KEVIN CHEN, JIANGUO HUI AND PETER CHEN*

Does China Discriminate Among Origins in the Pricing of its Wheat Imports?

INTRODUCTION

China, the world's largest wheat producer and consumer, has also emerged as the world's largest wheat importer during the 1990s. Fast economic growth and an increasing density of population relative to arable land will continue to make China the world's largest wheat importer in the coming decades (Rozelle *et al.*, 1996). Major wheat-exporting countries have seen great opportunities in China. However, the market is government-controlled and exclusively operated by a single giant buyer, the China National Cereals, Oil and Foodstuff Import and Export Corporation (COFCO), which manages all wheat imports and deals with both transnational private companies and wheat boards in exporting countries. Mercier (1993) hypothesized that China appears to be fairly efficient in taking advantage of its position as a major wheat importer by exercising market power and receives export subsidies or low prices for the wheat which it buys.

Do structural characteristics of the international wheat trade provide a giant buyer, such as China, with opportunities for non-competitive pricing in international wheat trade? The empirical evidence regarding the relevant degree of buyers' market power is limited and disputed (Love and Murniningtyas, 1992; Pick and Park, 1991), though a number of studies have suggested that large buyers may exercise market power (Carter and Schmitz, 1979; Mercier, 1993). For example, by jointly estimating market power with cost and demand parameters, Love and Murniningtyas found evidence that Japan exerted a high degree of monopsony power. However, by using the pricing to market model, Pick and Park concluded that this was not the case. In the same study, by contrast, the authors found evidence that China and the former Soviet Union had exerted a high degree of monopsony power in the international wheat trade. Nevertheless, Pick and Park's testing for monopsony power was rather indirect because their main focus was on the exporter's market power. They tested the shares of importing countries in the US wheat export (price) equation and interpreted the negative coefficient on the importing shares as evidence of monopsony power exercised by importing countries. Goodwin (1992) studied prices in international wheat markets and found that they are highly integrated in markets which are spatially separated markets. Given the limited and mixed evidence on buyers' market power, a direct test of monopsony power from the side of

*University of Alberta, AT&T, and Agriculture and Agri-food Canada, respectively.

buyers' pricing behaviour in the international wheat trade is obviously desirable.

The objective of this paper is to extend the pricing-to-market (PTM) framework first proposed by Krugman (1987) and implemented by Knetter (1989). Knetter's empirical model has been applied to investigate the notion of price discrimination across destination markets by major agricultural export countries (Pick and Park, 1991; Pick and Carter, 1994; Yumkellar *et al.*, 1994). As the PTM model was developed on the basis of pricing decisions by exporting firms across destinations, however, it might not be readily suitable for the examination of pricing behaviour by importers. In this paper it is modified for that purpose.

THE MODEL OF INVERSE PRICING TO MARKET

As in the case of an exporter, so an importer with market power can use exchange rate changes in order to 'price to market' (Krugman, 1987; Knetter, 1989). This can be called 'inverse pricing to market' (IPTM). Assume that an importer, say China, minimizes its total expenditure when buying wheat from n exporters $q_t = (q_{1t}, q_{2t}, \ldots, q_{nt})$ at prices $p_t = (e_{1t}p_{1t}, e_{2t}p_{2t}, \ldots, e_{nt}p_{nt})$ where p_{it} is the import price in terms of the importer's currency and e_{it} is the exchange rate measured in exporter's currency per unit of the importer's currency for $i = 1, 2, \ldots n$. The importer can behave as a monopsonist, segmenting markets and adjusting import prices to bilateral exchange rate changes. Supply in each origin market is represented as $q_{it} = F(e_{it}p_{it})\phi_{it}$, where ϕ_{it} is a random variable that may shift supply in market i in period t.

Let the importer's given level of utility when it imports the predetermined quantity of wheat be $\overline{U} = U(q_{1t}, \ldots, q_{nt})\mu_t$, where μ_{it} is a random variable that may shift the utility function in period t. The importer's decision problem therefore becomes

$$Min\left\{\sum_{i=1}^{n} p_{it}q_{it} \mid \overline{U} = U(q_{1t}, \ldots, q_{nt})\mu_t, q_{it} = F(e_{it}, p_{it})\phi_{it}\right\} \tag{1}$$

Differentiating equation (1) with respect to prices and expressing in terms of elasticities, the first-order conditions are

$$p_{it} = b_t \frac{\varepsilon_{it}}{1+\varepsilon_{it}}; i = 1, \ldots, n \text{ and } t = 1, \ldots, t \tag{2}$$

where $b_t = \omega(\partial U_t / \partial q_{it})$ (ω is the Lagrangean multiplier) and is interpreted as the marginal benefit of wheat imports from origin i in period t, and ε_{it} is the supply elasticity for exports in exporting country i in period t. These conditions parallel the price discriminating monopoly case (Knetter, 1989). Equation (2) embodies the basic result of price discrimination: the price discriminating monopsonist will equate marginal cost in each market to the common marginal benefit. It states that price in the importer's currency is a mark-down determined by elasticity of supply in the various origin markets. In a competitive market with constant marginal benefit, exchange rate changes should be fully reflected in import prices. If an importer has market power, it can adjust origin-specific import prices as exchange rates change. The extent to which exchange rate changes are reflected in import prices is taken to indicate the possible existence of price discrimination in international trade and as one of the key explanations for prices of 'similar' goods possibly differing among origins.

In order to test for price discrimination and measure the mark-down following Knetter, a two-way fixed-effects regression model is considered

$$lnp_{it} = \theta_t + \lambda_i + \beta_i lne_{it} + \nu_{it} \tag{3}$$

where θ_t is a time effect, λ_i is a country of origin effect, β_i is the parameter, e_{it} is the exchange rate and ν_{it} is a regression disturbance. Equation (3) can be used to distinguish between three models of market structure. First, that $\lambda = 0$ and $\beta = 0$ imply the competitive market structure, in which import prices will be the same for all supplying origins. There will be country effects ($\lambda = 0$) and changes in the bilateral exchange rates will not affect bilateral import prices ($\beta = 0$). Note that the origin-specific variables (such as EEP export subsidies in the United States) may affect the unit values, but if markets are integrated these effects will be transmitted across sources and are thus accounted for by the time effects in the model. Thus, in a competitive market, the time effect measures factors affecting price for all origins.

Second, the conditions that $\lambda \neq 0$ and $\beta = 0$ imply price discrimination with constant elasticity of export supply. The country effect, λ, measures the component of the mark-down factor that differs across origins when a monopsonistic importer can segment markets. Such price discrimination will not vary in response to bilateral exchange rate changes if there is constant elasticity of supply in the exporting country, implying that they are not significantly different from zero. Although the mark-down is constant, it may vary over time and across regions, implying that the country effects are significantly different from zero ($\lambda \neq 0$).

Third, that $\lambda \neq 0$ and $\beta \neq 0$ implies price discrimination with varying elasticity of export supply. If supply elasticity varies with exchange rate changes, the optimal mark-down from the marginal benefit for a monopsonistic importer will vary with exchange rates. Import prices will depend on exchange rates and this implies that $\beta \neq 0$. The sign of the coefficients reveals the way in which the mark-down varies with changes in the exchange rate. A positive (negative) coefficient indicates that export supply is less (more) convex than the constant elasticity supply curve, and that exchange rate changes are not (more than) fully reflected in import prices. At the same time, the mark-down may vary over time and across sources, implying that the country effects are significantly different from zero. This case is referred to as 'inverse pricing to market' because the optimal mark-down by a price-discriminating monopsonist will vary across regions and with changes in bilateral exchange rates, implying that both $\lambda \neq 0$ and $\beta \neq 0$.

DATA, ESTIMATION AND EMPIRICAL RESULTS

The basic data set to be analysed consists of annual observations from 1981 to 1995 on the prices of wheat imports from the five suppliers, Argentina, Australia, Canada, EU and the United States, as well as relevant bilateral exchange rates. Though the annual nature of price information is not entirely suitable, there is no easily available material to use instead. The prices are unit values measured in importer's currency, calculated using annual observations on the landed quantities and values of China's wheat imports by origin. All the information used in the study was obtained from various issues of *Yearbook of Chinese Imports and Exports* published by China Customs. However, 1985 and 1992 prices for Argentina and the 1994 price for the European Union are not observable owing to the lack of shipments. These three missing prices were therefore fitted using an estimated regression line between prices and time in the respective country. The exchange rates are expressed in units of the exporter's currency per unit of the Chinese yuan and are based on annual average nominal exchange rates published in the 1996 *International Financial Statistics Yearbook*. Official exchange rates for Argentina and China are used since, although they are not determined in the free market, they are adjusted by the respective governments to reflect economic conditions. To obtain real exchange rates for the five origin markets, the nominal exchange rates are adjusted by the consumer price indexes (CPI) in each country given by the *International Financial Statistics Yearbook* for 1996. The exchange rates are normalized by dividing each observation by the value for the first observation. This allows comparison of the β coefficients across origins.

Equation (3) contains a regression constant, a set of time effects and a set of country of origin effects. The dummy variable for year 1995 and for Argentina are dropped, hence the fixed country effects which show higher or lower import prices are measured relative to Argentina. The model is estimated with both nominal and real exchange rate measures. As suggested by Knetter, the rationale is that the optimal import price should be neutral with respect to changes in the nominal rate that corresponds to inflation in the origin market. The variance of ε_{it} in equation (3) might well vary with t or i, or both. Moreover, the error terms ν_{it} and ν_{jt} might be correlated for some $i \neq j$ if random shocks affect several exporters at the same point of time. Similarly, the error terms ν_{it} and ν_{is} might be correlated for some $t \neq s$ if certain shocks affect the same exporter at more than one point in time. To avoid these problems, we estimated equation (3) with two versions of Kmenta's model (1986), namely the groupwise heteroscedastic and timewise autoregressive model (GHTAM) and the cross sectionally correlated and timewise autoregressive model (CSCTAM).

For the purpose of comparison, we also estimated equation (3) by OLS. Tables 1 and 2 report estimates of equation (3) by OLS, GHTAM and CSCTAM using nominal and real exchange rates, respectively. Using the nominal exchange rate, the GHTAM estimates appear to be unstable, while both OLS and CSCTAM estimates are remarkably similar. The CSCTAM estimates, however, have smaller standard errors. Using the real exchange rate, the three models are more different, though the OLS and CSCTAM estimates appear to be close

TABLE 1 *Country effects and exchange rate coefficients for China wheat import price equation: nominal exchange rate*

Source country	Fixed effect model		Groupwise heteroscedastic and timewise autoregressive model		Cross sectionally correlated and timewise autoregressive model	
	λ	β	λ	β	λ	β
Argentina		0.005		0.000		0.006
		(0.397)		(0.004)		(0.997)
Australia	–0.432	0.094	–0.308	0.068	–0.454	0.099
	(0.873)	(0.836)	(1.051)	(1.017)	(1.724)*	(1.630)
Canada	–0.608	0.153	–0.503	0.129	–0.625	0.157
	(1.546)	(1.597)	(1.970)*	(2.062)**	(2.868)**	(2.905)**
EC	–0.161	0.041	–0.75	0.023	–0.180	0.045
	(0.505)	(0.550)	(0.253)	(0.313)	(0.686)	(0.697)
USA	–0.836	0.202	–0.751	0.183	–0.877	0.212
	(2.194)**	(2.161)**	(3.184)**	(3.157)**	(3.872)**	(3.707)**
Time	Yes		Yes		Yes	
	Adj. $R^2 = 0.786$		*Buse* $R^2 = 0.923$		*Adj.* $R^2 = 0.998$	
	$F^1_{4,51} = 2.008$		$F^1_{4,51} = 3.357$**		$F^1_{4,51} = 4.388$**	
	$F^2_{9,51} = 1.349$		$F^2_{9,51} = 2.924$**		$F^2_{9,51} = 3.495$**	

Note: Values in parentheses are *t*-statistics. The asterisks ** indicate that *t*-statistics and *F*-statistic are significant at the 0.05 level, while the asterisks * indicate that *t*-statistics and *F*-statistic are significant at the 0.10 level.
$F^1_{4,51}$ is the *F*-statistic for $H_0{:}\lambda_i = 0$ for all $i = 2, 3, 4, 5$;
$F^2_{9,51}$ is the *F*-statistic for $H_0{:}\lambda_i = 0$ for all $i = 2, 3, 4, 5$; $\beta_i = 0$, for all $i = 1, 2, 3, 4, 5$.

TABLE 2 *Country effects and exchange rate coefficients for China wheat import price equation: real exchange rate*

Source country	Fixed effect model		Groupwise heteroscedastic and timewise autoregressive model		Cross sectionally correlated and timewise autoregressive model	
	λ	β	λ	β	λ	β
Argentina		–0.002		–0.005		0.002
		(0.159)		(0.637)		(0.316)
Australia	–0.081	0.021	0.054	–0.009	–0.279	0.064
	(0.132)	(0.149)	(0.141)	(0.104)	(0.841)	(0.857)
Canada	–0.252	0.076	–0.123	0.046	–0.442	0.119
	(–0.406)	(0.556)	(0.326)	(0.530)	(1.375)	(1.578)
EC	–0.038	–0.001	0.156	–0.027	–0.131	(0.035)
	(0.073)	(0.013)	(0.429)	(0.318)	(0.407)	(0.462)
USA	–0.446	0.117	–0.333	0.092	–0.663	0.167
	(0.755)	(0.855)	(0.895)	(1.072)	(2.033)**	(2.182)**
Time	Yes		Yes		Yes	
	Adj. $R^2 = 0.786$		*Buse* $R^2 = 0.927$		*Adj.* $R^2 = 0.998$	
	$F^1_{4,51} = 0.1746$		$F^1_{4,51} = 2.898^{**}$		$F^1_{4,51} = 3.681^{**}$	
	$F^2_{9,51} = 1.367$		$F^2_{9,51} = 3.287^{**}$		$F^2_{9,51} = 4.308^{**}$	

Note: As for Table 1.

again. It is also interesting to note that the CSCTAM estimates using either nominal or real exchange rates appear similar, the CSCTAM estimates fitting data best among the three models. The following discussion is therefore based on CSCTAM estimates.

Using either nominal or real exchange rates, the country effects are significantly different from zero. The *F*-statistics, denoted as $F^1_{4,51}$ in Tables 1 and 2, indicate that the null hypothesis of identical values of λ_i across origins is rejected by the data at the 5 per cent level. Also the *F*-statistics, denoted as $F^2_{9,51}$, indicate that the null hypothesis of identical values of identical λ_i and β_i across origins is rejected. This indicates that China, as the largest importer of wheat, engages in price-discriminating behaviour in purchasing wheat from the international wheat market.

The regression results with nominal exchange rates suggest that Canada and the United States received lower import prices than Argentina, Australia and the EC during the period under study. Such lower prices could reflect either their inelastic supply compared to the other three sources or their sales effort to gain market share. In particular, imports from the United States may have been priced lower in a bid to gain market share. Since mid-1985, export subsidies (EEP) have contributed to an increase in US exports to China. Price discrimination against Canadian wheat could be attributed to monopsony power, in that China is the largest buyer, accounting for over 25 per cent of the total from 1980 to 1995. The regression with nominal exchange rates also indicates monopsonistic pricing in the form of imperfect exchange rate pass-through for imports from Canada and the United States. The positive β_i coefficients indicate that China, being capable of price discrimination, tries to offset relative price changes in the local currency induced by exchange rate fluctuations. The mark-downs are adjusted upwards by 1.6 per cent for a 10 per cent appreciation in the Chinese yuan for Canada and by 2 per cent for a 10 per cent appreciation in the Chinese yuan for the United States. Such pricing behaviour indicates inelastic supply of Canadian and US wheat exports to China. In such cases, the importer attempts to maintain stable prices by reducing the effect of the exporter's currency valuation in markets where there are other competing purchasers. Kraft *et al.* (1996) observed that, while Canada, the EU and the United States lowered their exporting prices as a result of trade war competition, Australia and Argentina appeared to be shifting out of wheat production.

The regression with real exchange rates indicates only one violation of invariance of import prices to origin and exchange rates. This is puzzling as nominal exchange rate changes frequently reflect inflation differentials across countries and therefore may not induce changes in the local currency relative to the price of an import. One would expect idiosyncratic adjustments in import prices to exhibit more correlation with nominal exchange rates than the price-level adjusted exchange rates. Similar results are observed in Knetter's study.

It is also interesting to compare the results with those of Pick and Park (1991) and Pick and Carter (1994). Pick and Park, using both nominal and real exchange rates, found that the United States receives a higher price from its wheat exports to China, but no evidence of imperfect exchange rate pass-through associated with China. Given the fact that the United States has the highest import demand elasticity in the Chinese market (Hui *et al.*, 1995), it is a surprising result. In contrast, Pick and Carter, using real exchange rates, found that the United States receives lower prices from its wheat exports to China and that there is strong evidence of imperfect exchange rate pass-through. Pick and Carter also estimated the PTM model for Canada, without finding that exports were lower-priced but having strong evidence of imperfect exchange rate pass-through associated with China. Obviously our results using real exchange rates are more consistent with Pick and Carter, except that no strong evidence of imperfect exchange rate pass-through associated with China is found in the case of Canada. The key difference rests on prior beliefs about whether the international wheat market could be characterized by either monopoly or monopsony.

CONCLUSIONS

This study extends the pricing-to-market (PTM) framework to ask whether China, as a large buyer, can engage in price discrimination among exporting origins in the international wheat market. Using price information about China's wheat imports from the five supply origins (Argentina, Australia, Canada, the EC and the United States), the evidence of price-discriminating behaviour on China's part is strong. In particular, China consistently paid lower prices for US wheat than it paid to Argentina, Australia, Canada and Europe. While quality differences could account for some of the price variations, structural characteristics in China's wheat import market provide opportunities for non-competitive pricing. Stronger evidence of non-competitive pricing is found in imperfect exchange rate pass-through observed for the United States. The result confirms Mercier's speculation that China appears to engage in strategic behaviour in an effort to extract additional benefits from the wheat exporters.

The ability of China to successfully practise price discrimination is likely to arise from a combination of (1) the structure and practice of single-desk state trading, (2) the difference in wheat export supply elasticities, (3) the excessive capacity in wheat-producing countries, and (4) the inherent characteristics of wheat production. To appreciate our results fully, three limitations are worth noting. First, no attempt is made to account for seller's market power, as identified in several studies in international trade. Second, no attempt is made to control for the prices of close substitutes in the import markets. Instead of the monopsonistic model, it would be interesting to assume oligopsony. Third, product and time aggregation could bias the coefficients. If there is heterogeneity within a wheat category used in this study, changes in the composition of imports may be correlated with exchange rates if the elasticity of supply for the varieties differs. The same argument applies to time aggregation. Further empirical work, when data permit, should investigate whether significant country effects reflect quality or time differences among wheat imports.

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