Effects of Exchange Rates on World Prices of Australian Wool*

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Abstract

Australian wool producers are being told that exchange rate have driven systematic fluctuation in the price of their wool at auction. This paper presents some key findings of a major collaborative study on the effect of exchange rates on Australian wool prices with the Economic Research Centre at the University of Western Australia. The effect of the exporter and importer's market powers on the extent of price changes due to exchange rates, was analysed using Australian Bureau of Statistics wool trade data. The results reflect the extent to which Australian wool exporters or importers of destination countries have "market power" that can be used to their advantage in the form of increasing prices.

Key Words: Exchange rate, wool prices and market power

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1. Introduction

Western Australia accounts for about one-quarter of Australia's wool clip, and almost all of this is exported. In the decade following the collapse of the Reserve Price Scheme in the early 1990s, the Australian wool industry experienced periods of depressed export prices and low profitability. One of the most imminent and critical challenges that Australian wool producers' face is systematic fluctuation of the export price of their products. Producers get the impression that exchange rates have driven systematic fluctuations in price of their wool at auction. However, changes in exchange rate can affect commodity prices both in export and import markets.

This study aims to investigate the relationship between the export price of selected wool from main ports of Australia and the exchange rate between Australia and relevant importing countries by an analysis of Exchange Rate Pass Through (ERPT).

An analysis of ERPT helps to determine the degree of transfer of changes in exchange rate to changes in commodity prices. When a full transfer is occurred, called "Complete ERPT"; when partial, called "Incomplete ERPT"; and called "Perverse (also incomplete) ERPT" when the commodity price is influenced in an unexpected way. Each of the above ERPTs can be either symmetric or asymmetric. That means, when the rate of transfer to a commodity price remains the same in both the appreciation and depreciation periods of the currency the ERPT is symmetric. Otherwise, it becomes asymmetric.

An incomplete and/or perverse ERPT can happen due to profit or market share maximisation behaviour of producers/exporters operating in an imperfectly competitive market environment. An incomplete, perverse and asymmetric ERPT may also happen due to (a) marketing constraints; (b) changes in production technology; and (c) market share objectives of exporters and importers.

This study has three related aims: (i) To analyse how the exchange rate shock is absorbed by the exporter's price and the importer's price, to see how the price Australian wool exporter's receive is affected by exchange rate changes; (ii) to quantify and investigate the differences between the response of wool prices in Fremantle, Sydney and Melbourne when exchange rate changes; and (iii) how origin specific and destination specific variables affect the extent of the impact of exchange rate changes on the export price.

2. Background Literature

The research on the effect of exchange rate shocks on commodity prices received its impetus with the free fluctuation of exchange rates since the post-Bretton Woods era. Since then it is frequently observed that changes in the exchange rates are not fully transferred to commodity prices (called incomplete pass through), or changes in the exchange rate influence commodity prices in unexpected directions (called perverse pass-through). In general, researchers attribute this type of influences to the profit or market share maximisation behaviour of the producers operating in imperfectly competitive markets[1].

Tivig's (1996) research on the perverse pass-through of exchange rates explores the seemingly idiosyncratic phenomena in the context of dynamic oligopoly competition. He theoretically proves that an exporter which aims to maximise its profit over time may change destination prices different from the normal case when the exchange rate changes. For example, while it is expected that the destination price would increase when its currency depreciates, an exporter operating in an imperfect market may strategically decrease its destination price in the current period. While this strategic behaviour is rigorously proved by Tivig (1996) and developed further by Gross and Schmitt (2000), this is in fact an extension of previous studies on incomplete pass-through. That is, the current perverse pass-through is the strategy to take a large market share, and practise the power in the next period to maximise the intertemporal profit, at the expense of the first period's profit loss.

[1] For example, foreign producers may respond to a dollar appreciation of the Australian dollar by partially decreasing their prices (in Australia) and also increasing their profit margins. In this case, the exchange rate pass-through to the importer's price is less than one. In other words, when the exchange rate of the exporter depreciates by 1 percent, its price at destination decreases less than 1 percent, or the elasticity of the exchange rate pass-through is inelastic. On the other hand, in periods of dollar depreciation, it is sometimes observed that the exporter increases its prices but not in the full extent, by also reducing its profit margins, in order to keep up sales and defend its market share. Accordingly the exchange rate pass-through to the importer's price is again less than 1 (for example, Dornbush, 1987; Gagnon & Knetter, 1995; Krugman, 1987; Tivig, 1996; Varangis and Duncan, 1993).

Notwithstanding some unexpected outcomes such as perverse movement or no pass-through of commodity prices, most studies that utilised disaggregated data (such as 4-digit country specific industry data) reported the existence of pass-through. However, the extent of pass-through was partial and differentiated by periods and market structure, across regions and products (for example, Feenstra, Gagnon & Knetter, 1996; Gagnon & Knetter, 1995; Knetter, 1989, Marston, 1990).

While intensive research has been carried out to find the existence of incomplete or perverse pass-through, both theoretically and empirically, on the other hand, the possibility of the asymmetric response was theoretically dealt with by a few economists as early as the mid 1980s (e.g., Foster and Baldwin, 1986). Nevertheless, it was not until the late 1990s that the empirical phase on this asymmetric response of the price to exchange rate fluctuation attracted interest of researchers. The literature on the asymmetric response of trade prices to exchange rate changes is still rare. Only a few papers contribute to both the empirical and theoretical literature in the area. Webber (2000) argues that the theoretical literature offers three basic explanations for asymmetry: (i) marketing constraints, (ii) production technology switching, and (iii) market share objectives.

Foster and Baldwin (1986) believe that the asymmetry may come about because foreign exporters fix the ratio of sales to investment in marketing capacity. When the importer's currency depreciates against the exporters, say 1 percent, if there is insufficient investment in marketing technology, then the exporter will not be able to attract extra importers to buy the product. In this case, the optimal action for the exporter may be to increase export price by 1 percent, which leaves the importer's price stable. Therefore, the import pass-through is zero. In contrast, if the importer's currency appreciates, the increase in import price will lead some importers to leave the market. This reduction in demand will cause a reduction in the market price, which will find pass-through of fluctuation of exchange rates to both export and import price.

The production technology switching is suggested by Ware and Winter (1988). They assume that there exists a price-taking firm that exports to both a domestic and an export market. The firm purchases its inputs from overseas or domestically. When exchange rate changes, the firm can change the source of its inputs and the type of production technology it uses. When domestic currency depreciates, the exporter will switch to domestic inputs (as foreign inputs are now more expensive) and technology. It will increase cost to some degree (as the foreign inputs were cheaper before depreciation), and accordingly increase domestic (export) price. If this increase in exporter's price is the same ratio as the depreciation of the currency, the two effects are offset, and the import pass-through will be zero. During the appreciation phase of domestic currency, the producer will switch to foreign inputs, which reduces cost, and consequently makes the domestic price lower. There is no guarantee that these depreciation effects and appreciation effects are symmetrical.

The third type of explanation for asymmetry was researched by Froot and Klemperer (1989) and Marston (1990), since Krugman (1987) considered "pricing-to-market" behaviour in imperfect markets. This argument is in line with a branch of research conventionally developed in the field of ERPT. In imperfect markets, market price is higher than marginal cost, and the difference is called "mark-up". This price mark-up plays a role of shock absorber, especially when the producer's aim is to capture gains in market share. When the exporter's currency appreciates, if the exporter (producer) wants to keep market share, they will reduce price mark-up (and profit) and try to keep the destination price. In contrast, when the exporter's currency depreciates, they can choose optimal degree of pass through (decreasing the destination price) by absorbing some shock with the mark-up, and transferring some shock to exporting price.

The purpose of this paper is to explore how much of the exchange rate shock is absorbed by exporter and importer's prices, or the ERPT for a variety of wool exported from three major ports in Australia to major destinations. The low value of Australian dollar until 2002 has substantially enhanced the competitiveness of Australian wool in foreign markets, which illustrates clearly the central importance of exchange rates in understanding wool prices. It is expected that Australian currency will become stronger (especially against the US dollar) for a while, which makes it crucial to understand how price of Australia's wool is affected by appreciation. This is particularly important and timely since recent research has found that in an importing country, the price of a given commodity at times does not fluctuate in response to exchange rate changes in the manner predicted by traditional models, such as the law of one price (Goldberg and Knetter, 1997). Some support for this idea is provided by the observation that, while the Australian -dollar price of wool is up by about 40 percent since

October 2001, it is only at its 10-year average price in terms of US dollars. Data and analysis methods used in this study are introduced in the following sections.

3. The Data

Extracts from the Australian Bureau of Statistics (ABS) export database and international trade data were provided by the DAWA, giving a total of 72 observations (monthly data for six financial years from July 1995 to June 2001) for the value and quantity of each type of wool exported and from each state to each destination. The results of the general and preliminary analysis of these data are presented in Tcha (2004) where a graphic and qualitative overview of the trade are provided.

The database holds two variables for a variety of wool exported from each Australian state to destinations: The quantity of export and the value of export for each period. The quantity is given in kilograms while the value is given in current Australian Dollar. The price of wool was computed simply by dividing the value by the quantity yielding to a new variable denominated in AUD/kg.

In some occasions, no trade took place between one exporting state and an import destination. No trade implies a null quantity and value and therefore the price for this period cannot be inferred. Since this study is focusing on the effect of fluctuation of the exchange rate on the fluctuation of domestic export price, we needed to undertake some transformations which enabled us to overcome the missing-observation problem without loosing significant information contained in the original database. Furthermore, minimising the number of missing observations is crucial since the method used is a system estimation[2] whereby a missing observation in one series cancels all the data of the system for this particular point in time. We proceeded with three transformations that are explained on the following pages.

The three main ports for wool exports from Australia are Sydney, Melbourne and Fremantle. Since the trade for wool is an auction taking place at each of the three ports, it is possible to group the six states in three ports linking each exporting state to their closest port. Figure 1 illustrates the grouping,

[2] This is discussed further in Section 4.

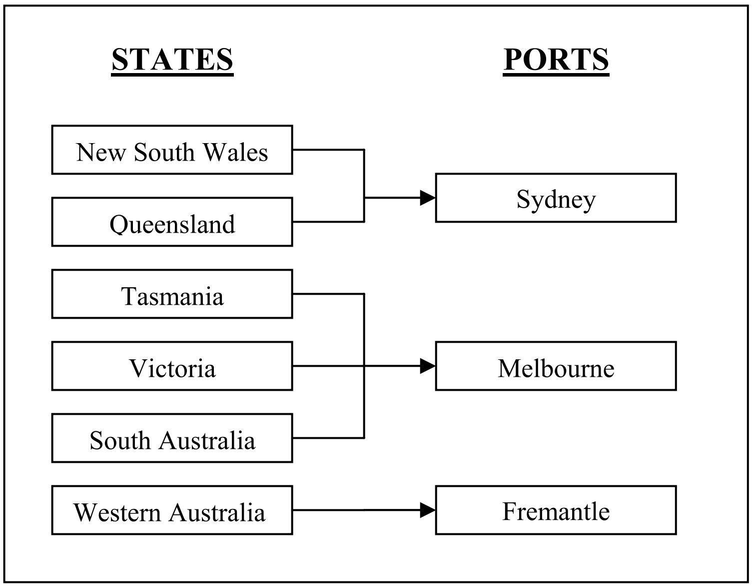

Figure 1. Grouping of states by ports.

The price for Sydney and Melbourne are calculated as a quantity weighted average price based on the export of two or three states. In consequence this initial grouping will yield more continuous sequences for Sydney (SYD) and Melbourne (MEL) but will leave Fremantle (FRE) unchanged. After this first transformation, some variables remained with too many missing values forcing the transformation from monthly data to quarterly. For each quarter a quantity weighted average price was computed. A complete series was therefore made up of 24 observations and Table 1 summarises the state of the variables after the two initial transformations described so far. Three kind of Greasy wool (HS 51011110 Greasy shorn wool (incl. fleece-washed wool), not carded or combed, 19 µm and finer, HS 51011120 Greasy shorn wool (incl. fleece-washed wool), not carded or combed, 20 µm to 23 µm, HS 51011130 Greasy shorn wool (incl. fleece-washed wool), not carded or combed, 24 µm to 27 µm) and one Scoured wool (HS 51211130 Degreased shorn wool, not carbonised, carded or combed, 20 µm to 23 µm) were selected as the number of missing values is too large for other kinds of wool. These Greasy raw wools were labelled as RAW 1, RAW 2 and RAW 3 respectively throughout the paper.

TABLE 1. NUMBER OF OBSERVATIONS IN THE TIME SERIES OF INTEREST

Wool / Destination	Sydney	Melbourne	Fremantle
Greasy (Raw) Wool			
51011110			
China	24	**23**	**21**
France	**23**	24	**22**
Italy	24	24	24
51011120			
China	24	24	24
Czech Republic	**23**	24	24
France	24	24	24
Germany	24	24	24
India	24	24	24
Italy	24	24	24
Japan	**22**	24	**18**
Spain	23	24	**22**
Taiwan	24	24	24
Turkey	**22**	24	24
United Kingdom	**23**	24	24
United States	24	24	**23**
51011130			
China	24	24	**22**
India	24	24	24
Spain	**23**	24	24
Scoured Wool			
51012120			
China	24	24	**19**
Germany	**10**	24	24
India	24	24	24
Italy	24	24	24
Japan	24	24	**22**
Korea, Republic of	24	24	**21**
Malaysia	**22**	24	**17**
Spain	**3**	**22**	**23**
Taiwan	**23**	24	**17**
Thailand	**22**	24	24
Turkey	**13**	24	**23**
United Kingdom	**19**	24	**23**
United States	**13**	24	**22**

Table 1 shows many of the variables are now available as a continuous sequence of 24 observations. The series with darker shading were discarded from the analysis since the number of missing observations remained too large. On the other hand, series highlighted with light shading could be filled doing some extrapolation for the missing observation. The criterion for selecting the series to be extrapolated was a minimum of 21 observations (i.e. a maximum of three missing observations). This extrapolation allowed us to include keeping a wide range of importing countries, which will increase the quality of the system estimation. Note, that the export of scoured wool from Sydney to the United Kingdom present an exception where a series with less than 21 observations was considered for extrapolation. Since the missing values for this particular series were disperse enough, it may be possible to make a sensible extrapolation and again may add some information when estimating the system of equation described later.

The extrapolation was carried out as suggested by Dagenais (1975). He assertes that missing observations can be extrapolated without hurting the result of the original estimation by regressing the variable with unobserved values on independent variables which are not included in the original equation but somehow related to the variable with missing observations. On a quarterly basis, prices from the different exporting port are characterised by smoother fluctuations and a strong positive correlation. This high correlation was highlighted in the main report[3]. Therefore, it is possible to regress one series on another and to use the estimated relationship between the two series to infer the missing values. As shown by Table 1 on the previous page, Melbourne has the greatest number of continuous time series (24 observations) and thus was used most of the time to conduct the extrapolation for the two other ports.

[3] See Tcha (2004).

4. The Exchange Rate Pass Through (ERPT) Model

Most of recent studies on ERPT or PTM have built their models based on Froot and Klemperer (1989) and Knetter (1986). This PTM model involves a firm, which produces and sells identical goods in multiple markets. The firm maximises its profit by selling in n separate markets at different prices, $p_1, \ldots, p_n$. The profit function of the firm is:

$$\Pi(p_1, \ldots, p_n) = \sum_{j=1}^{n} p_j q_j(e_j p_j) - C\left[\sum_{j=1}^{n} q_j(e_j p_j) w\right],$$

where p_j is the price in destination j in the exporter's currency; q_j is corresponding quantity demanded, which is a function of the price in the importer's currency, $e_j p_j$, with e_j the exchange rate (the destination-country cost of a unit of the exporter's currency); and $C(q, w)$ is the cost function, with q denoting total sales and w input prices. The first-order conditions result in the well-known expression for the price in destination j, expressed as a fraction of marginal cost and the elasticity of demand:

$$p_j = MC\,[\xi_j / (\xi_j - 1)], \qquad (1)$$

where ξ_j is the price elasticity of demand in destination j. This first order condition shows that, in imperfect markets, the price of a homogeneous commodity in each market depends on the market structure as represented by the value of the elasticity of demand. One implementation of this approach, which has been widely used since its introduction, was conducted by Knetter (1989), who estimated:

$$\log p_{jt} = \theta_t + \lambda_i + \beta_j \log e_{jt} + \varepsilon_{jt}, \qquad (2)$$

where p_{jt} is the price of exports to country j (in terms of the exporter's currency) measured at the export port; θ_t is a set of time effects; λ_j is a set of destination-specific effects; β_j is the exchange-rate elasticity; e_{jt} is the exchange rate; and ε_{jt} is a disturbance.

In a perfectly competitive market, prices are equalised across destinations, so that $\lambda_j = \beta_j = 0$ for all destinations, and only the time effects will be nonzero as they measure the common price in each period. However, if the market is not perfectly competitive, λ_j and/or β_j will not be zero.

As Australian wool occupies such a large market share in some countries (close to 100% in South Korea, for example), the idea of monopolistic aspects of pricing is particularly appealing. While prior research has investigated the extent to which Australia has market power in the world wool market, no previous study has analysed wool prices within the rigorous PTM framework which emphasises the joint roles of market structure and exchange rates in international pricing. This research aims to reveal how Australian wool exporters react differently (or similarly) to fluctuations in exchange rates between Australia and each of its major trading partners. This study takes into account the impact of the importer's market share, as well as the exporter's market share, as the importer's market power may affect Australia's wool exporters' response to exchange rate fluctuation. Another contribution of this study can be found from the use of highly disaggregated data. Eight-digit wool data, defined by World Trade Organisation (cf. Harmonized System Numbers), which classify each kind of wool by its stage of processing and quality, such as 51012120, which is scoured wool, degreased shorn but not carbonised, carded or combed, and its diameter ranges from 20μm to 23μm. As it is reported that the degree of ERPT depends on the level of data aggregation, it would be erroneous to use the results from aggregated data to derive implication for disaggregated specific products.

Variables and Methods

As discussed in the previous section, monthly data for 1995 to 2001 was converted into quarterly data, which produced 24 observations. For the four types of wool, the price at the exporting port, the wage rate at each and exchange rates were used in regression to estimate the elasticity of pass-through.

It is considered that the market share of each Australian port may affect the magnitude of the elasticity of exchange rate pass-through. Using a panel data set of automobile exports, Feenstra, Gagnon and Knetter (1996) found that the relationship between pass-through and market share is significantly nonlinear. Some other studies also consider the seller's market share, however, it is striking that the buyer's market power has not attracted researchers attention. Taking it into account that the buyer can have a certain degree of market power to negotiate the price and therefore its market share also affects the degree of ERPT, it is surprising that this issue has not investigated intensively in previous works.

From equations (1) and (2), the price of a certain kind of wool exported from port i in Australia to major destination j is affected by the marginal cost of producing wool in each state, which represents the origin-specific effects, and the exchange rate, which is destination-specific (as all the origin ports in Australia are sharing the same currency). Destination specific effects such as GDP, which is most widely used in previous research on ERPT for manufacturing goods are not included in this estimation for two reasons. First, quarterly data of GDP for some major destinations (such as China) is not available for the entire period. In addition, it is considered that the size of the industry that directly consumes wool is not necessarily correlated with the size of the whole economy. Therefore, GDP may be a good explanatory variable of demand for certain products using wool but not for wool itself. As the quarterly data of wool products for each country is not available either, it is not included for the analysis.

When the market is imperfectly competitive, one of the most important variables which may explain a producer's price is the competitor's price. For some kind of wool, Australia has significant competitors in the world market (For example, Uruguay for combed wool and New Zealand for raw and scoured wool). The price data for these competitors for the eight-digit classification is not available in particular in quarterly database. The other possible price variable is the price at the other ports. For example, it is a plausible scenario that Fremantle price is affected by Melbourne price or/and Sydney price. However, the Melbourne price was already used to extrapolate missing observations of Fremantle and Sydney prices and prices at the other ports are not directly used in estimating ERPT.

In consequence, the price from port i to destination j at time t (for simplicity, subscript t for time is not included in the equation) is expressed in terms of the wage and exchange rate, where the coefficient for exchange rate is hypothesised to be affected by port i's market share in country j (= $s_{i\,j}$) and country j's market share in the port i's total export (=$\mu_{i\,j}$). Using double-log, the equation is presented as:

$$\begin{aligned} \ln P_{i\,j} &= \alpha_0 + \alpha_1 \ln w_i + \eta_{ij} \ln e_j + u_{i\,j} \\ &= \alpha_0 + \alpha_1 \ln w_i + (\beta_0 + \beta_1 s_{i\,j} + \beta_2 s_{i\,j}^2 + \gamma_1 \mu_{j\,i} + \gamma_2 \mu_{j\,i}^2)\ln e_j + u_{i\,j} \end{aligned} \quad (3)$$

where i = Fremantle, Melbourne and Sydney, and j is major destination for each type of wool exported from each port. Exporter's and importer's market shares are included as quadratic functions following conventional consideration for exporter's market share as found in Feenstra, Gagnon and Knetter (1996).

The seemingly unrelated regression (SUR) method is used to estimate equation (3). The price of the same kind of wool exported from different ports in Australia would be influenced by certain variables which were not directly included in the equation (such as drought), and consequently the residuals might be correlated one another.[4] Accordingly, the contemporaneous correlation between cross sections and heteroscedasticity are allowed. As there are only 24 quarterly observations for 6 years, the stationarity of variables were not considered as advised by Enders (1998). However, it is suspected that the error term has a first-order autoregressive error structure such as $u_{i\,jt} = \varphi_{i\,j} u_{i\,j,t-1} + \varepsilon_{i\,jt}$. The Durbin-Watson statistics for the data sets used here, from initial estimation, suggested the possibility of autocorrelation and therefore, first order autocorrelation is also allowed.

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4 The SUR estimation method will increase efficiency of the estimator if the errors of the different equations in the system to be estimated are contemporaneously correlated. We can test for contemporaneous correlation using a simple LM test constructed as follow:

$$\lambda = T \sum_{ij} r_{ij}^2$$

where r_{ij}^2 is the squared correlation of the estimator of the variance obtained using OLS on each equation of the system. This test is distributed as $\chi^2(n)$, where n is the number of squared correlations term. For all the system estimated, the test statistic of no contemporaneous correlation is rejected at less than 1% significance level justifying the use of the SUR estimation. Furthermore, it is well known that if the error is not subject to contemporaneous correlation, SUR will be equivalent to standard GLS estimation.

When we denote cross-section observations by subscript h (h = 1, 2, 3…, H) and time series observations by t (t = 1, 2, 3…, T), the contemporaneous correlation between cross sections and heteroscedasticity are presented as $E(u_{ht}u_{kt}) = \sigma^2_{hk}$ and $E(u^2_{ht}) = \sigma^2_{hh}$. We also impose the following assumptions for the error disturbance term: $E(\varepsilon_{ht}) = 0$, $E(u_{h,t-1}\varepsilon_{ht}) = 0$, $E(\varepsilon_{ht}\varepsilon_{kt}) = \phi_{hk}$, $E(\varepsilon_{ht}\varepsilon_{ks}) = 0$ (for $s \neq t$), and $E(u_{ht}u_{kt}) = \sigma^2_{hk} = \phi_{hk}/(1-\varphi_h\varphi_k)$, (Parks, 1967).

With these assumptions on the error structure and components, the covariance matrix for the vector of random errors $\underline{u}$ can be expressed as:

$$E(\underline{u}\underline{u}') = V = \begin{bmatrix} \sigma^2_{11}\underline{\Omega}_{11} & \sigma^2_{12}\underline{\Omega}_{12} & \cdots & \sigma^2_{1H}\underline{\Omega}_{1H} \\ \sigma^2_{21}\underline{\Omega}_{21} & \sigma^2_{22}\underline{\Omega}_{22} & \cdots & \sigma^2_{2N}\underline{\Omega}_{2H} \\ \vdots & \vdots & \ddots & \vdots \\ \sigma^2_{H1}\underline{\Omega}_{H1} & \sigma^2_{H2}\underline{\Omega}_{H2} & \cdots & \sigma^2_{HH}\underline{\Omega}_{HH} \end{bmatrix},$$

where[5] $$\underline{\Omega}_{hk} = \begin{bmatrix} 1 & \varphi_k & \cdots & \varphi_k^{T-1} \\ \varphi_h & 1 & \cdots & \varphi_k^{T-2} \\ \vdots & \vdots & \ddots & \vdots \\ \varphi_h^{T-1} & \varphi_h^{T-2} & \cdots & 1 \end{bmatrix}.$$

The matrix *V* is estimated by a two-stage procedure, and the parameters in equation (3) are then estimated using the general linear squared (GLS) method. A consistent estimator of the first-order autoregressive parameter is obtained as follows:

$$\hat{\varphi}_h = \left(\sum_{t=2}^{T}\hat{u}_{ht}\hat{u}_{h,t-1}\right)\Big/\left(\sum_{t=2}^{T}\hat{u}^2_{h,t-1}\right) \quad h = 1,2,\cdots,H.$$

[5] When autocorrelation is not considered, the matrix $\underline{\Omega}_{hk}$ reduces to identity matrix I_T, and $V = \Sigma \otimes I_T$, where Σ is a variance-covariance matrix of σ_{hk}.

5. Estimation and Discussion

As the ERPT elasticity, which is the coefficient for (ln e), is a function of the exporter's market share and the importer's market share, once β's and γ's are estimated, the estimated ERPT elasticity for the export price at port i to destination j is obtained for all i, j, and t.

$$\frac{\partial \ln P_{ij}}{\partial \ln e_j} = \eta = \beta_0 + \beta_1 s_{ij} + \beta_2\, s_{ij}^2 + \gamma_1\, \mu_{ij} + \gamma_2\, \mu_{ij}^2 \qquad (4)$$

Analyses of ERPT are carried out in four steps, and more detailed discussions on the ERPT and the influence of market powers estimated are presented below.

Step 1. Estimating the ERPT

Tables 2 to 5 summarise the results of estimation of equation (4.3) for the four kinds of wool – RAW1 to RAW3 and Scoured wool - using the SUR method with AR(1). Discussions on the results for each type of wool follow.

RAW1 (Greasy Shorn Wool, not carded or combed, 19μm and finer, 51011110)

Table 2 reports the result of estimation for RAW1. For this type of wool, exports from the three ports to three destinations are examined. For all the three ports, export prices to Italy are positively and significantly affected by wage. It explains that as the wage rate increases by 1% in Australia, the price of wool is affected by 3.6 to 4.9%. For France, the same effect is found from wool from Fremantle and Melbourne, but not from Sydney. China is different from the other two destinations. For instance, export price is not affected by the wage. However, the export price from Sydney to China has a negative coefficient, of which the reason is not clear. For only two out of nine cases (Sydney-Italy and Fremantle-China), no coefficient for export and import market shares turns out to be significant. This result implies that the fluctuation of exchange rate between Australia and Italy does not change the export price of this kind of wool from Sydney to Italy, and that between Australia and China does not affect the export price of this kind of wool exported from Fremantle to China.

TABLE 2. EXPORT PRICE AND EXCHANGE RATE - RAW 1:

	□0	□1	□0	□1	□2	□1	□2	□
	Constant	**Ln(W)**	**Ln(E)**	**s*Ln(E)**	**s^2*Ln(E)**	**µ*Ln(E)**	**μ^2*Ln(E)**	**AR(1)**
				Fremantle				
China	-20.50	3.49	-0.06	0.23	-1.02	0.51	-1.17	0.34*
	(17.94)	(2.61)	(0.91)	(0.64)	(1.14)	(0.65)	(1.03)	(0.18)
France	-30.29***	4.42***	2.81***	-0.97*	1.13	0.79	0.32	0.08
	(5.92)	(0.89)	(0.54)	(0.58)	(0.87)	(1.09)	(2.97)	(0.18)
Italy	-33.95***	3.61***	1.87***	0.16	-0.77	-0.31	0.22*	0.18
	(5.78)	(0.67)	(0.40)	(0.29)	(1.05)	(0.19)	(0.13)	(0.16)
				Melbourne				
China	11.80	-1.36	-0.90	0.03	-0.06	0.74*	-0.85	0.71***
	(11.99)	(1.80)	(0.62)	(0.33)	(0.34)	(0.46)	(0.77)	(0.13)
France	-30.52***	4.94***	0.62	-1.81***	1.77***	6.06**	-22.26	-0.10
	(5.93)	(0.90)	(0.48)	(0.57)	(0.47)	(2.47)	(16.27)	(0.19)
Italy	-21.26***	3.43***	0.35	-0.25	0.33	-0.42***	0.28**	0.41***
	(5.03)	(0.65)	(0.32)	(0.31)	(0.48)	(0.15)	(0.11)	(0.11)
				Sydney				
China	32.72***	-4.48***	-1.03	-1.57***	1.47***	1.11	-1.58	0.28
	(12.19)	(1.74)	(0.64)	(0.37)	(0.47)	(0.94)	(3.15)	(0.16)
France	5.11	-0.76	1.13***	-0.68	0.29	11.72**	-261.92*	-0.10
	(3.28)	(0.49)	(0.37)	(0.44)	(0.59)	(6.28)	(139.26)	(0.10)
Italy	-21.76***	3.58***	0.34	-0.12	0.20	-0.75	0.52	0.44***
	(5.57)	(0.67)	(0.44)	(0.23)	(0.21)	(0.60)	(0.34)	(0.12)

Note: Estimation Method: Seemingly Unrelated Regression (SUR) with AR(1)
Sample: 1995-4 2001-2
Total system observations: 207
Standard error given below the coefficients
***, **, *: Significant at 1%, 5%, 10% Level of Significance respectively
LM Test for Contemporaneous Correlation: $\lambda = 134.57$***

As the export price does not change while the bilateral exchange rate changes, all the fluctuation in the exchange rate is incidental on the price at destination, in other words, the ERPT elasticity is one, or there is complete ERPT. For the other cases, the ERPT elasticity is found to be a function of some variables such as the export and import market share, or non-zero constant. This implies that a certain degree of incomplete, excessive or perverse pass-through exists. Also, depending on the significance and magnitude of each coefficient, the effects of exporter's market share and import market turn out to be different across ports, destinations and type of wools. For example, export prices from Sydney to China are found to be significantly affected by the port's share of the destination's import, while those from Sydney to France and Melbourne to Italy are significantly affected by the buyer's share in the port. Export prices from Melbourne to France are affected by both factors. For export price from Fremantle, the importer's market share is found to be significant for wool to Italy and the exporter's market share is found to be significant for wool to France, although both of them are marginally significant. More discussions on the ERPT exchange rate are presented in Step 2.

<u>RAW2 (Greasy Shorn Wool, not carded or combed, 20μm to 23μm, 51011120)</u>

The results of estimation for RAW 2 are summarised in Table 3. The price of this type of wool exported from Fremantle and Melbourne are positively affected (or insignificant) by the increase in wage. A 1% increase in wage in each state results in a 1.4 to 4.5% increase in the export price of this wool from each port. In contrast, this wage effect appears to be strongly negative in Sydney as was found for RAW 1. For 12 major destinations, the coefficient of the wage is found to be significant for 6 cases, where 5 of them were negative. Only the export price to Italy was positively affected by the increase in wage (the elasticity is 5.3). In case of the export price to the US, the elasticity is as low as –2.8, indicating that a 1% increase in wage rates in Sydney area, decreases the price to the US by 2.8%. It implies the squeezing of Australian wool exporters' profit, as the increase in wage is not properly transferred to the export price. In case of Fremantle, its export price to four economies (Czech, Spain, Taiwan and the UK) was found to be completely independent of exchange rate. As discussed for RAW1, this implies that as the export price does not change when exchange rate changes, all the changes in exchange rate are completely transferred to the destination price, namely complete ERPT is revealed. In other words, Australian exporters in the port are completely risk-safe from the fluctuation of exchange rate with these economies, receiving fixed price in Australian dollar, regardless of bilateral exchange rate. This complete pass-through is also found for two cases from Melbourne (to Japan and Turkey) and three cases for Sydney (to France, Taiwan and the UK). It is noteworthy that the export price to Taiwan and the UK does not change (or the complete ERPT) from the two ports. While Turkey experiences the same phenomenon for export from one port only (Melbourne), for the other two ports, the level of significance of coefficients is at margin (10%).

TABLE 3. EXPORT PRICE AND EXCHANGE RATE – RAW 2

	α_0 Constant	α_1 Ln(W)	β_0 Ln(E)	β_1 s*Ln(E)	β_2 s^2*Ln(E)	γ_1 μ*Ln(E)	γ_2 μ^2*Ln(E)	φ AR(1)
				Fremantle				
China	-4.71	1.17	2.09	-17.73**	28.02**	-0.08	0.43	0.21
	(18.19)	(2.71)	(1.37)	(7.85)	(12.72)	(1.16)	(1.69)	(0.17)
Czech	-1.23	0.34	0.15	0.01	-0.04	-0.78	7.94	0.52***
	(5.96)	(0.86)	(0.32)	(0.11)	(0.10)	(0.97)	(10.18)	(0.09)
France	-30.40***	4.54***	2.34***	-1.55	3.23	0.42	-2.50	0.10
	(6.01)	(0.93)	(0.71)	(1.90)	(2.36)	(1.55)	(3.92)	(0.15)
Germany	-5.39	1.05	0.02	-1.88	2.48	9.37*	-36.49	0.67***
	(5.90)	(0.92)	(0.26)	(2.10)	(3.69)	(5.44)	(31.03)	(0.10)
India	4.33	-0.10	-0.56	-0.83**	0.92***	0.43	-2.06	0.69***
	(6.81)	(0.92)	(0.38)	(0.26)	(0.28)	(0.45)	(1.82)	(0.11)
Italy	-29.90***	3.62***	1.09**	0.39	-0.65	1.06*	-6.50*	0.17
	(4.95)	(0.58)	(0.43)	(0.37)	(0.75)	(0.62)	(3.56)	(0.17)
Spain	-5.89	1.60	-0.48	0.11	-0.28	2.79	-125.96	0.52**
	(7.50)	(1.03)	(0.49)	(0.11)	(0.24)	(3.87)	(231.05)	(0.18)
Turkey	-5.61	1.28	-0.08	-0.09*	0.11*	0.49	-5.34	0.56**
	(8.71)	(1.54)	(0.12)	(0.05)	(0.07)	(0.67)	(14.33)	(0.18)
Taiwan	3.58	0.21	-1.15	-2.24	9.07	1.16	-9.40	0.73***
	(12.72)	(1.79)	(0.68)	(1.49)	(5.66)	(1.39)	(9.92)	(0.10)
United Kingdom	-6.51	1.31	0.60	-0.08	0.04	-9.20	67.15	0.34**
	(8.29)	(1.33)	(0.43)	(1.41)	(4.77)	(10.21)	(171.66)	(0.15)
United States	-7.21	1.34	0.19	-1.18	1.95	-27.10***	162.68**	-0.12
	(8.53)	(1.36)	(0.39)	(1.92)	(4.23)	(10.20)	(82.60)	(0.14)

Total system observation: 253
LM Test for Contemporaneous Correlation: λ = 132.97***

TABLE 3. CONTINUED.

	□0 Constant	□1 Ln(W)	□0 Ln(E)	□1 s*Ln(E)	□2 s^2*Ln(E)	□1 μ*Ln(E)	□2 $μ^2$*Ln(E)	□ AR(1)
				Melbourne				
China	-9.15	1.66*	-0.12**	1.07	-1.21	-0.76**	0.87*	0.68***
	(6.11)	(0.92)	(0.39)	(1.26)	(1.42)	(0.39)	(0.48)	(0.07)
Czech	-11.72	1.90*	0.29***	-0.14	0.21	0.94	-17.64	0.75***
	(7.59)	(1.16)	(0.22)	(0.15)	(0.24)	(1.36)	(22.40)	(0.07)
France	-9.44**	1.72***	0.00***	0.50	-1.11	-3.45	19.95	0.42***
	(4.40)	(0.67)	(0.40)	(1.02)	(1.47)	(2.77)	(13.28)	(0.12)
Germany	-3.94	0.84	0.11	-4.21	6.36*	12.40	-76.00	0.65***
	(6.36)	(0.99)	(0.65)	(2.97)	(3.61)	(9.51)	(54.67)	(0.09)
India	-6.51	1.40**	-0.29	-0.40*	0.58**	-0.97	15.43**	0.86***
	(4.35)	(0.64)	(0.27)	(0.21)	(0.29)	(0.80)	(7.75)	(0.04)
Italy	-5.00	0.67	0.43	-0.68***	1.02***	-0.39	1.67	0.53***
	(5.64)	(0.76)	(0.29)	(0.18)	(0.25)	(0.63)	(3.19)	(0.12)
Japan	-18.19*	2.58	0.71	0.19	-0.10	-1.28	30.41	0.30
	(11.25)	(1.69)	(0.50)	(0.17)	(0.14)	(2.29)	(34.77)	(0.18)*
Spain	-0.57	1.05	-1.01**	-0.19	0.13	0.29	-42.25	0.27
	(5.61)	(0.80)	(0.41)	(0.13)	(0.11)	(3.27)	(155.17)	(0.18)
Turkey	5.08	-0.85	0.15	0.00	-0.02	0.67	-3.79	0.64***
	(9.29)	(1.62)	(0.14)	(0.07)	(0.10)	(1.25)	(41.50)	(0.13)
Taiwan	-15.43***	2.98***	-0.75	-0.64**	0.70**	0.76	-2.43	0.85***
	(4.57)	(0.72)	(0.24)	(0.30)	(0.33)	(0.65)	(2.32)	(0.05)
United Kingdom	-38.14	4.00***	-2.59	6.63**	-5.44***	-9.33	73.52	1.00***
	(228.52)	(1.09)	(1.23)	(2.98)	(2.13)	(7.67)	(46.68)	(0.06)
United States	-6.49	1.22	0.08**	-0.65	0.46	4.21	-71.72**	0.79***
	(8.06)	(1.26)	(0.37)	(0.74)	(0.57)	(3.45)	(37.37)	(0.09)

Total system observation: 276
LM Test for Contemporaneous Correlation: □ = 300.23***

TABLE 3. CONTINUED.

	$\square_0$ Constant	$\square_1$ Ln(W)	$\square_0$ Ln(E)	$\square_1$ s*Ln(E)	$\square_2$ s^2*Ln(E)	$\square_1$ µ*Ln(E)	$\square_2$ μ^2*Ln(E)
				<u>Sydney</u>			
China	5.27	-0.64	-0.69*	-0.03	7.70	-37.73***	242.41*
	(5.65)	(0.89)	(0.38)	(2.56)	(5.64)	(8.88)	(144.34)
Czech	5.85	-0.78	-0.42	-0.75	2.35	-14.86***	74.03
	(4.13)	(0.65)	(0.25)	(0.79)	(2.37)	(5.95)	(100.22)
France	10.74*	-1.43**	-0.04	0.29	-0.42	-0.92	1.29
	(5.83)	(0.73)	(0.52)	(0.89)	(1.05)	(1.00)	(3.15)
Germany	-3.54	1.00	-0.12	-0.13***	0.12*	2.59***	-42.73***
	(4.08)	(0.69)	(0.04)	(0.04)	(0.06)	(0.67)	(17.36)
India	0.93	0.01	0.03	-0.24***	0.42***	9.50***	-360.49***
	(3.00)	(0.44)	(0.24)	(0.07)	(0.11)	(1.55)	(59.03)
Italy	-34.13***	5.13***	0.57	0.22	-0.48**	2.06***	-5.31**
	(10.06)	(1.45)	(0.55)	(0.19)	(0.23)	(0.72)	(2.70)
Japan	6.09***	-0.58**	-0.03	-0.12	-0.09	-0.61***	2.16***
	(2.37)	(0.25)	(0.23)	(0.20)	(0.25)	(0.25)	(0.81)
Spain	20.88***	-2.13***	-1.73***	-0.76	1.34	4.27**	-50.34*
	(3.77)	(0.45)	(0.44)	(0.51)	(1.31)	(2.07)	(28.36)
Turkey	4.92	-0.59	0.15	-0.26*	0.20	-0.52	4.64
	(3.95)	(0.60)	(0.29)	(0.15)	(0.19)	(0.72)	(4.45)
Taiwan	-2.25	0.50	-0.26	3.59	-6.53	1.61	-2.84
	(2.51)	(0.38)	(0.39)	(2.25)	(4.19)	(1.63)	(6.92)
United Kingdom	7.72***	-0.96***	-0.43	-3.92	3.90	5.19	27.47
	(2.11)	(0.33)	(0.56)	(2.80)	(3.77)	(5.41)	(28.11)
United States	20.20***	-2.82**	-0.88**	4.86***	-9.86***	-0.80	2.16*
	(5.50)	(0.81)	(0.30)	(1.72)	(3.58)	(0.77)	(1.31)

Total system observation: 288
LM Test for Contemporaneous Correlation: □ = 248.08***
Note: Estimation Method: Seemingly Unrelated Regression (SUR) with AR(1)
For Fremantle and Melbourne and SUR only for Sydney.
Standard error given below the coefficients
***, **, *: Significant at 1%, 5%, 10% Level of Significance respectively

RAW3 (Greasy Shorn Wool, not carded or combed, 20µm to 23µm, 51011120)

Table 4 summarises the results of the estimation for RAW3. For two cases out of nine, Fremantle-Spain and Melbourne-India, the export price is not affected by the exchange rate. For the other cases, export market shares and/or import market shares were found to affect the export price. In particular, Australia's wool exporters do not practise any market power, or pricing-to-market behaviour to India, as found from the results that the coefficient for linear and quadratic terms of the export market share is always insignificant, regardless of the exporting port. In fact, the coefficients for India's importing share turn out to be significant for export price at Fremantle and Sydney, implying that it practices market power to Australian exporters. For this kind of wool, it is found that the increase in wage rate is not transferred to export price, except only one case, from Melbourne to Spain.

Scoured wool (Degreased Shorn Wool, not carbonised, carded or combed, 20µm to 23µm, 51012120)

For this type of wool, we could find 9 major destinations for Fremantle, 11 for Melbourne and 9 for Sydney. Among the nine destinations from Fremantle, Japan is the only market where the complete ERPT is found. When the bilateral exchange rate between Australia and Japan fluctuates, it is found that the export price at Fremantle in Australian dollar does not change, which implies that, all other things being equal, the price in the Japanese market fluctuates by the same proportion. For Italy, while market shares do not appear to be significant, the constant ERPT is found to be 0.83. The US is the only market where both exporter's and importer's market shares are related to the ERPT elasticity. For the remaining cases, either exporter's or importer's market share matters.

The 12 major markets for Melbourne, the complete pass-through is found from 5 cases, to Germany, Italy, Japan, Korea and the UK. For Spain and Turkey, the constant pass-through, -0.82 and –0.32, are observed respectively. For Malaysia, Thailand and Taiwan, only Australia's market power works, and India is the only country where only the importer's market power matters. Both exporter's and importer's market power are found significant for this ports export to the US.

TABLE 4. EXPORT PRICE AND EXCHANGE RATE - RAW 3

	□0 Constant	□1 Ln(W)	□0 Ln(E)	□1 s*Ln(E)	□2 s^2*Ln(E)	□1 µ*Ln(E)	□2 μ^2*Ln(E)	□ AR(1)
Fremantle to China	-2.03	0.73	-0.70	-0.26	0.49	-0.25	0.39*	0.66***
	(11.11)	(1.64)	(0.56)	(0.41)	(0.81)	(0.21)	(0.23)	(0.10)
India	32.01***	-3.61***	-2.40***	-0.33	1.14	0.64***	-1.31***	-0.51***
	(3.12)	(0.41)	(0.34)	(0.31)	(0.75)	(0.18)	(0.35)	(0.16)
Spain	-7.61	1.44	-0.14	0.06	-0.06	0.01	0.05	0.74***
	(7.20)	(1.01)	(0.36)	(0.06)	(0.07)	(0.06)	(0.06)	(0.12)
Melbourne to Italy	2.23	-0.05	0.09	-1.08**	0.72**	-0.25	0.23	0.65***
	(5.78)	(0.86)	(0.41)	(0.53)	(0.37)	(0.65)	(0.46)	(0.09)
India	8.99	-0.86	-0.70	-0.11	0.10	0.20	-0.49	0.83***
	(8.38)	(1.19)	(0.60)	(0.29)	(0.22)	(0.26)	(0.76)	(0.10)
Spain	-16.67**	2.66**	0.09	0.19*	-0.26**	0.32*	-0.81**	0.76***
	(7.49)	(1.15)	(0.34)	(0.10)	(0.12)	(0.16)	(0.36)	(0.09)
Sydney to China	-1.17	0.50	-0.42	-6.70***	24.50***	1.51***	-1.16***	-0.46***
	(3.86)	(0.54)	(0.26)	(0.94)	(3.64)	(0.22)	(0.23)	(0.16)
India	50.51***	-5.56***	-4.23***	0.40	-0.52	1.20*	-4.43***	0.12
	(8.32)	(0.90)	(1.01)	(0.37)	(0.98)	(0.38)	(1.25)	(0.24)
Spain	8.07**	-0.33	-1.08***	0.28*	-0.45**	0.06	-0.15*	0.28
	(3.38)	(0.42)	(0.34)	(0.15)	(0.22)	(0.09)	(0.09)	(0.21)

Note: Estimation Method: Seemingly Unrelated Regression (SUR) with AR(1)
Sample: 1995-4 2001-2
Total system observations: 207
Standard error given below the coefficients
***, **, *: Significant at 1%, 5%, 10% Level of Significance respectively
LM Test for Contemporaneous Correlation: □ = 107.34***

TABLE 5. EXPORT PRICE AND EXCHANGE RATE - SCOURED

	□0 Constant	□1 Ln(W)	□0 Ln(E)	□1 s*Ln(E)	□2 s^2*Ln(E)	□1 μ*Ln(E)	□2 $μ^2$*Ln(E)	□ AR(1)
				Fremantle				
Germany	13.92***	-1.91***	-0.18	-0.43	0.10	-10.75*	39.86**	0.47***
	(4.63)	(0.73)	(0.61)	(2.24)	(2.33)	(6.49)	(18.94)	(0.17)
India	19.58***	-2.62***	-0.29	-0.70**	1.06*	0.82*	-1.26	0.08
	(5.72)	(0.73)	(0.55)	(0.34)	(0.62)	(0.46)	(2.15)	(0.18)
Italy	-6.91*	0.42	0.83**	-0.03	-0.15	0.15*	-0.04	0.17
	(4.05)	(0.50)	(0.31)	(0.15)	(0.18)	(0.09)	(0.12)	(0.16)
Japan	2.75	-0.65	0.75	-0.61	1.04	1.02	-3.96	0.34*
	(16.74)	(2.36)	(0.64)	(0.61)	(1.44)	(1.33)	(5.72)	(0.18)
Korea	1.61	-1.17	1.16***	-0.81	2.29	3.63***	-30.12***	-0.29
	(9.78)	(1.59)	(0.35)	(0.61)	(2.18)	(1.42)	(9.40)	(0.18)
Spain	-18.18	2.24	1.20	-0.15	0.03	6.69***	-77.79**	0.76***
	(19.66)	(2.92)	(0.69)	(0.10)	(0.09)	(2.03)	(31.40)	(0.11)
Thailand	-9.91	1.52	0.63**	-0.17	0.35	0.94***	-2.88***	0.72***
	(8.61)	(1.33)	(0.23)	(0.31)	(0.56)	(0.35)	(0.96)	(0.09)
United Kingdom	37.05***	-5.69***	-1.48**	4.19***	-5.05***	-2.45	-1.87	0.40**
	(11.98)	(1.93)	(0.57)	(0.81)	(1.18)	(5.63)	(35.43)	(0.16)
United States	-19.95***	3.42***	0.75**	2.38***	-0.46	-21.65***	37.94***	-0.63***
	(6.20)	(0.99)	(0.33)	(0.77)	(1.70)	(1.76)	(10.63)	(0.13)

Total system observations: 207
LM Test for Contemporaneous Correlation: □ = 93.06***

TABLE 5. CONTINUED

	□$_0$ Constant	□$_1$ Ln(W)	□$_0$ Ln(E)	□$_1$ s*Ln(E)	□$_2$ s^2*Ln(E)	□$_3$ μ*Ln(E)	□$_4$ $μ^2$*Ln(E)	□ AR(1)
				Melbourne				
Germany	7.18	-0.84	0.23	-0.57	0.55	-15.90	464.28	0.43**
	(6.77)	(1.06)	(0.90)	(2.92)	(3.00)	(39.76)	(890.89)	(0.18)
India	3.41	1.06	-2.63***	0.12	-0.04	-0.99***	3.03***	0.94***
	(5.01)	(0.74)	(0.38)	(0.14)	(0.12)	(0.30)	(0.97)	(0.07)
Italy	-3.17	0.79	0.06	0.06	-0.04	0.06	0.09	0.72***
	(7.11)	(1.01)	(0.31)	(0.11)	(0.12)	(0.16)	(0.52)	(0.09)
Japan	-7.43	1.34	0.19	-0.09	0.08	0.22	-0.68	0.68***
	(6.49)	(0.98)	(0.24)	(0.12)	(0.09)	(0.35)	(0.91)	(0.11)
Korea	-15.84*	2.96**	-0.17	-0.04	0.04	-0.03	0.25	0.80***
	(8.21)	(1.27)	(0.17)	(0.07)	(0.05)	(0.19)	(0.71)	(0.08)
Malaysia	6.62	-0.69	-0.65*	1.70***	-1.59***	0.65	0.37	0.54***
	(7.19)	(1.12)	(0.34)	(0.65)	(0.54)	(1.90)	(7.59)	(0.20)
Spain	17.68**	-1.89	-0.82*	-0.01	-0.04	-1.56	154.56	0.50***
	(8.61)	(1.30)	(0.46)	(0.08)	(0.07)	(3.98)	(173.42)	(0.11)
Thailand	5.39	-0.75	0.49***	-0.46**	0.53*	0.60	-2.83	0.62***
	(4.03)	(0.64)	(0.12)	(0.23)	(0.29)	(0.58)	(2.55)	(0.07)
Turkey	-25.61*	4.91*	-0.32**	-0.03	0.01	-0.81	11.88	-0.38*
	(14.79)	(2.58)	(0.14)	(0.06)	(0.05)	(0.79)	(14.28)	(0.20)
Taiwan	14.21	-1.48	-0.91	-0.31**	0.29**	-0.67	11.83	0.56***
	(10.48)	(1.50)	(0.55)	(0.15)	(0.13)	(1.30)	(11.63)	(0.10)
United Kingdom	-9.62	1.74	-0.09	-0.10	0.29	-9.04	52.04	0.67***
	(7.95)	(1.25)	(0.33)	(0.67)	(0.48)	(6.35)	(62.35)	(0.09)
United States	-11.29	2.02	-1.33	6.92***	-4.94***	-24.62***	124.55***	0.67***
	(10.13)	(1.60)	(0.88)	(2.04)	(1.36)	(4.72)	(32.64)	(0.16)

Total system observations: 276
LM Test for Contemporaneous Correlation: □ = 200.71***

TABLE 5. CONTINUED

	$\square_0$ Constant	$\square_1$ Ln(W)	$\square_0$ Ln(E)	$\square_1$ s*Ln(E)	$\square_2$ s^2*Ln(E)	$\square_3$ μ*Ln(E)	$\square_4$ μ^2*Ln(E)	$\square$ AR(1)
				Sydney				
China	16.68**	-1.99*	-1.34***	1.23**	-2.14***	0.74	-12.28	-0.23
	(7.45)	(1.08)	(0.37)	(0.54)	(0.76)	(1.88)	(8.87)	(0.17)
India	23.38***	-2.86***	-0.94*	-0.33***	0.65***	0.66***	-0.57	0.49***
	(4.10)	(0.53)	(0.53)	(0.12)	(0.19)	(0.15)	(0.43)	(0.18)
Italy	23.80***	-3.50***	0.11	-0.47**	1.18**	0.46	-3.28**	0.01
	(6.23)	(0.73)	(0.48)	(0.20)	(0.56)	(0.35)	(1.44)	(0.17)
Japan	-3.18	0.57**	0.30	0.32***	-0.32**	-0.31	0.60*	0.69***
	(6.42)	(0.87)	(0.28)	(0.13)	(0.16)	(0.19)	(0.33)	(0.12)
Korea	15.31**	-1.64	-0.42	-0.07	0.06	0.43*	-1.51	0.57***
	(7.11)	(1.01)	(0.28)	(0.10)	(0.13)	(0.26)	(1.04)	(0.14)
Malaysia	6.93*	-0.80	0.31	-4.55***	6.95***	8.03***	-17.59***	-0.56***
	(3.84)	(0.60)	(0.21)	(0.83)	(1.28)	(1.32)	(3.57)	(0.17)
Thailand	0.11	0.11	0.32	1.18***	-1.04***	-2.09***	3.86***	-0.65***
	(2.06)	(0.33)	(0.05)	(0.19)	(0.24)	(0.20)	(0.42)	(0.09)
Taiwan	38.82***	-4.82***	-1.92***	-0.09	0.06	-2.08*	24.80***	-0.41**
	(5.69)	(0.67)	(0.49)	(0.21)	(0.24)	(1.15)	(9.26)	(0.20)
United Kingdom	8.53	-1.16	-0.98*	2.95	-4.29	-9.75	-4.49	0.60***
	(7.44)	(1.19)	(0.53)	(3.08)	(9.19)	(25.67)	(687.10)	(0.16)

Note: Estimation Method: Seemingly Unrelated Regression (SUR) with AR(1)
Sample: 1995-4 2001-2
Total system observations: 207
Standard error given below the coefficients
***, **, *: Significant at 1%, 5%, 10% Level of Significance respectively
LM Test for Contemporaneous Correlation: $\square$ = 79.38***

Only one complete pass-through is found for scoured wool export from Sydney, to the UK. For India, Italy, Malaysia and Thailand, the two market shares matter. For China and Japan, Sydney's ERPT is affected by its market share in their imports, and for Taiwan, importer's market share turns out to be significant. Changes in wage rates give mixed results. While the export price for Fremantle to the US, Melbourne to Korea, Melbourne to Turkey and Sydney to Japan are positively affected, for the other cases, it turns out either insignificant or negative.

Step 2. Estimating ERPT Elasticities

Based on the findings in Tables 2 to 5, the elasticity of ERPT for each case for each type of wool is constructed, by using the export and import shares for each trade partners in given time, such as:

$$\eta_{ijt} = \hat{\beta}_0 + \hat{\beta}_1 s_{ij\,t} + \hat{\beta}_2 \; s_{ijt}^2 + \hat{\gamma}_1 \mu_{ijt} + \hat{\gamma}_2 \mu_{ijt}^2.$$

As discussed previously, we have the four types of wool under examination, which are exported from the three Australian ports. For RAW1 and RAW3, there are 3 major destinations, and for RAW2 and Scoured wool, 9 to 12 major destinations for each port. This altogether produces 83 trade cases. Since the elasticity using above equation is for each period (quarter), we have 24 ERPT elasticities for each of 83 cases. In this paper, average ERPT elasticity (over 24 quarters) is computed for each case, using the average export and import shares. This is discussed in Step 3.

Step 3. Computing Average ERPT Elasticity

The average ERPT elasticity for each type of wool from each port i to each destination j is computed where the bar means the average over 24 quarters, such as"

$$\overline{\eta}_{ij} = \hat{\beta}_0 + \hat{\beta}_1 \bar{s}_{ij} + \hat{\beta}_2 \; \bar{s}_{ij}^2 + \hat{\gamma}_1 \bar{\mu}_{ij} + \hat{\gamma}_2 \bar{\mu}_{ij}^2.$$

Before the results are discussed, it will be helpful to investigate the structural relationship between the magnitude of the elasticity of export ERPT and that of import ERPT, as many previous research concentrates on import ERPT. In this study, due to the availability of data and our major concern on Australian export price, we use the export price.

TABLE 6. THE EXPORT ERPT ELASTICITY AND IMPORT ERPT ELASTICITY

Magnitude of Export ERPT Elasticity	Phase of Pass-Through
$0 < \eta$	**Excessive** The import price moves in the expected direction but the effect is excessive.
$\eta = 0$	**Complete** The import price moves in the expected direction, and all the exchange rate shock is absorbed by the import price.
$-1 < \eta < 0$	**Incomplete** The import price moves in the expected direction, and the exchange rate shock is shared by the exporter and importer.
$\eta = -1$	**No Pass-Through** The import price does not change.
$\eta < -1$	**Perverse** The import price moves in the unexpected direction.

Suppose the transport cost and other transaction cost such as tariff are ignored.[6] The type of ERPT may be categorised in following five cases, which is also summarised in Table 6.

(1) When $0 < \eta$

It is possible to have the export ERPT larger than zero. This means that when the Australian currency appreciates (depreciates), the export price also increases (decreases), which make the destination price increase (decrease) even more than 1%. This is the excessive ERPT.

(2) When $\eta = 0$

When the destination price changes as much as change in exchange rate (in proportion) when the export ERPT elasticity is zero. In other words, when Australian dollar appreciates (depreciates) by 1% and the export ERPT is zero, then the export price does not change, which indicates that the destination (import) price increases (decreases) by 1% in local

[6] It is reported that only China among major importers of Australian wool imposes tariff on raw wool, which is still low, and stable.

currency. As discussed earlier, this is "complete ERPT" case in previous studies where import prices were examined.

(3) When $-1 < \eta < 0$

In the same 1% appreciation (depreciation) case, if the export ERPT ranges from zero to minus one, then the export price decreases (increases) less than one percent, which implies that the import price increases (decreases) more than zero but less than one percent[7]. Therefore we can observe "incomplete ERPT".

(4) When $\eta = -1$

This is the case whereby the export price decreases by 1% when Australian dollar appreciates by 1%. Therefore, while the export price decreases, the destination price is not affected.

(5) When $\eta < -1$

If the export ERPT is found to be smaller than –1, a 1% appreciation (depreciation) results in a decrease (increase) in the export price more than 1%, which implies that the destination's import price decreases (increases) more than one percent and we observe "the perverse" ERPT.

Inserting the average exporter's market share and the importer's market share over the 24 quarters, the average ERPT elasticity over the period for each port and destination is also computed. Table 4.6 reports these average export ERPT elasticities.

For RAW1, five cases are found to have normal ERPT, where two cases (Fremantle to China and Sydney to Italy) are complete pass-through, and three cases (Melbourne to France and to Italy, and Sydney to China) are incomplete pass-through. No perverse pass-through is reported, meaning that for this wool, the export price responds to the bilateral exchange rate in the expected direction. Nonetheless, for four cases, the export price is found to react to exchange rate fluctuation too sensitively, where two of them are for Fremantle (to France and to Italy). For another 28 cases, the response is in the expected direction but the magnitude is too high. Perverse pass-through, which is the case where the export price (and so import price) moves in different directions from expectation, is reported for eight cases, for only RAW3 (three cases) and scoured wool (five cases). For RAW3, it is found that export price

[7] Recall that the exchange rate used in this study is the value of Australian currency in terms of relevant foreign currency. A 1% appreciation of Australian dollar therefore increases the exchange rate.

from Fremantle to India decreases (increases) by 3.35% when Australian dollar appreciates (depreciates) by 1%. As a result, *ceteris paribus*, the price of this wool in India will decrease

TABLE 7. AVERAGE ERPT ELASTICITIES AND MARKET SHARE

Types of Wool	Exporting Port	Destination	Elasticity	Phase of Pass-Through	Market Share (%)	Import Share (%)
Greasy (≤19μm) **51011110**	**Fremantle**	China	0.00	Complete	12.93	16.59
		France	2.58	Excessive	22.76	8.27
		Italy	1.64	Excessive	12.09	75.14
	Melbourne	China	0.17	Excessive	53.90	23.26
		France	-0.04	Incomplete	50.75	5.73
		Italy	-0.15	Incomplete	32.44	71.01
	Sydney	China	-0.31	Incomplete	33.17	8.11
		France	1.19	Excessive	26.49	1.98
		Italy	0.00	Complete	55.47	89.91
Greasy (20 -23μm) **51011120**	**Fremantle**	China	-0.59	Incomplete	28.52	34.81
		Czech	0.00	Complete	32.92	3.26
		France	2.34	Excessive	42.06	17.31
		Germany	1.02	Excessive	33.51	10.93
		India	-0.18	Incomplete	47.92	10.69
		Italy	1.13	Excessive	26.01	9.45
		Spain	0.00	Complete	19.78	0.51
		Turkey	-0.01	Incomplete	40.81	2.30
		Taiwan	0.00	Complete	13.70	5.20
		UK	0.00	Complete	16.53	1.53
		USA	0.02	Excessive	15.17	2.37
	Melbourne	China	-0.28	Incomplete	46.16	36.80
		Czech	0.29	Excessive	28.63	1.94
		France	0.00	Complete	31.29	9.31
		Germany	0.87	Excessive	35.76	8.62
		India	-0.12	Incomplete	35.52	5.77
		Italy	-0.11	Incomplete	35.36	9.73
		Japan	0.00	Complete	43.9	3.00
		Spain	-0.01	Incomplete	45.73	0.81
		Turkey	0.00	Complete	34.87	1.52
		Taiwan	0.24	Excessive	45.15	12.26
		UK	-0.05	Incomplete	64.81	3.62
		USA	1.96	Excessive	65.76	6.63

Continued on next page

TABLE 7. CONTINUED

Types of Wool	Exporting Port	Destination	Elasticity	Phase of Pass-Through	Market Share (%)	Import Share (%)
	Sydney	China	-0.92	Incomplete	25.31	27.20
		Czech	-0.02	Incomplete	38.45	4.34
		France	0.00	Complete	26.65	10.78
		Germany	0.13	Excessive	30.73	10.56
		India	-0.01	Incomplete	16.55	3.61
		Italy	-0.05	Incomplete	38.63	15.04
		Japan	0.10	Excessive	45.62	7.04
		Spain	0.07	Excessive	34.50	0.94
		Turkey	-0.03	Incomplete	24.32	1.35
		Taiwan	0.00	Complete	41.15	14.71
		UK	0.00	Complete	18.66	1.72
		USA	-0.14	Incomplete	19.06	2.70
Greasy (24 -27µm) **51011130**	**Fremantle**	China	0.11	Excessive	16.71	46.79
		India	-3.35	Perverse	18.92	15.65
		Spain	0.00	Complete	33.73	37.56
	Melbourne	China	-0.40	Incomplete	74.34	70.32
		India	0.00	Complete	67.28	14.12
		Spain	0.05	Excessive	38.01	15.56
	Sydney	China	0.00	Complete	8.95	38.92
		India	-5.17	Perverse	13.81	11.77
		Spain	-2.02	Perverse	28.26	49.31
Scoured (20 -23µm) **51012120**	**Fremantle**	Germany	-0.39	Incomplete	52.07	6.03
		India	-0.01	Incomplete	19.31	9.22
		Italy	0.87	Excessive	41.06	26.66
		Japan	0.00	Complete	10.76	7.62
		Korea	1.23	Excessive	11.41	4.24
		Spain	0.08	Excessive	47.56	1.78
		Thailand	0.69	Excessive	20.48	10.81
		UK	-0.78	Incomplete	33.14	6.72
		USA	0.39	Excessive	31.36	8.63
	Melbourne	Germany	0.00	Complete	43.65	12.06
		India	-2.69	Perverse	55.43	14.33
		Italy	0.00	Complete	47.29	18.31
		Japan	0.00	Complete	53.55	10.24
		Korea	0.00	Complete	58.67	10.10
		Malaysia	-0.97	Incomplete	52.34	0.77
		Spain	-0.82	Incomplete	48.62	9.41
		Thailand	-1.23	Perverse	40.06	2.46
		Turkey	3.91	Excessive	64.79	2.45
		Taiwan	-0.03	Incomplete	40.85	4.39
		UK	0.00	Complete	59.84	5.01
		USA	1.48	Excessive	64.74	7.49

Continued on next page

TABLE 7. CONTINUED

Types of Wool	Exporting Port	Destination	Elasticity	Phase of Pass-Through	Market Share (%)	Import Share (%)
	Sydney	China	-1.22	Perverse	24.98	11.13
		India	-0.90	Incomplete	25.26	6.17
		Italy	-0.05	Incomplete	11.65	24.66
		Japan	0.11	Excessive	35.68	9.59
		Korea	0.04	Excessive	29.92	14.29
		Malaysia	-0.03	Incomplete	33.10	19.11
		Thailand	0.07	Excessive	39.47	0.53
		Taiwan	-1.95	Perverse	44.33	4.98
		UK	-1.16	Perverse	7.02	0.85

by 2.35%, due to a 1% decrease in India's currency value. While no perverse pass-through is found for exports from Melbourne, two cases are reported for Sydney: To India (-5.17) and Spain (-2.02). For scoured wool, no perverse case is found for exports from Fremantle. Two and three cases are reported for export price at Melbourne and Sydney respectively; Melbourne-India, Melbourne-Thailand, Sydney-China, Sydney-Taiwan and Sydney-the UK. It is noteworthy that perverse pass-through is frequently observed for Australia's exports to India. While it was suggested by Tivig (1996) that perverse pass-through can be a rational reaction to maximise dynamic profit, it is questionable whether this finding of perverse pass-through for Australia's wool export is truly due to that strategic behaviour.

Figures 2 summarises the distribution of ERPT elasticities, using a histogram. It shows that for 83 cases for all the ports to all the destinations for all types of wool, complete or incomplete pass-through ($-1< \eta = 0$) is found for 47 cases, which is about 57% of the total cases.

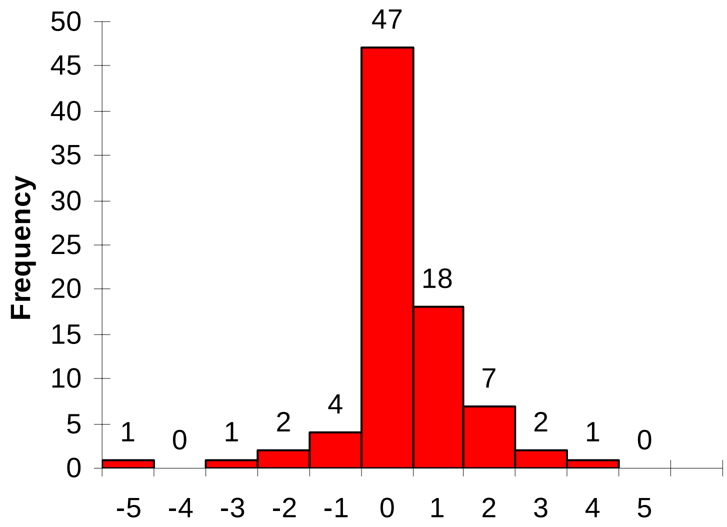

FIGURE 2. FREQUENCY OF ERPT ELASTICITIES – ALL WOOL

As we have only nine cases for RAW 1 and RAW 3, histograms are provided for RAW 2 and scoured wool only, which are presented as Figures 3 and 4. First of all, notwithstanding a high level of disaggregation, it is significant that the normal pass-through (including both complete and incomplete pass-through) is dominating; 24 cases out of 35 (or 69%) for RAW 1 and 15 cases out of 30 (or 50% for scoured wool). It is noteworthy that while five perverse cases are found from scoured wool, there is virtually no perverse pass-through for RAW 2. The frequency of excessive pass-through ($\eta > 0$) is roughly similar for both kinds of wool.

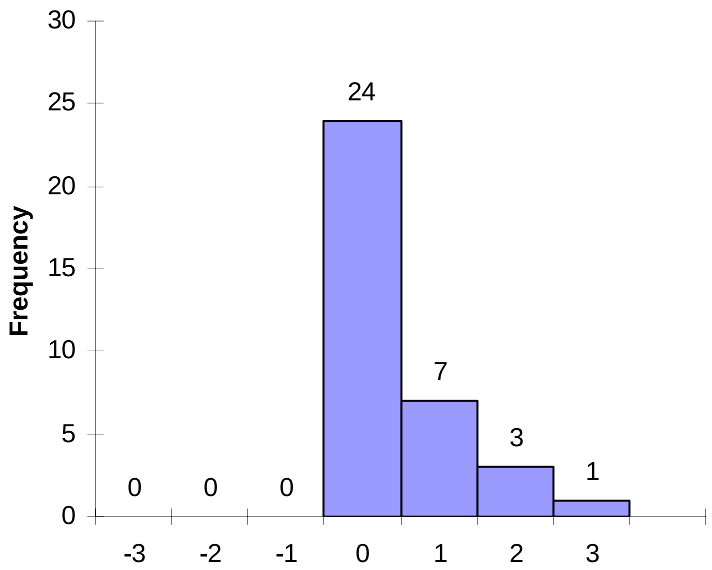

FIGURE 3. FREQUENCY OF ERPT - RAW 2

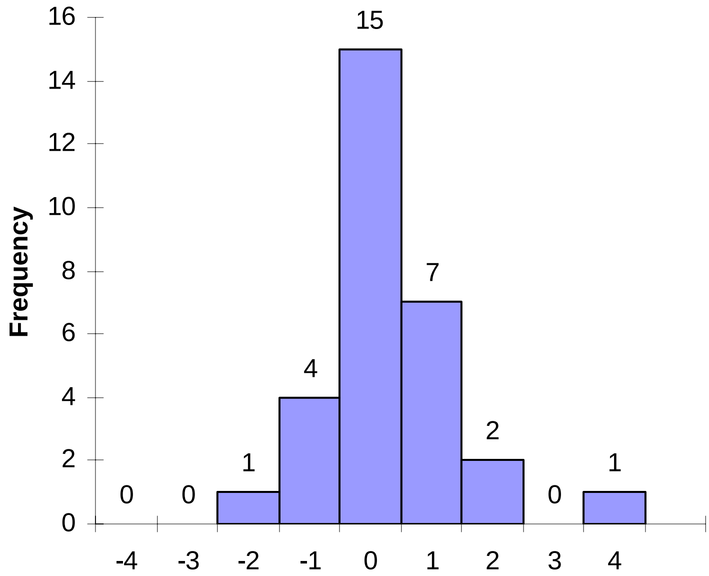

FIGURE 4. FREQUENCY OF ERPT - SCOURED

Step 4. ERPT on Market Power

It has been in the centre of the ERPT or PTM studies whether market share matters and, if so, what the systematic mechanism that the market share influences the ERPT elasticity is.

Table 8 summarises the relationship between market shares and the ERPT elasticity, based on Tables 2 to 5. The types of ERPT (normal, perverse and excessive) are determined by using the average elasticity computed in Step 3. The third column lists the cases where neither exporter's nor importer's market share affects the ERPT elasticity. Alternatively, it is the collection of the cases where complete pass-through is observed, or incomplete but constant pass-through is observed. The table summarises findings in this section. For example if one is interested in the ERPT for Fremantle price to Italy for RAW 1 (Greasy 51011110), the table shows that the ERPT is excessive, and Italy's market power is practised. Table 7 more accurately reports the magnitude of the ERPT for Melbourne price to Italy for the same type of wool. It is shown that Italy's market power also works in Melbourne when ERPT is normal. Table 7 shows the magnitude is –0.15. In contrast, the export price from Sydney to Italy is not affected by either's market share and the ERPT is normal.

TABLE 8. EFFECT ON MARKET SHARE ON ERPT

Type of Wool	Exporting Port	No Effect	Australia's market power	Importer's market power	Both	Total Cases
		Destination				
Greasy (51011110)	**Fremantle**	China	France (E)	Italy (E)		3
	Melbourne			Italy China	France	3
	Sydney	Italy	China (E)	France (E)		3
Greasy (51011120)	**Fremantle**	Czech France (E) Spain Taiwan UK	China India Turkey	Germany (E) Italy (E) USA (E)		11
	Melbourne	Czech (E) France Japan Spain Turkey	Germany (E) Italy Taiwan (E) UK	China USA (E)	India	12
	Sydney	France Taiwan UK	Turkey	China Czech Japan (E) Spain (E)	Germany (E) India Italy USA	12
Greasy (51011130)	**Fremantle**	Spain		China (E) India (P)		3
	Melbourne	India	China		Spain (E)	3
	Sydney			India (P)	China (E) Spain (P)	3

Continued on next page

TABLE 8. CONTINUED

Type of Wool	Exporting Port	Destination: No Effect	Australia's market power	Importer's market power	Both	Total Cases
Scoured (51012120)	**Fremantle**	Japan	UK	Germany Italy (E) Korea (E) Spain (E) Thailand (E)	India USA (E)	9
	Melbourne	Germany (P) Italy Japan Korea Spain Turkey (E) UK (P)	Malaysia Thailand (P) Taiwan (P)	India	USA (E)	12
	Sydney	UK	China (P) Japan (E)	Korea (E) Taiwan	India Italy Malaysia Thailand (E)	9
Total Cases		26	17	24	16	83
Excessive		3	5	14	6	28
Perverse		2	3	2	1	8
Normal		21	9	8	9	47

Note: (E) and (P) represent Excessive and Pervasive ERPT respectively.

6. Summary and Conclusions

The extensive wool price database of DAWA (Department of Agriculture, Western Australia) is used to carry out a sophisticated econometric study of the relationship between wool prices in three major ports in Australia (Fremantle, Melbourne and Sydney) and exchange rate changes, which quantify the degree of the fluctuation of export price due to exchange rate changes. This analysis also takes into account the effect of the exporter's and importer's market powers on the extent of price changes due to exchange rates. It reflects the extent to which Australian wool exporters have "market power" that can be used to their advantage in the form of increasing prices.

The ERPTs for four kinds of wool, exported from three major ports in Australia to major destinations are examined in this study. Altogether, 83 trade relationships are investigated using 24 quarterly observations that cover the period of 1995 to 2001. The major contributions of this study include the analysis of ERPT considering symmetry response cases, comparison of ERPT across different ports and across major destinations, and investigation of the effect of market shares. Major implications from this study can be briefly summarised in what follows.

Firstly, when symmetric response is assumed, the three kinds of responses to exchange rate changes - normal, perverse and excessive – are found in Australia's wool export to major destinations. The exporter's and the importer's market shares turned out to be important for selected cases. Overall, the normal ERPT was found for 47 trade cases (or 57%) out of 83 wool trade cases for four types of wool investigated, from all the three ports to all major destinations. For RAW 2, the ERPT for 24 cases out of 35 (or 69%) were found to be normal, and for scoured wool, that for 15 cases out of 30 (or 50%). All the excessive responses were found from the export price of scoured wool. While some perverse responses were also found, the frequency decreases as it becomes more perverse. These results imply that, setting aside some exceptions, the fluctuation in exchange rate changes the export price of Australian wool either incompletely or completely, in the expected direction.

Secondly, it was in general found that the origin specific variable, each state's wage rate has a positive effect on the ERPT, however some negative effects are also found. It implies that as the marginal cost of wool production increases, the export price varies too. As all the origins are the three ports in Australia, the same exchange rate is applied to them for each destination. In this regard, the exchange rate is a destination-specific variable. The exchange rate was found to be a significant determinant of the export price in many cases, and to be affected by origin-destination specific variables such as the exporter's market shares and importer's market shares.

It was statistically suggested that the Australian wool exporters practise market power in adjusting their export price of RAW 2 responding to exchange rates change. For scoured wool, however, this practice was not confirmed. More specifically, the export ERPT is likely to increase as the larger the Australian exporter's market share is, and the smaller the importer's market share is (for RAW 2).

Thirdly, compared to RAW 2, more irregular and unexpected results were found from Scoured wool. For instance, the export prices to Turkey and India exhibit substantially different movements from the others. A limited number of observations, or some noise created from aggregation (from monthly to quarterly) may generate data problems. In fact, large fluctuation of quantity traded was revealed for this type of wool, which is consistent with Goldberg and Knetter (1997)'s observation for a variety of manufacturing goods trade. They explained that the large fluctuation in quantity might be due to:

- A fairly high fraction of export shipments go unrecorded, introducing a great deal of noise into quantities;
- Industry specific reasons such as a great fluctuation in inventories, especially for durable goods;
- Shipping pattern change and goods are routed to intermediate destinations;
- When the markets involved are new or in transition phase. Buyers are learning about new products, but sellers have not yet established their position, and the set of competitors changes dramatically;

While the data we used are in very high quality, it is still possible that some observations are not accurate owing to aforementioned reasons. The lack of precision seems to be a function of volatile quantity data. This needs further investigation.

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