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NEW ZEALAND'S PASTORAL EXPORTS: CAN SMALL COUNTRIES PRACTISE PRICING-TO-MARKET?

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Literature presumes that exporters from small countries and particularly of primary products do not practise pricing-to-market (PTM) because of lack of market power. Our paper examines New Zealand's pastoral exports over 1988–2002 and finds strong evidence of PTM. Evidence rejects the hypothesis that New Zealand is a price taker in these markets. We find incomplete pass-through in sheep meat markets and more than complete pass-through in wool. The degree of PTM is more pronounced in meat and less, but significant, in wool. Interesting co-movement in export pricing of New Zealand and Australia and a high degree of PTM are noted when the two countries together dominate a market. Generally we report a smaller PTM when there is a larger promotional expenditure in the corresponding market.

JEL Classification: *F12, F14, D43.*

Keywords: *Meat and wool exports, pricing-to-market, exchange rate pass through, New Zealand economy.*

INTRODUCTION

Incomplete transmission of exchange rate fluctuations into equilibrium import prices is attributed to pricing-to-market (PTM). In the post-Bretton Woods era, traditional international trade models were challenged by observations on the inconsistent changes in commodity prices with respect to exchange rate fluctuations. The phenomenon has been widely studied since Krugman's (1987) seminal work on incomplete exchange rate pass-through (ERPT) of US dollar appreciation of the eighties[1]. Like Krugman's work, most of the evidence on PTM comes from trade in manufactured goods among large economies such as the United States, Germany and Japan (Knetter, 1989; Marston, 1990), and there is a persistent view that the behaviour arises only in large country trade of manufactured goods. To quote Krugman (1987: 56),

> "*…PTM is not universal. Our disaggregated US–German evidence seems to say that pricing-to-market is limited to the transportation equipment and machinery industries…*".

This view arises from the position that incomplete ERPT is the optimal response of intertemporal profit maximization behaviour of exporters if the market is imperfectly competitive.

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When sellers set prices with a mark-up on marginal cost, an exchange rate shock moves them to a different point on the demand curve where the previous mark-up is no-longer optimal (Krugman, 1987; Feenstra, 1989)[2]. The new mark-up implies a price change which is more or less than the exchange rate change. Because demand curves in different export markets are not identical, import prices in these markets get out of alignment. Exporters from small economies however do not enjoy sufficient market power to set their own mark-ups. Likewise non-manufactured primary goods being homogeneous, their markets are expected to be competitive and do not allow mark-ups and PTM.

We however take the view that the issue can not be settled *a priori*. Small countries can be large exporters of specific items with sizable market shares and be able to exercise their market power. Further, primary products are often differentiated by establishing brands or other product characteristics. Hence the assertion can not be accepted without empirical verification. Results of two recent studies encourage us to undertake verification. Griffith and Mullen (2001) study export pricing of Japonica rice from Australia and establish significant difference of price response to exchange rate fluctuations across destinations. The second one, Lee and Tcha (2005), provides evidence of destination specific price differentials of sheep meat export from Australia and New Zealand for the period 1989-2001. Both these studies examine primary exports, and the latter includes a small economy too.

A study of New Zealand's exports would provide an ideal ground for examining the question. Though a small economy exporting primary pastoral goods, New Zealand's exports do not appear to conform to the assumptions of competitive markets. The country has a large presence in the world market for meat and wool with only a small number of large exporters in these markets[3]. Table 1 brings out this feature clearly. The table presents the average market shares of New Zealand and Australia in selected sheep meat and wool importing countries between 1990 and 2001.

Table 1
New Zealand and Australia's Average Market Shares of Sheep Meat and Wool: Selected Importing Countries 1990-2001

	Sheep meat		*Wool*	
Country	*New Zealand*	*Australia*	*New Zealand*	*Australia*
Canada	60.45	34.85	18.88	8.97
China			21.88	54.0
France	14.33	1.57	5.69	55.03
Germany	69.9	6.68	11.61	47.05
Hong Kong	41.34	18.96		
India			25.79	39.68
Italy	27.5	0.25	5.22	57.86
Japan	43.55	54.90	16.82	53.70
Korea	38.09	42.50	3.77	72.73
UK	82.33	8.05	22.25	13.96
USA	29.79	69.5	24.06	48.71

Notes: Commodity SITC 0112; Meat of sheep and goats, SITC 268; Wool and other animal hair
Source: Database, International Trade by Commodity Statistics (ITCS), SITC/CTCI- Revision 2 OECD CDROM 1990-2000, 1990-2001.
International Trade Statistics Year Book, Vol: 1, Trade by Country, United Nations, Various issues, 1990-2002; and Database, Overseas Merchandise Trade, Statistics New Zealand, 2003.

Secondly sheep meat and wool are far from homogeneous at the final point of sale. There is substantial expenditure on product differentiation by New Zealand's marketing boards and other promotional agencies. They not only establish products as different from competitors', but also try to promote non-substitutable uses. Advertisement campaigns for New Zealand meat project the 'greenness' of New Zealand, suggesting that meat products from New Zealand are more 'organic'. Cuts' of New Zealand sheep meat also differ from other exporters'. In the case of wool the attempt is to establish that wool within certain fineness bands has different physical attributes and is unsubstitutable in specialised uses.

Resulting heterogeneity, presumed or real, may rule out perfect substitution. The degree of substitutability is further influenced by large market share because an exporter with larger market share faces a smaller effective elasticity compared to its rivals (Krugman,1987).

In pursuit of this issue our paper examines two major primary exports of New Zealand: sheep meat and wool. Unprocessed series of their export prices in New Zealand dollars differ widely across destinations. We have plotted the ratio of percentage change in export price to percentage change in exchange rate in the significant markets. Figures 1.a to 1.d plot the moving

Figure 1: Ratio of Export Price Variation to Exchange Rate Variation (Moving Averages)

Figure 1a: Sheep Meat-Italy

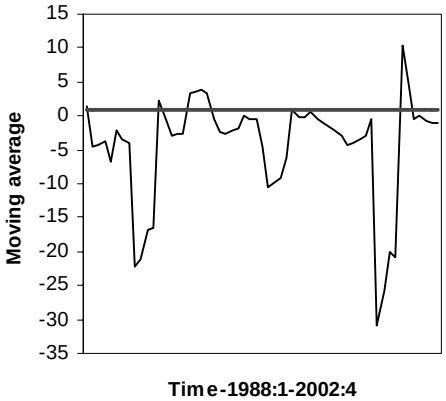


Figure 1b: Sheep Meat-UK

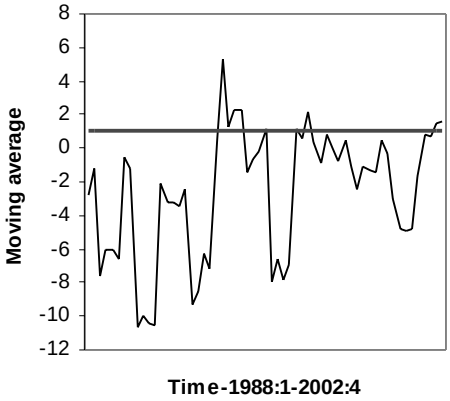


Figure 1c: Wool-India

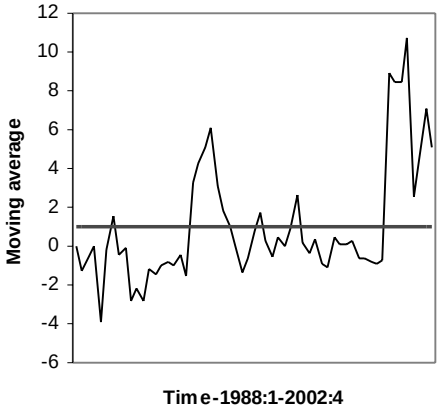
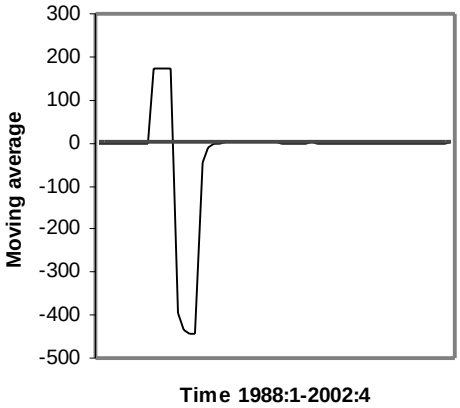


Figure 1d: Wool-China



averages of these ratios for some countries. Each figure portrays a specific product in a specific market at the four-digit level NZHS classification (1996) between 1988 to 2002. It is the divergence of these ratios from unity (the horizontal line) that provides the motivation for this paper. The aim of the paper is to generate evidences on the existence of PTM or otherwise, for small economies and primary product trade.

The rest of the paper is organised as follows. Section 2 uses a model of monopolistic competition to derive theoretical relations among export price, exchange rate and other market variables. The first part of Section 3 presents an econometric model based on the previous section. The second part explains the variables and source of data for the econometric model. Section 4 presents the results of estimation. This section also reports on a second exercise that takes account of possible seasonal variation of export prices in view of the seasonal nature of pastoral production. Section 5 interprets the results and tries to explain them in terms of products and markets characteristics.

THEORY

We use a model of monopolistic competition (Chamberlain, 1956). Each seller faces a distinct demand function determined by its market share, product differentiation effort, and competitors' prices. Suppose all exports of a product from New Zealand are sold by a single firm in n different countries. The price in the ith country is p_i in New Zealand dollars. Sale is $q_i = q_i(p_i e_i)$, where e_i is the number of the country's currency units exchanging for a NZ dollar. This demand function is influenced by (i) the market share of the NZ exporter, z_i; (ii) promotional expenditure a_i; and (iii) the vector of competitors' prices. The New Zealand exporter's profit in all markets together is:

$$\pi = \sum_{i=1}^{n} p_i q_i - \sum_{i=1}^{n} c_i - \sum_{i=1}^{n} a_i = \sum_{i=1}^{n} p_i q_i - c\left(\sum_{i=1}^{n} q_i\right) - \sum_{i=1}^{n} a_i \tag{1}$$

where $c(q)$ is the cost function. All monetary terms in equation (1) are in NZ dollars.

Price elasticity of demand in the ith market is $\left[\frac{-\partial q_i}{\partial p_i e_i} \cdot \frac{p_i e_i}{q_i}\right]$, and will be denoted by $E_i = -\frac{q_i'}{q_i} \cdot p_i e_i$. First-order conditions for profit maximisation with respect to sales are n equations:

$$p_i + \frac{q_i}{e_i q_i'} c', \quad \text{or} \quad p_i\left(1 - \frac{1}{E_i}\right) = c', \quad \text{i.e.} \quad p_i = c'\left(\frac{E}{E_i - 1}\right). \tag{2}$$

Equation (2) shows export price as a mark-up on marginal cost. The mark-up is determined by E_i, which is a function of $p_i e_i$, and the parameters z_i, a_i and competitors' prices. Equation (2) is interpreted as a long run equilibrium to allow estimation of the long-run relation between export price and other variables.

Change of export price with change of exchange rate, assuming c' is unaffected, is:

$$\frac{\partial p_i}{\partial e_i} = -c' \cdot \frac{1}{(E_i - 1)^2} E_i'\left(p_i + e_i \frac{\partial p_i}{\partial e_i}\right), \quad \text{or} \quad \frac{\partial p_i}{\partial e_i} = \frac{-E_i' c' p_i}{(E_i - 1)^2 + E_i' c' e_i}. \tag{3}$$

where $E_i' = \dfrac{\partial E_i}{\partial (p_i e_i)}$ is the partial of E_i with respect to importer's price[4]. Hence, the exchange rate elasticity of export price is:

$$\frac{\partial p_i}{\partial e_i} \cdot \frac{e_i}{p_i} = \frac{-E_i' c' e_i}{(E_i - 1)^2 + E_i' c' e_i} . \tag{4}$$

Leaving out c', the rest of the right hand side expression is the elasticity of mark-up to exchange rate. We will call it the PTM elasticity. Three cases can arise. *Case* (*i*) where $E_i' = 0$**,** therefore, $\dfrac{\partial p_i}{\partial e_i} \cdot \dfrac{e_i}{p_i} = 0$ Export price is unaffected by exchange rate changes; there is a fixed mark-up and no PTM. Exchange rate pass-through, defined as (1 + PTM elasticity) is equal to one or complete. *Case* (*ii*) $E_i' > 0$**,** therefore, $\dfrac{\partial p_i}{\partial e_i} \cdot \dfrac{e_i}{p_i} < 0$. If the demand function gets more elastic as price increases, as in a linear demand curve or curves less convex than constant-elasticity curves, then mark-up falls as exchange rate rises, leading to PTM. Pass-through is then incomplete and less than one. *Case* (*iii*) $E_i' < 0$, a somewhat unusual case where demand is more convex than constant elasticity demand curves (see Feenstra, 1989; Knetter, 1989). This 'perverse' pass-through may reflect intertemporal consideration of exporters under monopolistic competition. Profit maximizing exporters dynamically decrease (increase) their mark-ups when importer's currency appreciates (depreciates) in order to expand market shares and raise profit margins in future periods.

Methodology

The empirical model estimates PTM in New Zealand's pastoral exports at HS four-digit level. The commodity groups are: (i) meat of sheep and goats: fresh, chilled or frozen (HS: 0204); (ii) wool not carded or combed (HS: 5101). Sample periods for sheep meat and wool are respectively from 1990(1)-2002 (4) and 1988(1)- 2002 (4). The econometric work based on the analysis of section 2 uses a two-way error-component fixed-effects regression model

$$\ln p_{it} = \lambda_i + \theta_t \ln mc_t + \beta_{1i} \ln e_{it} + \beta_{2i} \ln cp_{it} + \beta_{3i} \ln z_{it} + \beta_{4i} \ln a_{it} + \nu_{it} \tag{5}$$

Variables are in natural log. *mc* and *cp* denote marginal cost and competitor's price. Australian export prices are used for *cp* since Australia is the most dominant competitor in the markets analyzed. The variable *mc* is an industry-specific producers' price index based on input prices. Its coefficient is identical across countries. θ_t reflects the effect of unit change of marginal cost, assumed to be common across destinations. λ_i is a time-invariant country effect. It accounts for unobservable differences among cross-section units. Other notations are as in the theoretical model.

Exchange rate elasticity of export price, β_{1i}, directly measures PTM elasticity. A negative/positive sign implies that the exporter reduces/increases export price in domestic currency when there is depreciation of the importer's currency.

Presuming that serial and contemporaneous correlation might exist Parks' (1967) method, available in SAS System (Version 8) as TSCREG procedure has been used with some modification to estimate equation (5). Parks' method follows a three step procedure to obtain

consistent and asymptotically efficient estimates in the presence of serially and contemporaneously correlated errors and heteroskadasticity (Parks, 1967:502).[5]

We re-estimated the equations with Zellner's (1962) SUR method and GLS AR(1)[6] to assess the robustness of estimates. This also gave us test statistics for serial correlation[7].

A statistically significant λ_i would indicate that NZ is not a price-taker in export markets. Significant β_1 would imply PTM. The extent of pass through is $(1 + \beta_1)$. Pass-through is incomplete if $\beta_1 < 0$, and more than complete if $\beta_1 > 0$. A significant λ_i but an insignificant β_1 will be interpreted to mean that NZ producers are not price takers, but they work with fixed mark-ups because $E' = 0$. Other β coefficients in equation (5) measure the elasticity of export price with respect to corresponding variables.

For sheep meat, Australian price being highly correlated with NZ export price,[8] we have used an instrumental variable: $\ln c\hat{p}_{it} = \hat{\lambda}_i + \hat{\theta}_t \ln mc_t^{au} + \hat{\beta}_{1i} \ln e_{it}^{au} + \hat{\gamma}_i \ln z_{it}^{au}$ estimated by GLS AR(1) procedure. Super script '*au*' in this equation stands for Australia.

We have used two sets of tests for hypotheses about coefficients. The first uses *F*-based Chow test for composite hypotheses for all countries in the panel, *e.g.*, H_0: $\beta_{1i} = 0$, for all *i*. The second uses *t*-distribution for coefficients for individual countries.

Augmented Dickey-Fuller tests were performed for logarithmic variables across each panel. MacKinnon statistics suggest that the ADF test on levels using time trend and a constant do not reject the hypothesis of non-stationarity in all series.

All first differenced variables are stationary except for producer price indices. Producer price indices become stationary in the second difference. However, the sample period being short our attempt to find a panel co-integration relation did not produce any solid relation.

Description of Variables and Data Sources

1. Export prices are quarterly average unit values. Export values (F.O.B) and quantities on quarterly basis are obtained from Statistics New Zealand. Unit value serieses have been constructed by dividing quarterly export value of a product by the physical quantity of export.
2. Exchange rates are quarterly averages of nominal bilateral spot exchange rate, defined as the number of importer's currency units per unit of the exporter's currency. This measure reflects average change within a quarter. They are collected from the database of the International Financial Statistics, 2003 and 2004. Exchange rates for all countries have been re-based on the starting year of the sample.
3. The producer price index of sheep and beef farming inputs has been used as index of marginal cost. Producer price indices are disaggregated at two-digit level according to New Zealand Industry classification (ANZSIC, 1993) system. PPI measures changes in prices of inputs in the production process. These indices, PPIQ.SIAA, have been collected from INFOS database, Statistics New Zealand.

   This variable does not contain selling costs. Selling cost has been treated as an input into product differentiation rather than production, and is included in promotional expenditure.

4. Competitor's price is the Australian export unit value for respective commodities (at the four-digit level) converted into New Zealand dollars. Australian trade statistics are obtained from the Australian Bureau of Statistics (ABS), and unit values constructed using procedure similar to that in 1 above.

5. We have defined an exporter's market share by volume. It is calculated as the ratio of import volume from a particular source country, to the import volume from all sources. Using m_i for import from country i in a destination with total import m, the market share of the ith exporter is $\frac{m_i}{m}$. Market shares at the level of HS four-digit classes are not available. So we have used data series at SITC four-digit level, which agree well with our products[9]. New Zealand's shares of OECD markets are calculated from the OECD (1990"2001) database. Average market shares for 1990-2001 has been taken as the 2002 market share. Data for non-OECD countries are from the International Trade Year Book (various issues) of the United Nations.

6. Promotional expenditure has been taken as the ratio of promotion related costs and total operational budget for an industry's overseeing board. Promotional expenditure by New Zealand Wool Board through the International Wool Secretariat (IWS) is collected from the financial statements of the New Zealand Wool Board annual reports over 1988-2003. The New Zealand Wool Board (currently, Wools New Zealand) is the main authority for export promotion of raw wool overseas.

   Unpublished data on promotional expenditure were obtained from the New Zealand Meat Board.

EMPIRICAL RESULTS

1. Country effects λ_i are overwhelmingly significant at one percent level for both product groups. The null hypothesis $\lambda_i = 0$, that "New Zealand is a price taker" in these export markets is rejected.

2. *F*-test for the composite hypothesis for β_1 indicates that the hypothesis of constant elasticity of demand is rejected for both exports at the panel level. Individual country coefficients tested with *t*-test confirm this finding for the majority of countries indicating PTM in those markets.

3. The *F*-test statistics show that the elasticity to Australian price (β_2), elasticity to market share (β_3), and elasticity to promotional expenditure (β_4) are different from zero at one percent level for both export categories.

   Estimates using SUR and GLS AR(1) method are very similar to these estimates. They are not reported below but can be made available upon request.

Sheep Meat

Estimates and test parameters for sheep meat markets are given in Table 2. They show that New Zealand exporter practices PTM for six out of the nine destinations: Canada, France, Germany, Hong Kong, Italy, and Korea. For the remaining countries — Japan, the UK and USA — the

hypothesis that exchange rate changes are completely passed-through can not be rejected. Estimated β_{1i} are negative for all destinations with the exception of the UK and lie between –0.122 and –0.51, indicating a strong tendency for local currency price stabilization. For example, PTM elasticity of -0.39 in Germany implies that for 10 per cent depreciation of Deutsche Mark NZ exporters would reduce mark-up by 3.9 per cent and the Deutsche Mark price would rise by only 6.1 per cent instead of 10 per cent.

Table 2
Parameter Estimates for Sheep Meat, 1990-2002

Country	*λ Country effect*	*β_1 Exchange rate*	*β_2 Australian price*	*β_3 Market share*	*β_4 Promotional expenditure*	*AR(1) (ρ) estimate*
Canada	1.81425	–0.34567 **	0.058706	0.05868	–0.19857 **	
	(0.81)	(–3.4)	(0.03)	(0.25)	(–1.71)	0.18696
France	6.08654 **	–0.51961 **	–3.67193 **	–0.05201	–0.28738 **	
	(2.45)	(–3.27)	(–1.84)	(–1.09)	(–2.67)	0.136696
Germany	1.26258	–0.39587 ***	0.543479	–0.28198 **	–0.22566 **	
	(0.48)	(–3.87)	(0.27)	(–3.2)	(–2.22)	0.100132
Hong Kong	9.54464 **	–0.47481 **	–6.32846 **	0.106111	–0.28626 **	
	(2.96)	(–2.72)	(–2.49)	(1.38)	(–2.29)	0.243812
Italy	–0.29803	–0.26919 **	1.26246	0.114933	–0.2574 **	
	(–0.04)	(–3.07)	(0.33)	(1.05)	(–2.28)	0.331796
Japan	–0.81204	–0.12271	1.48317	–0.56155 ***	–0.46325 **	
	(–0.33)	(–0.54)	(0.65)	(–1.93)	(–3.28)	0.288844
Korea	–9.02054 ***	–0.38226 **	10.14087 ***	–0.02179	–0.60074 ***	
	(–5.52)	(–3.24)	(6.09)	(–1.1)	(–4.87)	0.064965
UK	0.68113	0.167693	1.567381	0.202885	–0.13674	
	(0.6)	(1.15)	(1.09)	(0.57)	(–1.2)	0.267613
USA	0.88154	–0.36088	1.421107	–0.14643	–0.20894	
	(0.6)	(–1.37)	(0.77)	(-0.67)	(–1.45)	0.416246

Notes: 1. The superscripts *, ** and *** indicate the 10%, 5% and 1% levels of significance, respectively.
2. Figures in parentheses are *t* values.
$H_0: \lambda_1 = 0$, all *i*, $F = 790.31$ [0.0001] $H_0: \beta_3 = 0$, all *i*, $F = 2.18$ [0.0226]
$H_0: \beta_1 = 0$, all *i*, $F = 4.84$ [0.0001] $H_0: \beta_4 = 0$, all *i*, $F = 4.37$ [0.0001]
$H_0: \beta_2 = 0$, all *i*, $F = 17.03$ [0.0001]
$H_0: \rho = 1$, all *i*. Wald: $\chi^2 = 231.6289$ [0.000], DW = 1.9606

About country-wise variations, there is more PTM in EU countries except in the UK, which is historically its largest trading partner (82 per cent average market share for 1990-2002). A smaller degree of PTM is seen for Canada, Germany, Hong Kong, Korea, and Italy, where New Zealand has intermediate market shares. In France, where New Zealand practices the highest degree of PTM it has a small average market share of 14.33 per cent.

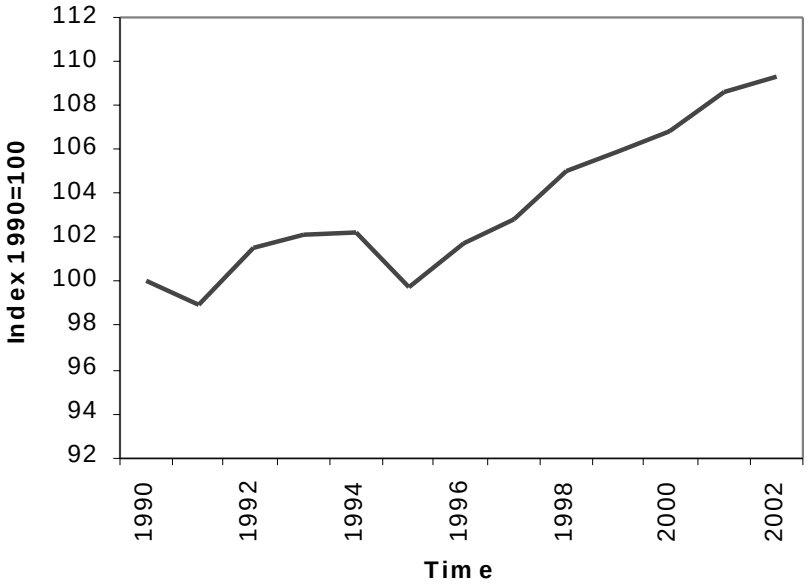
Elasticity with respect to the Australian price is significant for France, Hong Kong, and Korea. Its sign is positive in Korea where Australia has a large market share and negative in France and Hong Kong, where Australia has a small market share.

Market share elasticity (β_3) is significant at one percent level and negative for most destinations. A moderate value of elasticity is estimated for most destinations. The highest is for Japan where a 10 per cent increase in market share results in a reduction in sheep meat price by 5.61 per cent.

Promotional expenditure elasticity (β_4) is negative. Promotion increases differentiation allowing the exporter to adjust mark-ups more. Hence, theory expects promotion to be negatively related to exchange rate pass-through.

Estimates of θ_t (coefficient of the cost variable) provide an indication of the effect of cost on export price. Figure 2 plots a normalized index of this cost index showing a moderate increasing trend.

Figure 2: Index of Marginal Cost, Sheep Meat



Wool

Results for wool markets shown in Table 3 are strikingly different from meat. PTM elasticities are positive ('perverse' ERPT) and smaller. It means that when wool becomes dearer with depreciation of the importer's currency, exporter's perceived price elasticity of demand falls (more convex demand curve than constant elasticity curve). Knetter (1989) finds this type of pricing relationship for a number of export commodities like onions, bourbon, and orange juice in the USA and large cars and beer in Germany. A probable explanation is poor substitutability between New Zealand's strong wool and competing (mainly Australian) wools[10]. This leads to wool becoming less price-elastic when import price rises due to importer's currency depreciation.

Elasticity with respect to Australian price is positive for all countries except the UK. The elasticity coefficient is statistically significant for China, Germany, Italy and Korea - destinations where Australia has a large market share (see Table 1). The response is very high for Italy and Korea. Elasticity of market share is individually significant for five out of the nine countries: Germany, India, Italy, Japan and UK. However, the magnitudes are negligible.

As expected by theory, elasticity with respect to promotional expenditure is negative, for seven out of the nine countries.

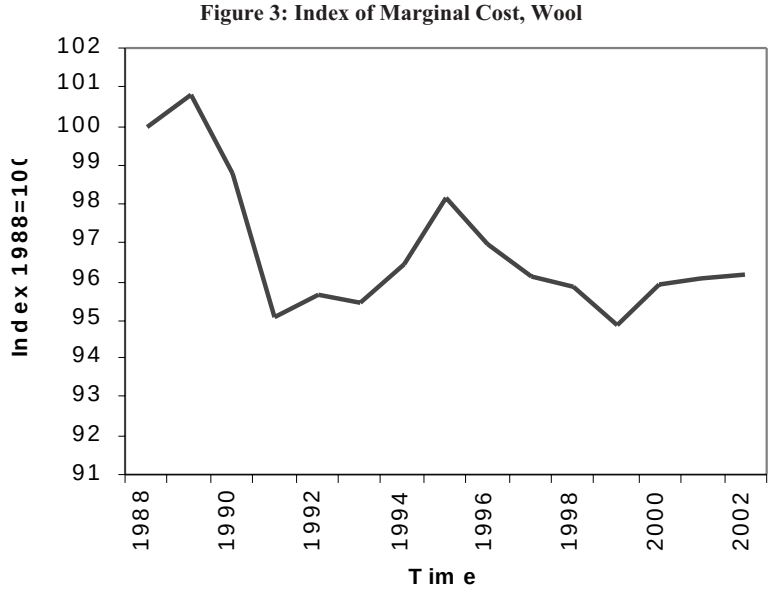
Table 3
Parameter Estimates for Wool, 1988-2002

Country	*λ Country effect*	*β_1 Exchange rate*	*β_2 Australian price*	*β_3 Market share*	*β_4 Promotional expenditure*	*AR(1) (ρ) estimate*
Canada	1.7125 ***	–0.14507	0.0315	0.02817	0.1049	
	(13.6)	(–1.02)	(1.13)	(0.44)	(0.79)	0.0387
China	1.4046 ***	0.10574 **	0.0612 ***	0.0253	–0.0263	
	(10.78)	(2.16)	(2.84)	(0.68)	(–0.26)	0.2586
Germany	1.2098 ***	0.06902	0.1896 **	–0.0821 **	–0.1739	
	(6.9)	(0.46)	(2.56)	(–1.72)	(–1.35)	0.2092
India	1.5501 ***	–0.02081	0.0388	–0.0389 ***	–0.0219	
	(12.93)	(–0.53)	(0.63)	(–2.98)	(–0.23)	0.3819
Italy	0.6176	0.12655	0.4521 ***	–0.0967 *	–0.5259 ***	
	(1.94)	(1.18)	(5.31)	(–1.81)	(–3.58)	0.1013
Japan	1.3298 ***	0.14235 *	0.0936	–0.0936 *	–0.1193	
	(6.82)	(1.74)	(1.47)	(–1.8)	(–1.14)	0.3813
Korea	1.0775 ***	0.1300	0.3007 ***	0.0018	–0.3633 ***	
	(4.91)	(1.52)	(3.54)	(0.06)	(–3.23)	0.1775
UK	1.9392 ***	0.0877	–0.0427	0.1322 ***	0.0516	
	(17.31)	(1.26)	(–1.15)	(4.19)	(0.68)	0.1775
USA	1.5740 ***	0.0382	0.0150	–0.0220	–0.0336	
	(7.81)	(0.39)	(0.23)	(–0.47)	(–0.31)	0.2234

Notes: 1. The superscripts *, ** and *** indicate the 10%, 5% and 1% levels of significance, respectively.
2. Figures inside the parenthesis are *t* values.
$H_0 : \lambda_1 = 0$, all *i*, $F = 500.94$ [0.0001] $H_0 : \beta_3 = 0$, all *i*, $F = 4.48$ [0.0001]
$H_0 : \beta_1 = 0$, all *i*, $F = 1.75$ [0.0763] $H_0 : \beta_4 = 0$, all *i*, $F = 4.64$ [0.0001
$H_0 : \beta_2 = 0$, all *i*, $F = 6.19$ [0.0001]
$H_0 : \rho = 1$, all *i*. Wald: $\chi^2 = 163.57$ [0.000], DW = 2.01046

There is not much variation in country effects in wool. Cost of production of New Zealand wool has been falling through the sample period (see Figure 3).

Figure 3: Index of Marginal Cost, Wool



Seasonal Variation

Trade in New Zealand pastoral products depends on production season and seasonal needs of buying countries. Meat exporters aim for the Christmas trade for lamb and plan for other festival consumption in destination countries. Farmers prepare lamb in the spring, target to get them strong before spring storms, and the killing season starts in October. Wool is shorn twice a year or three times in two years. For the majority of farmers, annual shearing takes place in late spring or summer. Fleece wool, shorn from the sheep's back, is categorized in terms of breed, fiber diameter, and time of shearing. The availability of various categories differs through the year.

Average quarterly export price of sheep meat and wool are higher in the fourth quarter. Therefore in a satellite exercise, a seasonal dummy was used for the fourth quarter. Estimated results for sheep meat and wool are presented in Tables 4 and 5. For sheep meat, the dummy is not statistically significant.

Table 4
Estimated PTM elasticity for Meat with a Dummy for the Fourth Quarter.

Country	β_1 *Exchange rate*	β_5 *Dummy variable*
Canada	–0.32623 **	0.0398
France	–0.4449 **	0.0753 *
Germany	–0.35868 **	0.0400
Hong Kong	–0.46301 **	–0.0261
Italy	–0.24837 **	0.0387
Japan	–0.09517	0.0162
Korea	–0.37223 **	–0.0137
UK	0.18875	0.0348
USA	–0.34849	0.00760

Notes: 1. The superscripts *, ** and *** indicate the 10%, 5% and 1% level of significance, respectively
$H_0 : \beta_1 = 0$, all *i*, $F = 4.68$ [0.0001] $H_0 : \beta_5 = 0$, all *i*, $F = 1.40$ [0.1838]

Table 5
Estimated PTM elasticity for Wool with a Dummy for the Fourth Quarter

Country	β_1 *Exchange rate*	β_5 *Dummy variable*
Canada	–0.15925	0.05408
China	0.09065 *	–0.0483 **
Germany	0.08205	0.1315 ***
India	–0.01705	0.0019
Italy	0.05090	0.24093 ***
Japan	0.11301	0.0108
Korea	0.0899	–0.0292
UK	0.1039	–0.0098
USA	0.02435	0.0077

Notes: 1. The superscripts *, ** and *** indicate the 10%, 5% and 1% level of significance, respectively
$H_0 : \beta_1 = 0$,all *i*, $F = 1.28$ [0.2463] $H_0 : \beta_5 = 0$, all *i*, $F = 15.26$ [0.0001]

But for wool it is significant at one percent level for the joint hypothesis, and China, Germany, and Italy individually. Wool export prices are higher during NZ summer than at other times. When the seasonal pattern is accounted for, China is the only country with significant exchange rate elasticity, which shows that NZ does not engage in PTM in other destinations. We also note that the constant elasticity for the joint hypothesis is not rejected when the seasonal variations are considered.

DISCUSSION

Difference in PTM behaviour between meat and wool can be partly explained by the difference in the elasticity of demand arising from meat products facing close substitutes while finer New Zealand wool has no close substitute. PTM behaviour similar to our estimates in meat has been reported for products with close substitutes (*e.g*., Knetter, 1989, 1993 and Feenstra, 1989) and similar to wool for products with poor substitutes (Knetter, 1989).

As noted, PTM elasticities are positive for wool. In theory, positive elasticity should result if price elasticity of demand falls with price. This is likely if the product is poorly substitutable and at the same time the seller has a large share of the market. A second possibility, which is arguably the case for New Zealand wool, is a general equilibrium effect. Depreciation of the importer's currency makes its exports cheaper, shifting the demand curve for wool imports upward because wool is an input for its exports. Strong brands of New Zealand wool used in industry are not substitutable by Australian wool and get the lion's share of the benefit. This would imply a fall in elasticity of demand for New Zealand wool when its price increases due to the depreciation of the importer's currency.

We can isolate four types of New Zealand–Australia price relation. First, response to Australian price is positive and large, and the degree of PTM is large too. This is pronounced in sheep meat and more seen in Asia: Hong Kong, Japan, and Korea- where Australia has a large market share. Second, in wool market, the positive co-movement of prices is significant in China, Germany, Italy and Korea- where Australia again has a large market share. In these markets PTM is significant too, though not large. Third, price response is positive but small, and the degree of PTM is large. This combination is observed for both wool and sheep meat in Europe. Finally, where response to Australian price is negative, large and PTM is large. Examples are France and Hong Kong in sheep meat.

The first two types of price relationships above are instances where Australia has a larger market share and the positive price co-movement can be interpreted as New Zealand following Australia's price leadership. However, positive price co-movement is a common feature of oligopolistic markets and need not necessarily result from leader-follower relation. To test if this is so, we would need to use a different pair of theoretical and econometric models. More relevant for our analysis is that even in these markets New Zealand sellers do not behave competitively as is evidenced by significant PTM.

A related question is what accounts for the variation of response to Australian prices in different countries for the same product group? Even though relative market share may very well play some role, the pattern does not too closely follow relative market shares. It is possible that the effect of market share is moderated by other variables which we can not control for. Note that our theoretical model leaves all possibilities open and hence is not suited to answer this. A rise (fall) in competitor's price is expected to shift New Zealand's demand function upward (downward). But that does not unambiguously fix the price response which depends on the price elasticity at the current price and how it changes around it. Since demand functions are supposed to be different across countries, we do not expect uniform response. We could speculate on the reasons for the better known markets using relevant information and market anecdotes. We do not attempt that here because they are not immediately verifiable and secondly the conclusions about PTM would remain unaltered whatever the explanation for variation in price

response (*i.e.*, assuming that the theoretical model is adequate). For the same reason we refrain from speculating about country effects, which are expected to depend on both demand factors as well as institutional factors like degree of protection etc.

Elasticity with respect to promotional expenditure is negative and large for most Asian countries for both products. Promotion increases differentiation enabling the exporter to adjust mark-ups more easily. Hence, theory expects promotion to be negatively related to exchange rate pass-through.

The relationships between cost and other variables are uniformly different for meat and wool. In meat, cost is increasing (Figure 2) and elasticity with respect to cost is positive. Generally response to Australian price is found to be pronounced irrespective of market shares. Since Australian meat products are close substitutes, an increase in Australian price may lead to an increase in demand for New Zealand meat and hence an increase in the marginal cost and price. In wool, the time trend of cost is negative (Figure3) and elasticity with respect to cost is negative too. Response to Australian price is positive, but is not pronounced. Substitution between New Zealand and Australian wool being low, an increase in Australian price may not increase the demand for New Zealand wool, and therefore cost and price. This discussion presumes marginal cost changes to reflect movement along the same cost curve. There must also have been shift(s) in the cost functions making our reasoning less biting to that extent.

In explaining the variation in PTM of the same product across markets, competitor's behaviour and promotional expenditure are instrumental. The effect of these variables on PTM behaviour is more conspicuous in Asian markets. The monopolistic competition model does not readily provide reasoning for the expected signs of the coefficients of these variables. Further, our theoretical model provides only the equilibrium relation among variables. For understanding the effect of these variables where large and specialised trading bodies are involved, it would be worthwhile to use a model of strategic intertemporal competition.

NOTES

1. For example Hooper and Mann (1989); Kasa, K. (1992); Gagon and Knetter (1995); Menon (1995); Feenstra, Gagnon and Knetter (1996); Lee (1997); Kongsted (1998); Adolfson (1999); Alexius and Vredin (1999); Otani, *et al*., (2003).
2. Some supply-side factors are also used to complement this demand-side view. They include menu costs (Krugman, 1987), entry/exit costs (Baldwin, 1988; Dixit, 1989), adjustment costs and sales and distribution costs (Gagnon, 1989; Kasa, 1992).
3. World's leading sheep meat producers are China, India and the EU. But these economies consume a high proportion of their meat production domestically.
4. If marginal cost is not constant but changes with exchange rate through imported inputs, then equation (2) is modified as $\frac{\partial p_i}{\partial e_i} = \frac{-E'c'p_i}{(E-1)^2 + E'c'p_i} + \frac{E(E-1)}{(E-1)^2 + c'E'e_i} \cdot \frac{\partial c'}{\partial e_i}$, implying that the effect of exchange rate on export price will be larger (smaller) if $\frac{\partial c'}{\partial e_i}$ is $> 0\ (< 0)$.
5. The first step estimates each of the *n* equations for cross-section units by OLS and obtains estimated residuals and the covariance matrix. Then a consistent estimator of the AR1 parameter is obtained, removing autoregressive characteristics of the data by transforming the covariance matrix. In the

third step regression coefficients for each of the *n* equations are obtained by applying GLS on the transformed model.

6. 'Eviews' software package has been used to estimate the parameters by these methods.
7. Although Park's method estimates ρ_i, it does not provide test statistics for it.
8. Average correlation coefficient between New Zealand and Australian export price for sheep meat across destinations is 78 per cent.
9. For sheep meat SITC 0112: Meat of sheep and goats, fresh, chilled or frozen; for wool SITC 268: Wool and other animal hair-excluding wool tops.
10. Among 33 ten digit categories, 16 categories of NZ wool exceed 29.5 micron range. More than half of the product at four-digit level is in the strong wool category.

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