-58.830	-59.871	-61.190
4		1.6511*	1.5647*	1.5117**	-57.299	-59.121	-61.180
3			1.3578	1.3152	-56.035	-58.637	-60.436
2				1.2221	-55.265	-58.649	-61.187
1					-54.807	-58.971	-62.248

Autocorrelation

	PCM21	PRS21	PDT21	IRS21	PFPD21	PDP21	Vector
5	0.4485	0.46777	3.5341*	3.2657*	1.7041	2.7425	
4	1.9104	2.8839*	1.5334	1.6241	3.179*	2.6576	1.1229
3	1.2132	2.7023*	.3792	1.5211	0.83014	1.1776	1.5996*
2	1.006	1.5558	4.8822**	5.4636**	1.5257	2.8871*	1.6315**
1	1.8845	1.2701	4.0637**	5.1458**	2.0333	2.2357	1.3996*

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4b: Test of *VAR* system Reduction 5-1 industry 22 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	0.55687	0.93366	1.0298	1.1386	-57.576	-58.617	-59.936
4		1.4574	1.3968*	1.4675*	-56.214	-58.036	-60.095
3			1.2581	1.3787*	-54.868	-57.471	-59.269
2				1.4597	-53.926	-57.310	-59.848
1					-52.247	-56.411	-59.688

	Autocorrelation						
	PCM22	PRS22	PDT22	IRS22	PFPD22	PDP22	Vector
5	1.934	4.5062**	3.2352*	2.942*	2.3112	1.772	
4	2.6471	2.6524	1.0546	0.72403	2.876*	1.6909	0.94901
3	1.4842	2.3319	0.35882	0.5304	1.5251	1.5152	1.123
2	3.6497*	2.3892	0.2746	0.55581	0.77665	1.7737	1.10119
1	3.7643**	1.113	0.61598	1.6005	1.1962	1.9176	1.2902

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4c: Test of *VAR* system Reduction 5-1 industry 23 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	1.0690	0.90920	1.1200	1.1835	-60.697	-61.738	-63.058
4		0.74205	1.1332	1.2075	-59.234	-61.056	-63.115
3			1.6116*	1.5105*	-58.169	-60.771	-62.570
2				1.3153	-56.522	-59.906	-62.444
1					-55.496	-59.660	-65.937

Autocorrelation

	PCM23	PRS23	PDT23	IRS23	PFPD23	PDP23	Vector
5	0.84005	2.1512	2.0688	4.124*	2.466	1.8042	
4	1.3961	0.88655	4.1702**	3.5958*	1.7679	2.1877	1.4955
3	0.6805	1.2376	1.9878	2.736*	1.5522	1.4015	1.3374
2	0.65427	3.6375*	0.26959	0.81075	0.67521	0.36237	1.4572*
1	1.2287	3.206*	0.26401	1.0984	0.93638	0.77767	1.3628*

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4d: Test of *VAR* system Reduction 5-1 industry 24 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	0.92575	0.81753	0.97235	1.0916	-62.040	-63.081	-64.400
4		0.71964	1.0118	1.1654	-60.694	-62.515	-64.574
3			1.3785	1.4614*	-59.446	-62.048	-63.846
2				1.4814	-57.775	-61.158	-63.696
1					-56.576	-60.740	-64.017

Autocorrelation

	PCM24	PRS24	PDT24	IRS24	PFPD24	PDP24	Vector
5	0.73236	1.4983	3.7428*	4.365**	1.6813	2.6607	
4	0.4439	1.3214	1.7813	1.8455	2.588	0.80843	0.78835
3	0.16111	0.85524	0.93923	0.91063	1.9601	0.55194	0.90112
2	0.81409	2.0104	2.7393*	1.6561	0.57412	1.472	1.1261
1	0.46263	2.068	2.4135	1.735	0.47724	0.95647	0.92683

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4e: Test of *VAR* system Reduction 5-1 industry 25 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	1.6791*	1.7540**	1.7196**	1.8769**	-48.336	-49.473	-51.092
4		1.5904*	1.4940*	1.6598**	-47.141	-49.130	-50.713
3			1.2670	1.5225*	-45.819	-48.660	-51.208
2				1.7232*	-45.239	-48.933	-51.444
1					-45.488	-50.034	-53.510

Autocorrelation

	PCM25	PRS25	PDT25	IRS25	PFPD25	PDP25	Vector
5	3.9825*	0.53067	0.3374	0.97638	0.15722	1.5558	1.3444
4	5.9818**	1.9838	3.158*	2.3758	0.70249	1.6678	
3	1.1444	0.41976	0.69221	1.9074	2.9467*	2.2172	2.4815*
2	0.77108	1.4017	1.2553	0.81492	0.69725	1.4395	1.6871*
1	1.7443	3.4646*	3.0959*	4.4254**	0.88751	1.4525	1.5795*

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4f: Test of *VAR* system Reduction 5-1 industry 26 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	1.0423	1.2346	1.3054	1.3827*	-63.757	-64.798	-66.118
4		1.4295	1.4307*	1.4871*	-62.381	-64.203	-66.262
3			1.3537	1.4248*	-61.114	-63.716	-65.514
2				1.4390	-60.146	-63.529	-66.067
1					-59.088	-63.252	-66.529

Autocorrelation

	PCM26	PRS26	PDT26	IRS26	PFPD26	PDP26	Vector
5	3.5551*	4.234*	2.0855	1.7008	1.9994	0.77358	
4	2.1404	7.5122**	3.848*	3.2082*	3.5332*	4.0473*	1.6509
3	1.0881	2.9555*	1.2843	1.1803	2.5784	2.2566	1.8546**
2	3.2154*	1.6905	1.9822	1.2876	4.0001**	1.3338	1.6066**
1	1.3489	1.4998	1.706	1.8147	0.88055	1.717	1.4432*

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4g: Test of *VAR* system Reduction 5-1 industry 27 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	0.89730	1.2412	1.5441**	1.5715**	-55.888	-56.929	-58.249
4		1.6404*	1.9198**	1.8397**	-54.450	-56.272	-58.331
3			2.0299**	1.7703**	-53.695	-56.298	-58.096
2				1.3506	-52.917	-56.300	-58.838
1					-51.682	-55.846	-59.123

Autocorrelation

	PCM27	PRS27	PDT27	IRS27	PFPD27	PDP27	Vector
5	1.2499	1.2329	1.4153	1.6682	3.8965*	1.4124	
4	1.0688	0.83542	0.099893	0.1939	1.2155	0.41967	1.308
3	2.0455	1.8698	0.4868	1.2452	2.1082	1.203	2.1874**
2	0.2365	2.9817*	4.9807**	5.436**	3.7095*	8.2663**	1.5881**
1	1.0066	3.1275*	1.1485	1.8314	1.5483	2.4258	1.5602**

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4h: Test of *VAR* system Reduction 5-1 industry 28 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	1.3891	1.2838	1.4456*	1.5490*	-53.180	-54.317	-55.936
4		1.0853	1.3464	1.4588*	-51.821	-53.810	-55.393
3			1.6008*	1.6251**	-50.820	-53.662	-56.209
2				1.5185*	-49.645	-53.339	-55.851
1					-49.496	-54.052	-57.518

Autocorrelation

	PCM28	PRS28	PDT28	IRS28	PFPD28	PDP28	Vector
5	1.8056	1.4113	0.95797	0.042956	0.77371	5.1386*	3.3294*
4	1.701	2.9088*	0.29582	0.33844	1.8049	6.3345**	
3	2.275	0.99412	0.85357	2.1631	0.43697	5.4308**	1.4257
2	0.28818	0.95981	1.4256	1.2094	1.304	3.9553*	1.9762**
1	2.2242	2.1643	3.1819*	1.4572	2.0184	2.9965*	1.471*

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.4i: Test of *VAR* system Reduction 5-1 industry 29 for Model 2: PCM, PRS, PDT, IRS, PFPD and PDP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC
5	0.95434	1.0884	1.2354	1.6788**	-59.983	-61.023	-62.343
4		1.2420	1.3935*	1.9447**	-59.481	-61.303	-63.362
3			1.5018*	2.2246**	-58.331	-60.933	-62.732
2				2.8210**	-57.188	-60.571	-63.109
1					-56.024	-60.188	-63.465

Autocorrelation

	PCM29	PRS29	PDT29	IRS29	PFPD29	PDP29	Vector
5	1.4752	1.8685	1.2536	6.5017**	1.4236	1.3887	
4	1.1665	2.0119	0.080054	1.3829	2.0219	0.6915	1.0288
3	0.55416	0.56705	0.96145	0.71903	0.31655	0.34537	1.2514
2	0.76006	3.5247*	5.9085**	5.5893**	1.1027	1.4019	1.2855
1	1.4835	2.887*	0.44945	2.6998*	0.56469	1.0148	1.666**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

A5.2.2 Model 2: *VAR* System Reduction for LSD, LPFPD and LPFUC

The *VAR* system reduction results for *LSD*, *LPFPD* and *LPFUC* are presented in Table 5.5a-i. The *VAR* system reduction is not significant in industry 21. Since there is no evidence of autocorrelation at any lag length, the appropriate lag length is determined by the *SC*, *HQ* and *AIC* criteria. According to the *SC* and *HQ* criteria, 5 lags are appropriate as oppose to the *AIC* criterion that chooses 4 lags. Since two of the criteria choose 5 lags, the cointegration analysis will be based on 5 lags in the *VAR* system.

In industry 22, it is statistically significant at the 5 percent level, when the *VAR* system reduces from 5 lags to 4 lags. At this lag length, the *LPFUC* variable shows that there is evidence of autocorrelation at the 1 percent level. However, as a vector, there is no evidence of autocorrelation. Furthermore, since the other lag lengths show evidence of autocorrelation in the vector, 5 lags in the *VAR* system are appropriate.

5 lags in the *VAR* system are significant at the 5 percent level in industry 23. There is no evidence of autocorrelation in the individual variables or in the vector. In fact, the SC and HQ criteria also indicate that 5 lags are appropriate. Hence, 5 lags in the *VAR* system are appropriate.

The system reduction shows that only 3 lags are significant at the 5 percent level in industry 24. At this lag length, there is no evidence of autocorrelation in the residuals of the individual variables and also the variables as a vector. As a result, 3 lags are used for the cointegration analysis.

In industry 25, only lag length 4 is not indicating the evidence of autocorrelation. It is also significant at the 5 percent level when the system reduces from 4 lags to 1 lag. As a consequence, 4 lags in the *VAR* system are chosen.

5 lags are chosen for industry 26 by the *SC* and *HQ* criteria. Since it is not significant in the system reduction, and also there is no evidence of autocorrelation at each lag length, 5 lags are appropriate as indicated by the *SC* and *HQ* criteria.

For industry 27, 3 lags are appropriate in the *VAR* system. 3 lags are significant at the 5 percent level and there is no evidence of autocorrelation in the individual variables and in the variables as a vector.

It is significant at the 5 percent level for the *VAR* system to reduce from 4 lags to 2 lags in industry 28. There is no evidence of autocorrelation at this lag length. Also the *AIC* criterion indicates that 4 lags are appropriate. Hence, 4 lags are used in the cointegration analysis.

Lag length 4 is chosen for the cointegration analysis since it is significant at the 5 percent when the *VAR* system reduces from 4 lags to 3 lags. There is no evidence of autocorrelation at this lag length. Furthermore, the *AIC* also indicates that 4 lags are appropriate.

Table A5.5a: Test of *VAR* system Reduction 5-1 industry 21 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD21	LPFPD21	LPFUC21	Vector
5	1.7044	1.5464	1.4699	1.5189	-20.594	-20.919	-21.644	1.1423	1.2336	1.2755	1.0438
4		1.3338	1.2948	1.3927	-20.237	-20.757	-21.917	1.6351	0.97916	1.1797	1.1089
3			1.2349	1.3950	-19.841	-20.557	-21.152	0.34011	0.68125	0.93684	1.4234
2				1.5402	-19.481	-20.392	-21.422	1.174	0.98415	2.359	1.5062
1					-19.215	-20.321	-21.786	0.6934	2.07	2.0925	1.3469

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5b: Test of *VAR* system Reduction 5-1 industry 22 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD22	LPFPD22	LPFU22	Vector
5	2.0132*	1.8939*	2.7471**	2.6970**	-17.729	-18.054	-18.779	2.4749	2.257	4.2292**	1.1395
4		1.6741	2.9233**	2.7403**	-17.438	-17.958	-19.118	2.2532	1.0968	0.98835	1.689*
3			4.0570**	3.1491**	-17.507	-18.223	-18.818	3.141*	0.77417	0.27495	1.6254*
2				1.9431	-17.211	-18.122	-19.152	2.7987*	0.69835	2.4128	2.1196**
1					-17.006	-18.112	-19.576	6.3801**	0.90487	1.8971	2.2774**

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5c: Test of *VAR* system Reduction 5-1 industry 23 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD23	LPFPD23	LPFUC23	Vector
5	2.1635*	1.8917*	1.8036*	1.7459*	-17.249	17.574	-18.299	1.8971	2.0831	1.5787	1.4857
4		1.5161	1.5117	1.4931	-16.864	-17.384	-18.544	2.5099	1.4793	1.7358	1.712*
3			1.4671	1.4376	-16.510	-17.226	-17.821	1.3924	1.7323	1.5979	1.7494*
2				1.3762	-16.185	-17.096	-18.125	5.1287**	0.3586	1.4103	1.4517
1					-16.008	-17.114	-18.579	4.481**	2.0386	0.79022	1.5583*

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5d: Test of *VAR* system Reduction 5-1 industry 24 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD24	LPFPD24	LPFUC24	Vector
5	0.46556	0.63667	1.1373	1.0908	-18.897	-19.222	-19.947	0.68288	0.57599	1.5367	0.61962
4		0.84010	1.5332	1.3508	-18.435	-18.955	-20.115	0.63137	0.28444	0.9456	0.59602
3			2.2670*	1.6258	-18.220	-18.936	-19.530	0.9532	0.31771	0.35638	0.51271
2				0.92945	-17.763	-18.674	-19.704	4.0318**	0.49127	0.60772	0.95885
1					-17.238	-18.344	-19.809	2.3689	0.4844	1.0558	1.0772

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5e: Test of *VAR* system Reduction 5-1 industry 25 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD25	LPFPD25	LPFUC25	Vector
5	1.4030	1.5089	1.6078*	1.6246*	-18.359	-18.684	-19.409	0.33906	1.8438	1.863	1.6971*
4		1.5802	1.6679	1.6549*	-17.997	-18.517	-19.677	1.554	1.0425	1.3322	1.5389
3			1.7031	1.6355	-17.685	-18.401	-18.995	4.2942**	1.0955	0.1949	1.775*
2				1.5136	-17.371	-18.282	-19.312	5.0038**	0.44167	0.36231	1.8058*
1					-17.045	-18.151	-19.615	3.1099*	0.43143	1.0744	1.4054

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5f: Test of *VAR* system Reduction 5-1 industry 26 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD26	LPFPD26	LPFUC26	Vector
5	1.4321	1.6041	1.2920	1.1378	-18.561	-18.886	-19.611	0.68484	0.33082	0.955	1.2186
4		1.7356	1.1897	1.0116	-18.048	-18.568	-19.728	1.0453	2.4407	2.099	1.0545
3			0.62324	0.62515	-17.539	-18.255	-18.849	3.5939*	0.92784	0.52097	1.34
2				0.64201	-17.255	-18.166	-19.195	2.1591	0.30513	0.37676	1.159
1					-16.934	-18.040	-19.505	2.2398	0.91227	0.38245	1.0397

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5g: Test of *VAR* system Reduction 5-1 industry 27 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD27	LPFPD27	LPFUC27	Vector
5	0.99037	0.91534	1.3402	1.0934	-19.023	-19.348	-20.073	1.1684	1.6405	2.1248	1.6003*
4		0.84306	1.5188	1.1294	-18.454	-18.975	-20.134	0.69413	1.8685	1.8786	1.4643
3			2.2339*	1.2872	-18.234	-18.950	-19.544	0.67688	1.3385	1.2758	1.1699
2				0.33373	-17.778	-18.689	-19.718	2.3424	1.0301	0.69696	1.0433
1					-17.366	-18.472	-19.936	2.5639*	0.88452	0.34805	1.039

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5h: Test of *VAR* system Reduction 5-1 industry 28 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD28	LPFPD28	LPFUC28	Vector
5	1.0506	1.3611	1.5438	1.8546**	-18.822	-19.148	-19.872	0.55356	2.5556	1.8817	1.177
4		1.6746	1.7880*	2.1182**	-18.629	-19.150	-20.310	0.35917	0.3167	0.62298	1.3448
3			1.8348	2.2493**	-18.341	-19.056	-19.651	1.2281	0.37931	0.54239	1.3321
2				2.5578*	-18.045	-18.956	-19.985	2.2421	0.48763	1.3964	1.3783
1					-17.646	-18.752	-20.216	4.5525**	0.31067	2.4769	1.8115**

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.5i: Test of *VAR* system Reduction 5-1 industry 29 for Model 2: LSD, LPFPD and LPFUC

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LSD29	LPFPD29	LPFUC29	Vector
5	1.1735	1.5881	1.1612	1.2285	-18.045	-18.371	-19.095	0.44289	4.9826*	2.7199	0.80954
4		1.9924*	1.1433	1.2335	-17.663	-18.184	-19.344	1.8717	0.99267	1.3652	1.0923
3			0.29061	0.80938	-17.091	-17.806	-18.401	3.8738**	1.2382	1.2907	1.4986
2				1.3946	-16.853	-17.764	-18.794	3.9265**	0.90425	0.30844	1.2517
1					-16.480	-17.586	-19.050	3.2458*	0.75083	0.62567	1.1409

Note: * *indicates statistical significance at the 5 percent level of F-statistic*
** *indicates statistical significance at the 1 percent level of F-statistic*

A5.2.3 Model 2: *VAR* System Reduction for LIRS, LPDP and LUCP

The *VAR* system reduction results for *LIRS*, *LPDP* and *LUCP* are presented in Table 5.6a-i. 5 lags in the *VAR* are chosen for the cointegration analysis in industry 21. It is significant at each reduction from 5 lags and there is no evidence of autocorrelation. Furthermore, the *SC* and *HQ* criteria also indicates 5 lags are appropriate.

For industry 22, 4 lags in the *VAR* are chosen. It is statistically significant at the 5 percent level when the *VAR* system reduces from 4 lags to 2 lags and there is no evidence of autocorrelation in the residuals.

The system reduction is not significant at each lag length in industry 23. Even though the *SC* and *HQ* criteria indicating 5 lags as the appropriate lag length, however, at there is evidence of autocorrelation in the vector. The *AIC* criterion picks up 4 lags and since there is no evidence of autocorrelation, 4 lags are chosen for the cointegration analysis.

For industry 24, 5 lags in the *VAR* are appropriate as indicated by the *SC* and *HQ* criteria. At this lag length, there is no evidence of autocorrelation in the residuals. Since there is no significant statistic in the *VAR* reduction, the *SC* and *HQ* criteria's choice are taken seriously.

4 lags in the *VAR* are chosen for industry 25. The system reduction from 4 lags to 2 lags is significant at the 5 percent level and the *AIC* criterion suggests lag 4 is appropriate. However, this statistic should be treated with caution since there is evidence of autocorrelation.

The criteria of choosing the appropriate lag length depend on the *SC*, *HQ* and *AIC* criteria for industry 26, since there is not significant statistic in the *VAR* reduction. 5 lags in the *VAR* are chosen since the *SC* and *HQ* criteria indicate that this is appropriate and there is no evidence of autocorrleation.

For industry 27, 5 lags are appropriate since it is significant when the *VAR* reduces from 5 lags to 1 lag. There is no evidence of autocorrelation and the *SC* and *HQ* criteria show that this is the appropriate lag length.

The system reduction is not significant at each lag length in industry 28. As a result, the choosing criteria are based on the *SC*, *HQ* and *AIC* criteria. Since *SC* and *HQ* criteria indicate that 5 lags are appropriate and there is no evidence of autocorrelation, 5 lags in the *VAR* are used in the cointegration analysis.

3 lags in the *VAR* are chosen for industry 29 for cointegration analysis purposes. It is significant at the 1 percent level when reduces to 2 lags. There is also no evidence of autocorrelation.

Table A5.6a: Test of *VAR* system Reduction 5-1 industry 21 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS21	LPDP21	LUCP21	Vector
5	2.4721*	2.8868**	3.2658**	2.7049**	-23.215	-23.541	-24.266	2.406	1.5535	1.877	1.0562
4		3.0371**	3.3437**	2.5348**	-22.719	-23.240	-24.400	4.2381**	1.2259	3.4036*	1.3586
3			3.2759**	2.0365*	-22.669	-23.384	-23.979	3.451*	2.2352	1.2875	1.9059**
2				0.73552	-22.615	-23.526	-24.555	11.577**	1.8315	1.9195	2.7763**
1					-22.496	-23.602	-25.067	7.134**	1.7951	2.9582*	2.3639**

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6b: Test of *VAR* system Reduction 5-1 industry 22 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS22	LPDP22	LUCP22	Vector
5	1.6653	1.5558	1.9187**	2.6208**	-21.561	-21.887	-22.612	1.1445	0.846	1.3536	0.92531
4		1.3927	1.9618*	2.8157**	-21.601	-22.121	-23.281	1.0179	2.5238	0.57422	1.3196
3			2.4891*	3.4545**	-21.423	-22.139	-22.733	3.0164*	0.94752	0.57105	1.2296
2				4.1137**	-24.074	-21.985	-23.014	2.7844*	0.86793	4.0261**	1.6216*
1					-20.800	-21.906	-23.371	12.892**	0.7479	2.7545*	2.4699*

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6c: Test of *VAR* system Reduction 5-1 industry 23 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS23	LPDP23	LUCP23	Vector
5	0.78954	0.51044	0.59308	0.72836	-23.202	-23.528	-24.252	1.1887	0.58818	0.84362	1.7021*
4		0.23562	0.48724	0.71878	-22.798	-23.319	-24.479	0.94707	0.20695	2.4316	1.3262
3			0.77880	1.0120	-22.319	-23.035	-23.629	0.61671	0.24318	1.419	1.0411
2				1.2659	-21.739	-22.650	-23.679	0.93686	0.75391	0.86222	0.7227
1					-21.284	-22.390	-23.855	1.0063	0.32488	1.0918	0.79142

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6d: Test of *VAR* system Reduction 5-1 industry 24 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS24	LPDP24	LUCP24	Vector
5	1.4596	1.2438	1.2100	1.3395	-22.120	-22.445	-23.170	1.5664	0.93193	0.83702	0.94231
4		1.0025	1.1106	1.2617	-21.785	-22.305	-23.465	1.5146	1.0716	1.2426	1.1796
3			1.1106	1.3931	-21.367	-22.082	-22.677	1.759	0.85273	0.57135	1.1424
2				1.6723	-20.942	-21.853	-22.883	1.7614	0.78912	0.44977	1.167
1					-20.627	-21.733	-23.198	1.7622	1.7856	0.61752	1.4856

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6e: Test of *VAR* system Reduction 5-1 industry 25 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS25	LPDP25	LUCP25	Vector
5	2.2693*	1.5576	2.2360**	2.5619**	-20.386	-20.712	-21.436	1.1645	1.9768	3.1359*	1.9401**
4		0.79495	2.0513*	2.4526**	-20.249	-20.769	-21.929	5.6994**	1.0804	3.3239*	2.174**
3			3.3965**	3.3409**	-20.217	-20.933	-21.527	4.197**	1.1031	2.5622	2.3436**
2				2.9159**	-19.751	-20.662	-21.692	5.8919**	0.25061	1.064	2.6134**
1					-19.595	-20.701	-22.165	7.284**	0.38673	2.3775	2.745**

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6f: Test of *VAR* system Reduction 5-1 industry 26 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS26	LPDP26	LUCP26	Vector
5	0.78203	1.1185	1.2839	1.1324	-22.780	-23.105	-23.830	0.4666	0.11923	0.39826	0.42068
4		1.4839	1.5611	1.2694	-22.268	-22.788	-23.948	1.088	0.55164	1.7762	0.59382
3			1.5979	1.1301	-21.938	-22.653	-23.248	2.8356*	0.68981	1.0517	0.93643
2				0.64552	-21.606	-22.517	-3.546	1.4994	0.9662	2.4024	1.0833
1					-21.150	-22.256	-23.720	0.64878	0.24258	0.9093	1.2684

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6g: Test of *VAR* system Reduction 5-1 industry 27 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS27	LPDP27	LUCP27	Vector
5	1.9080	1.3473	1.5554	1.7641*	-22.625	-22.950	-23.675	1.3877	1.6332	0.35905	0.90324
4		0.75169	1.3041	1.6192*	-22.373	-22.893	-24.053	0.080228	0.87314	1.1705	0.81845
3			1.8984	2.0919**	-22.095	-22.811	-23.405	0.37273	0.47109	2.1317	0.97384
2				2.1849*	-21.621	-22.532	-23.561	1.0706	1.2785	1.9225	1.137
1					-21.395	-22.501	-23.965	0.92284	3.6377*	0.82265	1.725*

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6h: Test of *VAR* system Reduction 5-1 industry 28 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS28	LPDP28	LUCP28	Vector
5	1.6196	1.1678	1.3395	1.1703	-24.055	-24.380	-25.105	0.63907	1.5625	2.0482	0.95955
4		0.69418	1.1544	0.98154	-23.539	-24.060	-25.219	0.46481	0.97886	1.8189	1.2533
3			1.6557	1.1491	-23.219	-23.935	-24.529	0.88397	1.7463	0.80938	1.1415
2				0.62518	-22.733	-23.644	-24.673	1.2143	1.3753	0.92284	1.1694
1					-22.450	-23.556	-25.021	1.4093	0.60748	1.1353	1.2124

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Table A5.6i: Test of *VAR* system Reduction 5-1 industry 29 for Model 2: LIRS, LPDP and LUCP

Lag Length in *VAR*	4	3	2	1	SC	HQ	AIC	Autocorrelation			
								LIRS29	LPDP29	LUCP29	Vector
5	1.0011	1.2877	1.8303*	1.6238*	-21.258	-21.583	-22.308	1.4797	2.2581	0.56076	1.4676
4		1.5818	2.2510**	1.8333*	-20.787	-21.307	-22.467	0.55842	0.61974	0.79053	1.1061
3			2.8421**	1.8934*	-20.667	-21.382	-21.977	1.9554	0.65582	2.8265*	1.4799
2				0.87495	-20.354	-21.264	-22.294	4.4146**	0.75052	1.5877	1.6997*
1					-19.944	-21.050	-22.514	4.1669	0.94793	1.6833	1.4821

Note: ** indicates statistical significance at the 5 percent level of F-statistic*
*** indicates statistical significance at the 1 percent level of F-statistic*

Data Appendix

Quarter	***PCM21***	***PCM22***	***PCM23***	***PCM24***	***PCM25***	***PCM26***	***PCM27***	***PCM28***	***PCM29***
Sep.1984	0.20866	0.21610	0.26075	0.32891	0.09529	0.25526	0.24850	0.21111	0.22957
Dec.1984	0.22555	0.17044	0.26062	0.32476	0.09275	0.26270	0.24057	0.20947	0.22093
Mar.1985	0.22499	0.20458	0.24896	0.31020	0.09023	0.25765	0.23808	0.20318	0.22646
Jun.1985	0.22006	0.17286	0.24299	0.29246	0.05357	0.25493	0.20996	0.19707	0.22708
Sep.1985	0.22661	0.19731	0.24950	0.30168	0.06393	0.26377	0.21652	0.19557	0.22911
Dec.1985	0.25105	0.15375	0.23665	0.29557	0.04777	0.25495	0.20714	0.17715	0.22117
Mar.1986	0.25032	0.19435	0.23898	0.31068	0.09493	0.26832	0.21772	0.18729	0.21966
Jun.1986	0.25366	0.19287	0.25015	0.33271	0.13552	0.27011	0.24197	0.21552	0.23911
Sep.1986	0.23858	0.16473	0.25161	0.32459	0.10521	0.26870	0.25197	0.20863	0.25380
Dec.1986	0.24639	0.16919	0.23092	0.32315	0.08817	0.24991	0.24804	0.21343	0.22105
Mar.1987	0.25286	0.19157	0.24471	0.34386	0.09429	0.25527	0.25665	0.22383	0.22995
Jun.1987	0.24833	0.16676	0.25139	0.34752	0.10132	0.26837	0.23755	0.22082	0.22630
Sep.1987	0.25491	0.17410	0.25164	0.35200	0.09748	0.26158	0.23754	0.23758	0.23215
Dec.1987	0.27131	0.14813	0.22965	0.33975	0.10370	0.26058	0.24002	0.23180	0.20972
Mar.1988	0.25640	0.14798	0.21632	0.32109	0.11962	0.25999	0.23254	0.22949	0.16600
Jun.1988	0.22493	0.16391	0.24935	0.33860	0.13775	0.26952	0.23979	0.25059	0.22655
Sep.1988	0.24461	0.19364	0.26914	0.33011	0.12630	0.27856	0.24361	0.26617	0.24491
Dec.1988	0.25195	0.15876	0.25731	0.33425	0.16445	0.28201	0.22860	0.25904	0.24260
Mar.1989	0.23704	0.19847	0.25784	0.32236	0.12429	0.29812	0.23236	0.25204	0.25384
Jun.1989	0.23562	0.21026	0.28192	0.32888	0.12443	0.30734	0.22968	0.26266	0.23399
Sep.1989	0.27189	0.20790	0.28494	0.31445	0.24596	0.31671	0.26115	0.28450	0.24079
Dec.1989	0.29715	0.17098	0.27444	0.33553	0.23725	0.30254	0.21635	0.23924	0.22082
Mar.1990	0.28105	0.21046	0.28491	0.33265	0.26420	0.28019	0.23557	0.22318	0.23216
Jun.1990	0.28198	0.23100	0.31193	0.34355	0.28468	0.31782	0.25857	0.24373	0.24769
Sep.1990	0.28401	0.28045	0.30479	0.36883	0.29627	0.31774	0.26796	0.25432	0.25277
Dec.1990	0.30505	0.24345	0.29446	0.37998	0.32606	0.31123	0.26793	0.23780	0.23892

Quarter	***PCM21***	***PCM22***	***PCM23***	***PCM24***	***PCM25***	***PCM26***	***PCM27***	***PCM28***	***PCM29***
Mar.1991	0.29825	0.28033	0.31323	0.37326	0.31825	0.31417	0.26596	0.23297	0.25779
Jun.1991	0.30506	0.31328	0.33673	0.40189	0.29432	0.32589	0.28563	0.28352	0.27131
Sep.1991	0.31728	0.32045	0.34486	0.42205	0.31108	0.34089	0.29200	0.30315	0.29606
Dec.1991	0.32083	0.29016	0.33752	0.40838	0.29861	0.33451	0.27049	0.29958	0.28242
Mar.1992	0.29984	0.29646	0.33941	0.41225	0.30311	0.32726	0.27920	0.29765	0.28182
Jun.1992	0.29805	0.31514	0.35711	0.43891	0.30975	0.32507	0.28381	0.31831	0.26572
Sep.1992	0.29394	0.31543	0.35333	0.43817	0.31831	0.32994	0.29217	0.30278	0.27535
Dec.1992	0.30189	0.28140	0.33954	0.43717	0.32083	0.32301	0.28228	0.29011	0.26852
Mar.1993	0.29936	0.30561	0.34939	0.40409	0.31475	0.32305	0.28753	0.28668	0.26268
Jun.1993	0.31053	0.32261	0.33874	0.42472	0.32525	0.34338	0.29199	0.28165	0.24524
Sep.1993	0.30087	0.31062	0.34800	0.43313	0.30793	0.35180	0.32072	0.29322	0.24971
Dec.1993	0.31000	0.28595	0.36961	0.45414	0.30431	0.32043	0.31102	0.25728	0.25296
Mar.1994	0.30678	0.32065	0.37826	0.44819	0.28094	0.30651	0.31514	0.28163	0.25956
Jun.1994	0.31206	0.32889	0.39965	0.45698	0.31766	0.34899	0.31134	0.28611	0.27315
Sep.1994	0.23226	0.27883	0.25277	0.32615	0.20960	0.26320	0.23259	0.25884	0.26802
Dec.1994	0.23917	0.25599	0.17560	0.34233	0.20985	0.27269	0.21364	0.24624	0.30048
Mar.1995	0.23711	0.26538	0.21341	0.33702	0.21610	0.26875	0.20797	0.25838	0.29490
Jun.1995	0.24015	0.28953	0.24770	0.33040	0.22062	0.24574	0.22280	0.27662	0.29525
Sep.1995	0.23722	0.28214	0.27911	0.34958	0.20878	0.28395	0.22810	0.28312	0.30153
Dec.1995	0.24061	0.26570	0.30773	0.35368	0.21003	0.29678	0.22408	0.26536	0.30083
Mar.1996	0.23516	0.27323	0.24809	0.32703	0.20749	0.32387	0.22247	0.25530	0.29215
Jun.1996	0.22959	0.25723	0.24589	0.32640	0.19971	0.29916	0.22195	0.26484	0.30935
Sep.1996	0.22089	0.29966	0.25629	0.33131	0.19853	0.27037	0.22455	0.26278	0.27972
Dec.1996	0.21378	0.24589	0.21586	0.33543	0.19757	0.27968	0.22022	0.25206	0.28553
Mar.1997	0.21869	0.20678	0.18593	0.31740	0.23408	0.27316	0.21262	0.24285	0.28579
Jun.1997	0.21730	0.23344	0.16381	0.31109	0.22576	0.26570	0.22667	0.24634	0.28358
Sep.1997	0.23088	0.25386	0.18992	0.32715	0.20465	0.26600	0.22009	0.23729	0.24166
Dec.1997	0.22724	0.23541	0.17015	0.32526	0.21865	0.26282	0.21447	0.23519	0.23960

Quarter	*PCM21*	*PCM22*	*PCM23*	*PCM24*	*PCM25*	*PCM26*	*PCM27*	*PCM28*	*PCM29*
Mar.1998	0.22727	0.22625	0.18768	0.32644	0.21271	0.27422	0.20552	0.23356	0.22191
Jun.1998	0.21749	0.21456	0.20264	0.30421	0.19912	0.26223	0.22664	0.25170	0.19836
Sep.1998	0.21259	0.23036	0.22597	0.29503	0.20860	0.26449	0.24580	0.22589	0.20858
Dec.1998	0.21804	0.20122	0.25001	0.29605	0.20320	0.24512	0.23344	0.21212	0.20852
Mar.1999	0.22039	0.21270	0.20791	0.28960	0.20161	0.22115	0.22684	0.18365	0.17852
Jun.1999	0.21296	0.19073	0.19548	0.31576	0.20513	0.25230	0.23232	0.20947	0.22705
Sep.1999	0.20758	0.20237	0.24525	0.30356	0.20882	0.25963	0.22189	0.21627	0.26047
Dec.1999	0.22711	0.17930	0.26170	0.29544	0.21057	0.24741	0.22615	0.22348	0.24884
Mar.2000	0.22622	0.18096	0.23274	0.27997	0.22116	0.27686	0.22985	0.22749	0.26069

Quarter	*DPRS21*	*DPRS22*	*DPRS23*	*DPRS24*	*DPRS25*	*DPRS26*	*DPRS27*	*DPRS28*	*DPRS29*
Sep.1984	0.93530	0.72064	0.80832	0.79026	0.67721	0.91324	0.89706	0.56421	0.75966
Dec.1984	0.93029	0.74227	0.83820	0.79339	0.68621	0.91980	0.89048	0.56652	0.78741
Mar.1985	0.91383	0.65552	0.81625	0.76533	0.66791	0.90157	0.87235	0.53736	0.75173
Jun.1985	0.92105	0.71641	0.81406	0.78700	0.65743	0.90988	0.88334	0.53788	0.74547
Sep.1985	0.91349	0.68162	0.81272	0.77929	0.64397	0.91137	0.86434	0.49546	0.72071
Dec.1985	0.92304	0.71537	0.83210	0.80763	0.68581	0.91864	0.87016	0.50719	0.74708
Mar.1986	0.91407	0.65874	0.83592	0.77580	0.62730	0.91030	0.84523	0.47770	0.74036
Jun.1986	0.91386	0.73051	0.84772	0.78366	0.71004	0.91099	0.86348	0.50818	0.74832
Sep.1986	0.91316	0.68332	0.81915	0.75664	0.68173	0.89966	0.85183	0.51474	0.72703
Dec.1986	0.91138	0.69888	0.85703	0.82969	0.68441	0.92080	0.85567	0.49072	0.74562
Mar.1987	0.89782	0.63953	0.85012	0.78158	0.65936	0.90831	0.84436	0.50460	0.72651
Jun.1987	0.91458	0.69844	0.84538	0.79253	0.68819	0.91206	0.86238	0.53280	0.75579
Sep.1987	0.91335	0.67169	0.82808	0.78104	0.68308	0.91390	0.85976	0.53339	0.73561
Dec.1987	0.91526	0.68028	0.84353	0.79807	0.68778	0.91437	0.85841	0.52587	0.74155
Mar.1988	0.91431	0.60182	0.83203	0.78027	0.65439	0.90605	0.84479	0.50879	0.73274
Jun.1988	0.92094	0.70352	0.83477	0.78775	0.67108	0.90370	0.86477	0.55630	0.75373
Sep.1988	0.92606	0.70113	0.80742	0.79490	0.67998	0.91207	0.86073	0.55533	0.74150
Dec.1988	0.92163	0.72582	0.81420	0.81807	0.70629	0.92167	0.86376	0.54803	0.76935
Mar.1989	0.91478	0.64777	0.77927	0.78071	0.66673	0.91159	0.84028	0.49430	0.71518
Jun.1989	0.91290	0.69532	0.78978	0.79696	0.65673	0.89677	0.83941	0.52180	0.74145
Sep.1989	0.92583	0.67606	0.79494	0.80018	0.67447	0.89808	0.85367	0.50475	0.70944
Dec.1989	0.92296	0.65867	0.82173	0.80241	0.67762	0.90399	0.83653	0.50530	0.74922
Mar.1990	0.92189	0.59426	0.82511	0.79096	0.66721	0.90212	0.84694	0.47362	0.72277
Jun.1990	0.92509	0.69335	0.83435	0.80158	0.67839	0.90292	0.86688	0.51125	0.76557
Sep.1990	0.92576	0.63546	0.83073	0.80486	0.69577	0.90315	0.85808	0.48406	0.76502
Dec.1990	0.93237	0.69129	0.83108	0.83205	0.66729	0.90753	0.83893	0.45924	0.76442
Mar.1991	0.93484	0.62667	0.83618	0.83146	0.63344	0.89853	0.81365	0.43058	0.73146
Jun.1991	0.93010	0.65002	0.83628	0.82911	0.71832	0.89766	0.83102	0.46962	0.73362

Quarter	***DPRS21***	***DPRS22***	***DPRS23***	***DPRS24***	***DPRS25***	***DPRS26***	***DPRS27***	***DPRS28***	***DPRS29***
Sep.1991	0.93039	0.61934	0.83213	0.81605	0.75286	0.89828	0.80553	0.44672	0.72433
Dec.1991	0.91969	0.66405	0.83207	0.83091	0.75439	0.89579	0.80848	0.42686	0.73648
Mar.1992	0.92857	0.61473	0.82837	0.81936	0.71290	0.88565	0.78921	0.41411	0.68991
Jun.1992	0.92777	0.63811	0.82781	0.82040	0.72066	0.89736	0.79922	0.42637	0.74354
Sep.1992	0.92202	0.60203	0.81018	0.82185	0.70187	0.89030	0.76158	0.39802	0.71599
Dec.1992	0.92109	0.65656	0.81098	0.83365	0.70274	0.89414	0.76424	0.38857	0.72436
Mar.1993	0.91777	0.59762	0.81928	0.83382	0.68106	0.90566	0.77906	0.41767	0.72700
Jun.1993	0.91622	0.64059	0.79405	0.84235	0.70362	0.91332	0.79644	0.41396	0.73504
Sep.1993	0.90964	0.61179	0.78362	0.83367	0.68850	0.90397	0.75192	0.40740	0.64920
Dec.1993	0.90778	0.60692	0.80051	0.84129	0.70760	0.90536	0.77490	0.39534	0.67942
Mar.1994	0.91108	0.59866	0.79786	0.85035	0.69820	0.91126	0.75283	0.42247	0.75519
Jun.1994	0.91901	0.58422	0.81054	0.83949	0.70804	0.91329	0.79180	0.41934	0.77392
Sep.1994	0.91452	0.54434	0.80771	0.83589	0.70610	0.91384	0.79234	0.39857	0.71952
Dec.1994	0.90944	0.53295	0.79955	0.84290	0.69907	0.91607	0.79333	0.39734	0.73677
Mar.1995	0.90716	0.50833	0.78422	0.84197	0.68105	0.90938	0.75862	0.37759	0.76775
Jun.1995	0.91300	0.56419	0.78709	0.83753	0.68939	0.90757	0.78391	0.37057	0.78530
Sep.1995	0.90382	0.54094	0.78577	0.83771	0.66941	0.90243	0.77544	0.37642	0.71803
Dec.1995	0.90752	0.54380	0.80324	0.84642	0.70313	0.90793	0.77118	0.37765	0.74217
Mar.1996	0.91176	0.50500	0.81062	0.85435	0.69654	0.90568	0.75694	0.39598	0.73304
Jun.1996	0.90690	0.55013	0.83393	0.86434	0.71201	0.90817	0.76676	0.40323	0.75478
Sep.1996	0.90282	0.51884	0.82303	0.84906	0.69350	0.89625	0.78614	0.41195	0.72592
Dec.1996	0.91068	0.55586	0.82903	0.85004	0.70519	0.90166	0.79383	0.38371	0.70880
Mar.1997	0.90333	0.54123	0.83366	0.86218	0.69832	0.90474	0.75680	0.42079	0.75216
Jun.1997	0.90653	0.56124	0.83157	0.84949	0.70734	0.90489	0.76292	0.37716	0.73408
Sep.1997	0.89841	0.48136	0.82162	0.84513	0.69734	0.89404	0.72312	0.37990	0.68551
Dec.1997	0.89756	0.50403	0.81827	0.84786	0.68683	0.88588	0.65442	0.35099	0.69428
Mar.1998	0.90040	0.47761	0.80112	0.85911	0.67883	0.88774	0.59610	0.36838	0.70347
Jun.1998	0.90029	0.53479	0.82483	0.84368	0.68722	0.88206	0.59041	0.35198	0.65219

Quarter	***DPRS21***	***DPRS22***	***DPRS23***	***DPRS24***	***DPRS25***	***DPRS26***	***DPRS27***	***DPRS28***	***DPRS29***
Sep.1998	0.89925	0.50365	0.81191	0.81926	0.67445	0.88686	0.56560	0.36776	0.61468
Dec.1998	0.89221	0.53788	0.82163	0.81187	0.67248	0.89241	0.60130	0.37213	0.71412
Mar.1999	0.89320	0.50866	0.79718	0.85894	0.65549	0.89265	0.67617	0.37595	0.74090
Jun.1999	0.88758	0.54737	0.82737	0.84575	0.66847	0.89870	0.72809	0.36635	0.70976
Sep.1999	0.88346	0.47543	0.81415	0.85432	0.65550	0.87885	0.69863	0.35932	0.63941
Dec.1999	0.89001	0.47544	0.81337	0.84743	0.64203	0.87008	0.62166	0.30624	0.63545
Mar.2000	0.89133	0.43106	0.80473	0.85078	0.60021	0.87899	0.60419	0.34187	0.64211

Quarter	*IRS21*	*IRS22*	*IRS23*	*IRS24*	*IRS25*	*IRS26*	*IRS27*	*IRS28*	*IRS29*
Sep.1984	0.17449	0.08644	0.07054	0.04273	0.13575	0.05033	0.13850	0.27065	0.03057
Dec.1984	0.18614	0.07686	0.07227	0.04098	0.13218	0.05190	0.13009	0.27767	0.03191
Mar.1985	0.17725	0.07882	0.06801	0.04149	0.14577	0.05109	0.12379	0.28509	0.02870
Jun.1985	0.16003	0.07405	0.07188	0.03990	0.15169	0.05318	0.12987	0.29301	0.02639
Sep.1985	0.14917	0.07914	0.07629	0.04112	0.14831	0.05646	0.11853	0.30153	0.02944
Dec.1985	0.16937	0.07378	0.07744	0.04233	0.13124	0.05768	0.12018	0.29862	0.02937
Mar.1986	0.15635	0.08296	0.07584	0.04011	0.14204	0.05716	0.11715	0.30045	0.02792
Jun.1986	0.15453	0.08208	0.07570	0.03928	0.14550	0.05740	0.12159	0.29453	0.02938
Sep.1986	0.15019	0.08236	0.07342	0.04088	0.13585	0.05479	0.12009	0.31273	0.02968
Dec.1986	0.16133	0.07488	0.07347	0.04592	0.13935	0.05863	0.11287	0.30377	0.02978
Mar.1987	0.15414	0.08234	0.07129	0.04561	0.14907	0.05651	0.11064	0.30118	0.02921
Jun.1987	0.15029	0.07520	0.07373	0.04513	0.15243	0.05750	0.12122	0.29487	0.02962
Sep.1987	0.15147	0.07889	0.07577	0.04642	0.14276	0.05910	0.12317	0.29131	0.03111
Dec.1987	0.16213	0.07268	0.07296	0.04749	0.14032	0.05921	0.12329	0.29079	0.03112
Mar.1988	0.15236	0.08046	0.07132	0.04685	0.14797	0.06205	0.12197	0.28794	0.02909
Jun.1988	0.14800	0.07461	0.06816	0.04378	0.14866	0.05840	0.12798	0.30128	0.02914
Sep.1988	0.15369	0.08109	0.06652	0.04511	0.14030	0.06170	0.12622	0.29507	0.03032
Dec.1988	0.16097	0.07407	0.06432	0.04610	0.13618	0.06066	0.12592	0.30179	0.02999
Mar.1989	0.15936	0.07399	0.05975	0.04383	0.14642	0.06187	0.12869	0.29874	0.02735
Jun.1989	0.14147	0.06680	0.06150	0.04420	0.15394	0.05484	0.13800	0.31089	0.02837
Sep.1989	0.14565	0.07009	0.06403	0.04297	0.14302	0.05845	0.14178	0.30623	0.02777
Dec.1989	0.16122	0.06739	0.06487	0.04536	0.14376	0.05687	0.13282	0.29726	0.03044
Mar.1990	0.16365	0.06653	0.06463	0.04423	0.15215	0.05591	0.13515	0.28989	0.02787
Jun.1990	0.16456	0.06334	0.06448	0.04378	0.15415	0.05352	0.13889	0.28687	0.03041
Sep.1990	0.17034	0.06991	0.06721	0.04757	0.14822	0.05455	0.13519	0.27335	0.03365
Dec.1990	0.20116	0.06163	0.06198	0.04828	0.14812	0.05351	0.12419	0.26977	0.03135
Mar.1991	0.20506	0.06641	0.06144	0.04776	0.15660	0.05019	0.12273	0.26170	0.02810
Jun.1991	0.19439	0.05742	0.06342	0.04407	0.18190	0.04804	0.12882	0.25671	0.02523

Quarter	*IRS21*	*IRS22*	*IRS23*	*IRS24*	*IRS25*	*IRS26*	*IRS27*	*IRS28*	*IRS29*
Sep.1991	0.18333	0.06431	0.06764	0.04891	0.18170	0.04943	0.11681	0.25878	0.02909
Dec.1991	0.19075	0.06107	0.06632	0.05161	0.17727	0.04709	0.11516	0.25959	0.03114
Mar.1992	0.19434	0.07289	0.06613	0.05087	0.18807	0.04709	0.11727	0.23747	0.02588
Jun.1992	0.18948	0.06112	0.06293	0.04898	0.18747	0.04789	0.11783	0.25550	0.02880
Sep.1992	0.18461	0.06483	0.06564	0.05083	0.18557	0.04877	0.10765	0.26063	0.03147
Dec.1992	0.19465	0.06492	0.06471	0.05280	0.17587	0.04732	0.10466	0.26421	0.03085
Mar.1993	0.17810	0.06920	0.06075	0.05246	0.18875	0.05061	0.10826	0.26404	0.02784
Jun.1993	0.16592	0.06620	0.06105	0.05153	0.18507	0.05286	0.11581	0.27308	0.02849
Sep.1993	0.16801	0.06865	0.06538	0.05185	0.17735	0.05204	0.10726	0.27767	0.03180
Dec.1993	0.17110	0.05888	0.06362	0.05454	0.17320	0.05309	0.10577	0.28658	0.03323
Mar.1994	0.16851	0.06565	0.06201	0.05294	0.18170	0.05371	0.10151	0.28206	0.03191
Jun.1994	0.16788	0.05547	0.06296	0.05453	0.17924	0.05634	0.10578	0.28376	0.03403
Sep.1994	0.15972	0.05621	0.06413	0.05100	0.17012	0.05764	0.11357	0.29158	0.03601
Dec.1994	0.16979	0.05062	0.06459	0.05182	0.16787	0.05833	0.10975	0.28886	0.03837
Mar.1995	0.16640	0.05418	0.06368	0.04509	0.17971	0.05653	0.10589	0.29394	0.03457
Jun.1995	0.15778	0.05135	0.06412	0.04611	0.17992	0.05268	0.11102	0.30161	0.03541
Sep.1995	0.15793	0.05703	0.06539	0.04915	0.17433	0.05158	0.11158	0.29492	0.03808
Dec.1995	0.16818	0.04968	0.06547	0.05207	0.18375	0.04862	0.10006	0.29545	0.03671
Mar.1996	0.16471	0.05274	0.06320	0.04814	0.19647	0.04876	0.09779	0.29818	0.03001
Jun.1996	0.15451	0.04838	0.06278	0.04836	0.20096	0.04756	0.09315	0.31226	0.03206
Sep.1996	0.15944	0.05305	0.06497	0.04781	0.18086	0.04671	0.10082	0.30704	0.03930
Dec.1996	0.17670	0.04949	0.06519	0.04867	0.18367	0.04558	0.10012	0.29566	0.03491
Mar.1997	0.15997	0.05530	0.06763	0.04839	0.19209	0.04687	0.09652	0.29998	0.03325
Jun.1997	0.15331	0.05119	0.06502	0.04958	0.19505	0.04731	0.09687	0.30620	0.03547
Sep.1997	0.16153	0.05296	0.06573	0.05165	0.18506	0.04520	0.09101	0.30801	0.03886
Dec.1997	0.17028	0.05013	0.06720	0.05694	0.18412	0.04348	0.08104	0.30801	0.03879
Mar.1998	0.16240	0.05419	0.06342	0.05269	0.19367	0.04466	0.08812	0.30763	0.03322
Jun.1998	0.15540	0.04896	0.06806	0.05245	0.19250	0.04290	0.08809	0.31281	0.03884

Quarter	***IRS21***	***IRS22***	***IRS23***	***IRS24***	***IRS25***	***IRS26***	***IRS27***	***IRS28***	***IRS29***
Sep.1998	0.16110	0.05809	0.06675	0.05042	0.17704	0.04653	0.08323	0.31916	0.03768
Dec.1998	0.16884	0.05056	0.06373	0.05008	0.17831	0.04841	0.08484	0.31498	0.04025
Mar.1999	0.15962	0.05527	0.06434	0.05203	0.18341	0.04866	0.08485	0.31675	0.03507
Jun.1999	0.14552	0.04993	0.06660	0.05377	0.18489	0.05042	0.09109	0.32462	0.03316
Sep.1999	0.15005	0.05570	0.06876	0.05615	0.17276	0.04467	0.09052	0.32448	0.03691
Dec.1999	0.16779	0.04642	0.07203	0.05409	0.17235	0.04158	0.08978	0.32023	0.03572
Mar.2000	0.16319	0.05068	0.07338	0.05124	0.18539	0.04580	0.07894	0.32238	0.02900

Quarter	***PDT21***	***PDT22***	***PDT23***	***PDT24***	***PDT25***	***PDT26***	***PDT27***	***PDT28***	***PDT29***
Sep.1984	0.16320	0.06229	0.05702	0.03377	0.09193	0.04596	0.12425	0.15270	0.02322
Dec.1984	0.17316	0.05705	0.06057	0.03252	0.09070	0.04774	0.11584	0.15730	0.02513
Mar.1985	0.16198	0.05167	0.05551	0.03176	0.09736	0.04606	0.10799	0.15320	0.02157
Jun.1985	0.14739	0.05305	0.05851	0.03140	0.09973	0.04839	0.11472	0.15760	0.01967
Sep.1985	0.13626	0.05394	0.06200	0.03205	0.09551	0.05146	0.10245	0.14940	0.02122
Dec.1985	0.15633	0.05278	0.06443	0.03419	0.09000	0.05299	0.10457	0.15145	0.02194
Mar.1986	0.14292	0.05465	0.06340	0.03112	0.08910	0.05203	0.09902	0.14352	0.02067
Jun.1986	0.14122	0.05996	0.06417	0.03078	0.10331	0.05229	0.10499	0.14968	0.02199
Sep.1986	0.13715	0.05628	0.06015	0.03093	0.09261	0.04929	0.10229	0.16098	0.02158
Dec.1986	0.14703	0.05233	0.06297	0.03810	0.09537	0.05399	0.09658	0.14907	0.02220
Mar.1987	0.13839	0.05266	0.06061	0.03565	0.09829	0.05133	0.09342	0.15198	0.02122
Jun.1987	0.13746	0.05252	0.06233	0.03577	0.10490	0.05245	0.10453	0.15711	0.02239
Sep.1987	0.13835	0.05299	0.06274	0.03626	0.09751	0.05401	0.10590	0.15538	0.02289
Dec.1987	0.14839	0.04944	0.06154	0.03790	0.09651	0.05414	0.10584	0.15292	0.02308
Mar.1988	0.13930	0.04842	0.05934	0.03656	0.09683	0.05622	0.10304	0.14650	0.02131
Jun.1988	0.13630	0.05249	0.05690	0.03449	0.09976	0.05277	0.11067	0.16760	0.02196
Sep.1988	0.14232	0.05685	0.05371	0.03585	0.09540	0.05627	0.10864	0.16386	0.02248
Dec.1988	0.14835	0.05376	0.05237	0.03771	0.09618	0.05591	0.10876	0.16539	0.02307
Mar.1989	0.14578	0.04793	0.04656	0.03422	0.09762	0.05640	0.10814	0.14767	0.01956
Jun.1989	0.12915	0.04644	0.04857	0.03522	0.10109	0.04918	0.11584	0.16222	0.02104
Sep.1989	0.13485	0.04739	0.05090	0.03438	0.09647	0.05250	0.12103	0.15457	0.01970
Dec.1989	0.14880	0.04439	0.05331	0.03640	0.09742	0.05141	0.11110	0.15021	0.02281
Mar.1990	0.15087	0.03954	0.05332	0.03498	0.10152	0.05043	0.11447	0.13730	0.02014
Jun.1990	0.15223	0.04392	0.05380	0.03509	0.10457	0.04832	0.12040	0.14666	0.02328
Sep.1990	0.15769	0.04443	0.05584	0.03829	0.10313	0.04927	0.11601	0.13232	0.02574
Dec.1990	0.18756	0.04261	0.05151	0.04017	0.09884	0.04857	0.10418	0.12389	0.02397
Mar.1991	0.19170	0.04162	0.05138	0.03971	0.09920	0.04510	0.09986	0.11268	0.02055
Jun.1991	0.18081	0.03732	0.05304	0.03654	0.13067	0.04312	0.10705	0.12055	0.01851

Quarter	**PDT21**	**PDT22**	**PDT23**	**PDT24**	**PDT25**	**PDT26**	**PDT27**	**PDT28**	**PDT29**
Sep.1991	0.17057	0.03983	0.05629	0.03991	0.13679	0.04440	0.09409	0.11560	0.02107
Dec.1991	0.17543	0.04055	0.05519	0.04289	0.13373	0.04218	0.09310	0.11081	0.02293
Mar.1992	0.18045	0.04481	0.05478	0.04168	0.13408	0.04170	0.09255	0.09834	0.01785
Jun.1992	0.17579	0.03900	0.05209	0.04018	0.13510	0.04297	0.09417	0.10894	0.02142
Sep.1992	0.17022	0.03903	0.05318	0.04177	0.13025	0.04342	0.08199	0.10374	0.02253
Dec.1992	0.17929	0.04262	0.05248	0.04402	0.12359	0.04231	0.07998	0.10267	0.02235
Mar.1993	0.16346	0.04135	0.04977	0.04374	0.12855	0.04583	0.08434	0.11028	0.02024
Jun.1993	0.15202	0.04241	0.04847	0.04341	0.13022	0.04828	0.09224	0.11304	0.02094
Sep.1993	0.15282	0.04200	0.05124	0.04322	0.12210	0.04704	0.08065	0.11312	0.02064
Dec.1993	0.15532	0.03573	0.05093	0.04588	0.12256	0.04806	0.08196	0.11329	0.02258
Mar.1994	0.15352	0.03930	0.04947	0.04502	0.12686	0.04895	0.07642	0.11916	0.02410
Jun.1994	0.15429	0.03240	0.05103	0.04578	0.12691	0.05146	0.08376	0.11899	0.02634
Sep.1994	0.14607	0.03060	0.05180	0.04263	0.12012	0.05268	0.08999	0.11622	0.02591
Dec.1994	0.15441	0.02698	0.05164	0.04368	0.11735	0.05344	0.08707	0.11478	0.02827
Mar.1995	0.15096	0.02754	0.04994	0.03796	0.12239	0.05141	0.08033	0.11099	0.02654
Jun.1995	0.14405	0.02897	0.05047	0.03862	0.12403	0.04781	0.08703	0.11177	0.02781
Sep.1995	0.14274	0.03085	0.05138	0.04117	0.11670	0.04655	0.08652	0.11101	0.02734
Dec.1995	0.15263	0.02702	0.05259	0.04408	0.12920	0.04415	0.07716	0.11158	0.02725
Mar.1996	0.15017	0.02663	0.05123	0.04113	0.13685	0.04416	0.07402	0.11807	0.02200
Jun.1996	0.14013	0.02661	0.05235	0.04180	0.14308	0.04319	0.07142	0.12591	0.02420
Sep.1996	0.14394	0.02752	0.05347	0.04059	0.12542	0.04187	0.07926	0.12649	0.02853
Dec.1996	0.16092	0.02751	0.05405	0.04137	0.12952	0.04110	0.07948	0.11345	0.02475
Mar.1997	0.14451	0.02993	0.05638	0.04172	0.13414	0.04241	0.07305	0.12623	0.02501
Jun.1997	0.13898	0.02873	0.05407	0.04212	0.13797	0.04281	0.07391	0.11549	0.02604
Sep.1997	0.14512	0.02549	0.05400	0.04365	0.12905	0.04041	0.06581	0.11702	0.02664
Dec.1997	0.15284	0.02527	0.05499	0.04828	0.12646	0.03852	0.05304	0.10811	0.02693
Mar.1998	0.14623	0.02588	0.05081	0.04526	0.13147	0.03965	0.05253	0.11333	0.02337
Jun.1998	0.13991	0.02618	0.05614	0.04425	0.13229	0.03784	0.05201	0.11010	0.02533

Quarter	***PDT21***	***PDT22***	***PDT23***	***PDT24***	***PDT25***	***PDT26***	***PDT27***	***PDT28***	***PDT29***
Sep.1998	0.14487	0.02926	0.05419	0.04131	0.11940	0.04126	0.04708	0.11738	0.02316
Dec.1998	0.15064	0.02719	0.05236	0.04066	0.11991	0.04320	0.05102	0.11721	0.02874
Mar.1999	0.14258	0.02812	0.05129	0.04469	0.12022	0.04343	0.05737	0.11908	0.02598
Jun.1999	0.12916	0.02733	0.05510	0.04548	0.12359	0.04531	0.06632	0.11893	0.02354
Sep.1999	0.13256	0.02648	0.05598	0.04797	0.11324	0.03926	0.06324	0.11659	0.02360
Dec.1999	0.14933	0.02207	0.05859	0.04584	0.11065	0.03617	0.05581	0.09807	0.02270
Mar.2000	0.14546	0.02185	0.05905	0.04360	0.11127	0.04026	0.04769	0.11021	0.01862

Quarter	*PFPD21*	*PFPD22*	*PFPD23*	*PFPD24*	*PFPD25*	*PFPD26*	*PFPD27*	*PFPD28*	*PFPD29*
Sep.1984	1.11033	1.12894	0.90753	0.91773	1.13457	0.86165	0.93496	1.00399	1.07738
Dec.1984	1.10134	1.13757	0.86834	0.89839	1.12476	0.83335	0.94132	0.99280	1.06482
Mar.1985	1.10360	1.16271	0.90621	0.92224	1.16866	0.84421	0.96734	1.02951	1.10259
Jun.1985	1.16420	1.26938	0.99732	1.02259	1.22710	0.96597	1.08600	1.13433	1.22355
Sep.1985	1.12990	1.23886	0.98175	0.99609	1.13561	0.99623	1.09966	1.12799	1.23284
Dec.1985	1.10975	1.30081	1.00136	0.99459	1.16396	1.06416	1.13086	1.16562	1.25366
Mar.1986	1.12665	1.28853	0.97890	0.97138	1.12600	1.09626	1.12744	1.18522	1.22298
Jun.1986	1.13402	1.27559	0.96849	0.95485	0.97641	1.10480	1.12855	1.19220	1.21758
Sep.1986	1.17117	1.37179	1.06216	0.99461	1.02775	1.24911	1.22392	1.35511	1.31246
Dec.1986	1.16990	1.32204	1.04226	1.00190	1.03366	1.22370	1.20634	1.29983	1.27591
Mar.1987	1.18981	1.28460	1.00146	1.00049	1.05792	1.21973	1.17723	1.26366	1.25348
Jun.1987	1.16090	1.22118	0.99258	0.98408	1.04539	1.19784	1.13425	1.22142	1.18743
Sep.1987	1.12391	1.19487	0.98848	0.97794	1.05358	1.14159	1.11185	1.19145	1.18250
Dec.1987	1.15253	1.21210	1.02702	0.98941	1.08719	1.25076	1.12901	1.21686	1.19062
Mar.1988	1.14649	1.17290	1.05200	0.98929	1.05897	1.24652	1.12109	1.20836	1.15936
Jun.1988	1.06628	1.09775	1.02123	0.95552	1.03072	1.18406	1.08354	1.14032	1.09377
Sep.1988	1.00351	1.04266	0.98557	0.95017	0.98884	1.06407	1.06132	1.06393	1.03990
Dec.1988	0.99953	1.00932	0.97534	0.94843	0.94719	1.04374	1.01070	1.04098	1.01177
Mar.1989	0.97830	0.98470	0.94539	0.93009	0.97079	1.00584	0.96734	0.99570	0.98144
Jun.1989	0.99854	1.00757	0.97826	0.97893	1.01356	0.99937	1.03874	1.02129	1.01578
Sep.1989	1.00764	1.01732	1.01157	1.02148	1.01871	1.00377	1.02646	1.02565	1.03863
Dec.1989	0.99250	1.01003	1.00085	1.00168	1.00653	0.97882	0.99227	0.99660	1.00253
Mar.1990	0.99423	0.98592	0.98839	0.99560	1.00841	1.00747	1.01009	0.99753	0.99405
Jun.1990	1.00599	0.98671	0.99732	0.98374	0.96717	1.00687	0.97185	0.98038	0.96797
Sep.1990	0.97458	0.97088	0.95175	0.97107	0.91783	0.99097	0.94645	0.96676	0.94552
Dec.1990	0.98456	0.98882	0.96043	0.93872	0.95520	1.02792	0.96644	1.00445	0.95307
Mar.1991	0.99531	0.97914	0.94018	0.94771	1.02154	1.02470	0.99914	1.01290	0.96493
Jun.1991	1.00096	0.97696	0.92231	0.93034	0.91731	0.97301	1.01282	0.99113	0.95149

Quarter	PFPD21	PFPD22	PFPD23	PFPD24	PFPD25	PFPD26	PFPD27	PFPD28	PFPD29
Sep.1991	0.98332	0.96801	0.90912	0.90412	0.88781	0.95830	1.01877	0.98739	0.92987
Dec.1991	0.97161	0.98716	0.90800	0.87578	0.87833	0.99637	1.03052	0.99383	0.91982
Mar.1992	0.98675	1.01851	0.92539	0.89935	0.87647	1.03622	1.05426	1.02457	0.94301
Jun.1992	1.00282	1.00595	0.93783	0.87342	0.86514	1.04220	1.04251	1.01491	0.93848
Sep.1992	1.02923	1.03443	0.99858	0.87696	0.88378	1.14151	1.06588	1.06062	0.96572
Dec.1992	1.03223	1.05381	1.01839	0.87568	0.90862	1.06423	1.10005	1.09848	0.99421
Mar.1993	1.03199	1.05317	1.02999	0.87653	0.90615	1.05434	1.11548	1.10449	1.01703
Jun.1993	1.01548	1.06642	1.15183	0.85475	0.88846	1.07132	1.12893	1.11492	1.03592
Sep.1993	0.99113	1.08151	1.24295	0.85682	0.90809	1.07444	1.14721	1.15951	1.05328
Dec.1993	0.98729	1.07626	1.29272	0.84671	0.89977	1.09274	1.16207	1.16202	1.05114
Mar.1994	0.95826	1.01760	1.00207	0.95830	0.97987	1.05420	1.10378	1.11965	1.00356
Jun.1994	0.94695	1.00768	0.97743	0.93135	0.96290	1.02580	1.08318	1.11716	0.98238
Sep.1994	0.95841	1.00088	0.96780	0.91176	0.97772	1.02025	1.05870	1.11197	0.97966
Dec.1994	0.97456	0.98399	0.96658	0.89376	0.94934	1.00612	1.02114	1.09294	0.96479
Mar.1995	0.97847	0.98230	0.96848	0.88576	0.97541	1.00175	1.00435	1.09851	0.96600
Jun.1995	1.00935	1.00506	0.99617	0.90829	1.00781	1.04700	1.02278	1.15263	0.98103
Sep.1995	1.02218	0.99676	1.05609	0.87904	1.00197	1.03559	1.03059	1.12265	0.95979
Dec.1995	1.00423	0.98685	1.07052	0.88173	0.99317	1.02792	1.04870	1.08650	0.95064
Mar.1996	0.99156	0.97451	1.05454	0.86986	0.98870	1.02792	1.04550	1.06593	0.94732
Jun.1996	0.97956	0.95008	0.99628	0.84317	0.95882	0.99738	1.02704	1.01348	0.93259
Sep.1996	0.97970	0.94267	0.94578	0.83997	0.95253	1.00960	1.02634	1.00500	0.93215
Dec.1996	0.96972	0.93495	0.93190	0.83554	0.93181	1.01564	1.03174	0.99500	0.91674
Mar.1997	0.96222	0.94147	0.92599	0.84164	0.93026	1.00260	1.00803	0.98947	0.92185
Jun.1997	0.96330	0.94056	0.92263	0.84161	0.93756	0.98966	0.98878	0.98540	0.92851
Sep.1997	0.98509	0.96083	0.94471	0.87346	0.95817	1.00859	0.99638	1.01257	0.94216
Dec.1997	1.01966	1.00130	0.97518	0.91317	0.98540	1.07131	1.02719	1.04466	0.98911
Mar.1998	1.03918	1.02419	0.98843	0.94000	1.01078	1.08476	1.04811	1.06397	1.01339
Jun.1998	1.06764	1.04049	1.01179	0.96362	1.03100	1.13567	1.06601	1.07162	1.03741

Quarter	***PFPD21***	***PFPD22***	***PFPD23***	***PFPD24***	***PFPD25***	***PFPD26***	***PFPD27***	***PFPD28***	***PFPD29***
Sep.1998	1.06402	1.07771	1.04925	1.01047	1.05577	1.20307	1.10480	1.11096	1.09488
Dec.1998	1.04560	1.06688	1.00240	0.99028	1.04247	1.21843	1.12009	1.12346	1.08340
Mar.1999	1.03015	1.05016	0.99394	0.98607	1.01787	1.18190	1.11380	1.11125	1.06358
Jun.1999	1.02142	1.00999	0.99085	0.96173	0.97188	1.11473	1.07633	1.06850	1.02621
Sep.1999	0.97474	0.99537	0.99303	0.93055	0.92771	1.09471	1.05315	1.05743	0.98375
Dec.1999	0.96157	1.01084	1.01992	0.91325	0.94198	1.11509	1.06017	1.07294	0.99838
Mar.2000	0.94649	1.00269	1.01739	0.91263	0.93268	1.09184	1.04482	1.06783	1.03236

Quarter	*PDP21*	*PDP22*	*PDP23*	*PDP24*	*PDP25*	*PDP26*	*PDP27*	*PDP28*	*PDP29*
Sep.1984	0.99933	0.95906	0.99319	1.00356	1.15534	0.99933	0.97675	0.94064	0.93732
Dec.1984	1.00386	0.95885	1.00235	1.00805	1.15392	1.00106	0.96846	0.94005	0.94374
Mar.1985	0.99983	0.96089	1.00426	1.00397	1.16166	0.99845	0.97131	0.93687	0.94183
Jun.1985	0.99570	0.94740	0.99386	0.99034	1.18767	0.98498	0.97536	0.93595	0.92333
Sep.1985	0.99111	0.95497	0.99570	0.99374	1.20445	0.98056	0.96295	0.93906	0.92389
Dec.1985	0.99645	0.95820	1.00081	0.99906	1.18333	0.97947	0.95787	0.94911	0.92593
Mar.1986	0.99401	0.96612	1.00603	1.01201	1.16596	0.97729	0.95093	0.96222	0.94000
Jun.1986	1.01109	0.98725	1.02927	1.03307	1.04520	0.99299	0.96534	0.98646	0.96454
Sep.1986	1.01701	0.98788	1.01960	1.03341	1.02076	0.98041	0.97436	0.99407	0.96906
Dec.1986	1.01307	0.98524	1.01245	1.03889	1.04503	0.97127	0.95690	1.00292	0.97127
Mar.1987	1.00625	0.98962	1.01049	1.03528	1.06029	0.96997	0.95019	1.00762	0.96150
Jun.1987	0.99855	0.99293	1.01311	1.04264	1.05525	0.96876	0.95439	1.01023	0.97472
Sep.1987	0.99793	0.99774	1.00671	1.04122	1.04857	0.97219	0.95877	1.01080	0.97570
Dec.1987	0.99018	1.00021	0.99961	1.03148	1.04458	0.96264	0.96999	1.01694	0.97411
Mar.1988	0.99133	1.00564	0.99541	1.03170	1.03566	0.95095	0.98044	1.01561	0.96778
Jun.1988	0.99014	1.01294	0.99933	1.03535	1.02368	0.96037	0.98095	1.01617	0.97801
Sep.1988	0.99668	1.01192	1.00030	1.03041	1.00385	0.96839	0.98446	1.01776	0.98035
Dec.1988	0.98972	1.00839	1.00003	1.02836	0.99190	0.97791	0.99540	1.02043	0.98435
Mar.1989	0.99347	1.00492	1.00135	1.01886	0.98233	0.98289	1.00471	1.01532	0.98289
Jun.1989	0.99869	0.99756	0.99825	1.00593	0.99671	0.98422	1.00894	1.00296	0.97284
Sep.1989	1.00199	0.99766	0.99426	0.99893	0.99460	0.99281	1.00425	1.00489	0.97854
Dec.1989	1.00555	0.99765	0.99850	0.99447	0.99587	0.99850	0.99559	1.00440	0.99749
Mar.1990	0.99576	1.00644	1.00444	1.00073	1.01048	1.00372	0.99308	0.99837	1.00869
Jun.1990	0.99675	0.99808	1.00249	1.00458	0.99947	1.00556	1.00691	0.99251	1.01438
Sep.1990	0.99132	0.99175	1.00462	1.00101	1.02634	1.01651	0.99631	0.98967	1.00779
Dec.1990	0.97125	0.96845	0.99472	1.00729	1.09911	1.01678	0.98587	0.98057	1.00255
Mar.1991	0.97890	0.98835	1.01365	1.02483	1.04788	1.04588	0.97158	0.99504	1.01717
Jun.1991	0.98634	0.98867	1.01745	1.04097	1.02196	1.05535	0.96801	0.99968	1.02755

Quarter	PDP21	PDP22	PDP23	PDP24	PDP25	PDP26	PDP27	PDP28	PDP29
Sep.1991	0.99374	0.99358	1.02399	1.06069	1.02415	1.05495	0.95147	0.99882	1.03199
Dec.1991	0.99857	0.99370	1.01871	1.07692	1.02702	1.05399	0.94017	1.00092	1.03679
Mar.1992	1.00846	0.99815	1.02448	1.07430	1.01380	1.04472	0.93906	1.00091	1.03804
Jun.1992	1.00872	0.99227	1.02900	1.07806	1.01921	1.03531	0.93865	1.00030	1.03436
Sep.1992	1.00719	0.98255	1.01677	1.07672	1.03227	1.02692	0.94232	1.00034	1.02316
Dec.1992	1.01720	0.97892	1.00894	1.08744	1.03085	1.02563	0.93248	1.00229	1.02375
Mar.1993	1.02134	0.97922	1.01003	1.09136	1.02306	1.02507	0.92518	1.00932	1.02320
Jun.1993	1.02350	0.97337	1.01645	1.09528	1.02505	1.02817	0.91814	1.01090	1.02071
Sep.1993	1.04239	0.97080	1.01873	1.09604	0.99919	1.02297	0.92229	1.00690	1.01835
Dec.1993	1.04257	0.97127	1.02789	1.10542	0.99709	1.02316	0.91502	1.00952	1.02408
Mar.1994	1.04526	0.97760	1.04032	1.11303	0.96726	1.02763	0.91458	1.01636	1.04248
Jun.1994	1.04398	0.97798	1.03787	1.11597	0.97683	1.03751	0.90952	1.01261	1.04767
Sep.1994	1.03893	0.97827	1.03455	1.12535	0.96951	1.04445	0.91705	1.01325	1.03985
Dec.1994	1.03912	0.97431	1.02696	1.12389	0.96398	1.04185	0.93242	1.00709	1.03547
Mar.1995	1.04384	0.96443	1.02118	1.11756	0.96691	1.02945	0.95074	0.99302	1.03125
Jun.1995	1.04329	0.96052	1.01435	1.11249	0.97711	1.01934	0.95333	0.99185	1.02909
Sep.1995	1.03562	0.96341	1.01324	1.14695	0.97978	1.01794	0.95531	0.98842	1.03296
Dec.1995	1.04537	0.96575	1.01781	1.16654	0.97420	1.01353	0.94378	0.98794	1.03918
Mar.1996	1.04601	0.96665	1.01535	1.18019	0.97673	1.01159	0.93851	0.98903	1.03895
Jun.1996	1.03972	0.97096	1.01427	1.18585	0.98555	1.01227	0.92698	0.99836	1.03795
Sep.1996	1.04908	0.97595	1.01444	1.20351	0.97744	1.01713	0.91457	0.99871	1.04642
Dec.1996	1.05270	0.97343	1.01182	1.20587	0.99672	1.01905	0.90259	0.99347	1.05270
Mar.1997	1.04960	0.97124	1.01167	1.20206	0.99849	1.01875	0.90971	0.99060	1.04872
Jun.1997	1.05470	0.97692	1.00967	1.20512	0.97483	1.02127	0.92063	0.98868	1.04590
Sep.1997	1.05662	0.98130	1.00355	1.21069	0.96114	1.01898	0.92975	0.98746	1.04436
Dec.1997	1.06329	0.97629	1.00017	1.20350	0.96858	1.01366	0.92563	0.98583	1.03978
Mar.1998	1.06902	0.97832	1.00738	1.22174	0.94452	1.01928	0.92329	0.98982	1.04284
Jun.1998	1.06745	0.97375	1.00687	1.21969	0.94253	1.01960	0.92619	0.99132	1.04657

Quarter	***PDP21***	***PDP22***	***PDP23***	***PDP24***	***PDP25***	***PDP26***	***PDP27***	***PDP28***	***PDP29***
Sep.1998	1.07092	0.97147	1.00824	1.24275	0.92722	1.01711	0.92785	0.99217	1.05183
Dec.1998	1.07336	0.97831	1.01848	1.25867	0.92566	1.02442	0.91465	0.99209	1.05851
Mar.1999	1.07836	0.98770	1.02568	1.26204	0.91609	1.02914	0.90348	0.99639	1.06429
Jun.1999	1.06693	0.99075	1.02267	1.26291	0.93593	1.02650	0.90003	0.99756	1.07308
Sep.1999	1.06095	0.97605	1.01876	1.28230	0.97959	1.01339	0.89597	0.98500	1.06441
Dec.1999	1.06532	0.96269	1.00688	1.26832	0.98243	1.00049	0.91230	0.97863	1.05338
Mar.2000	1.05009	0.95444	1.01152	1.24802	1.01617	0.98634	0.92924	0.96656	1.03667

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