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Pricing to Market Behavior: Evidence from Selected Canadian and U.S. Agri-Food Exports

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This study examines the pricing behavior of Canadian and U.S. agri-food exporters consistent with a model that permits the identification of pricing to market (PTM) behavior and imperfect market competition in agri-food markets. The estimation strategy takes advantage of recently developed panel unit root tests to determine the time-series properties of the data and avoid the problem associated with lower power conventional unit root tests. Among U.S. products, the conventional PTM model indicated evidence of a greater degree of imperfect competition in international markets for U.S. wheat. While price discrimination and market segmentation are apparent for Canadian exports in selected markets, the export adjustment pattern in most cases tended to exacerbate the effect of exchange rate fluctuations on foreign currency prices of Canadian products.

Key words: agri-food exports, fixed effects model, panel unit root tests, pricing to market behavior

Introduction

Canadian and U.S. agri-food exporters have faced substantial changes in exchange rate variability over the last 15 years. How they segment markets and adjust their prices to exchange rate fluctuations has been the subject of only a few empirical studies (e.g., Pick and Park; Pick and Carter). This phenomenon of market segmentation combined with imperfect competition and importer currency price setting is referred to as pricing to market (PTM) behavior (Krugman). Agri-food studies that have provided some insights into PTM behavior have focused not only on U.S. and Canadian exporters, but also on Thailand exporters (Yumkella, Unnevehr, and Garcia). In this study, we employ a recently developed panel unit root test to determine the time-series properties of the data in addition to examining the pricing behavior of Canadian and U.S. exporters for wheat, pulse (dry peas, lentils), and tobacco. The latter two commodities have not been studied previously in this context of identifying the presence of price-discriminatory behavior on the part of Canadian and U.S. exporters.

A comparative analysis of the pricing strategy of Canadian and U.S. exporters provides an interesting case study on pricing policy because Canada, while a relatively small country, is a major exporter of wheat and pulse. Over the last decade, these two commodities have been the subject of policy disputes between both countries. This has

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prompted trade investigations by the U.S. International Trade Commission [(USITC); Canada-U.S. Joint Commission on Grains].

Agri-food marketing and trading systems in Canada and the U.S. have not evolved in the same manner over the years. In Canada there is a greater focus on regulations related to quality assurance in the grain handling and marketing system, while in the U.S. there is a greater emphasis on private marketing arrangements. It is plausible to expect that the U.S., as the world's largest wheat exporter, would behave very much like price-discriminating oligopolists in foreign markets given the highly concentrated structure of the export industry.

The objective of this analysis is to examine the pricing strategies of Canadian and U.S. exporters for wheat, pulse, and tobacco. These products differ in institutional market arrangements and demand characteristics. In this study, we employ industrial organization theory to identify the effects of exchange rate variability and PTM behavior, since they can provide interesting insights on the pricing practices of exporters in response to changes in exchange rates and government policies.

In particular, we attempt to determine what commodity and market characteristics are associated with different patterns of price adjustment to exchange rates. Estimates of PTM coefficients can suggest whether export pricing strategies are different across commodities and destinations. For example, how does the response of price markups to exchange rate fluctuations differ between Canadian and U.S. exporters in similar foreign markets? Are Canadian exporters likely to adjust prices in order to maintain foreign currency price stability in foreign markets? Answers to these questions may provide information on how differences in institutional market arrangements, market structure, and macroeconomic policies among North American countries are likely to shape export pricing behavior.

To date, the bulk of the empirical research in the economics literature on export price adjustment in response to exchange rate changes has focused on manufactured goods, with the thrust toward understanding how price discrimination by exporters differs across commodities and over destination markets. Several explanations have been advanced in the literature to explain PTM, including imperfect competition, invoice currency decisions by exporters, and the need to maintain market share. PTM studies have shown exporters' responses to exchange rates depend on the time period covered, nature of the industry categories and countries included, how exchange rates and costs are defined, and whether annual or quarterly data are employed.

Knetter (1989) analyzed the relationship between price discrimination and export prices in destination markets and found that German manufactured goods exporters appeared to be more responsive to exchange rate fluctuations in foreign markets than U.S. exporters. While Marston[1] studied Japanese manufacturing firms' price-discriminating practices between domestic and export markets, he was able to demonstrate that Japanese exporters were willing to vary export-domestic price margins to protect their competitive market position. Knetter (1993) showed that, unlike U.S. export industries, German, Japanese, and UK manufactured goods industries demonstrated price stability in the foreign currency price of exports. For most industries, identical export price adjustment was evident only for German and Japanese exports, but not for either the U.S. or UK exports.

[1] Related studies that used a similar framework and investigated Japanese exporters' response to exchange rates include Ohno; Saxonhouse; and Athukorala and Menon.

In a subsequent study to ascertain whether destination-specific price markups were asymmetric with respect to exchange rate changes, Knetter (1994) found the asymmetric response was not statistically significant in most cases, but that the estimated PTM coefficient provided greater support for the market share hypothesis. Knetter (1995), in attempting to separate the cost and demand determinants of exchange rate pass-through, found that PTM was more pronounced among German exporters than U.S. exporters. His explanation of PTM behavior was due more to industry coverage than to country-specific factors. Gagnon and Knetter showed there was long-run evidence of a high degree of markup adjustment to exchange rates for Japanese exporters, weak PTM estimates for German exporters, and little markup evidence for U.S. exporters. The authors concluded that long-run PTM behavior could not be explained by the invoicing policies of exporters.

While panel studies by Knetter and by Gagnon and Knetter have made an invaluable contribution to the literature, they did not utilize a panel unit root test—such as the Im, Pesaran, and Shin (IPS)[2] test—to exploit the panel properties of the data. Instead, these investigations relied on conventional (country-by-country approach) unit root tests by employing the standard Dickey-Fuller and augmented Dickey-Fuller (ADF) tests. In most cases, the researchers were never able to reject a unit root in any of their data and concluded that most of the data were integrated of order one, I(1). This evidence was used in part to imply that common-currency price differentials existing across countries may be associated with permanent rather than transitory exchange rate changes. Knetter (1995) estimated his model in first differences as an appropriate remedy to adopt when variables are nonstationary, whereas Gagnon and Knetter estimated their model both in levels and first differences, and augmented their procedure with an error correction method to separate short-run and long-run PTM behavior.

Theoretical Framework and Model Specification

In this section, we develop a theoretical model that distinguishes marginal cost from exporter markup adjustments associated with exchange rate changes (Knetter 1989, 1992, 1995). We apply this model to Canadian and U.S. wheat, pulse, and tobacco exports in order to test for evidence of imperfect competition and price discrimination in foreign markets.

Conceptually, the model is partial equilibrium in nature, with the underlying assumption that an exporter has marginal costs roughly equal for all destination markets. There is also the assumption that export markets are segmented with limited opportunities for arbitrage (Gron and Swenson). The model focuses on destination-specific demand differences for the product, and controls for unobserved common marginal costs with time effects. The model ignores uncertainty and adjustment costs, and does not make any distinction between temporary and permanent exchange rate changes on exporter behavior.[3]

Industrial organization theory is used to describe the nature of market competition that is characteristic of commodity markets. The model takes advantage of multiple

[2] Recent studies employing the IPS technique have included McCoskey and Selden; Coakley and Fuertes; and Holmes.

[3] Papers by Froot and Klemperer, and by Kasa considered the dynamic adjustment by distinguishing the effect between temporary and permanent exchange rate changes.

transactions and the variation in panel data to pinpoint features of different market structural characteristics: perfect competition and two variants of imperfect competitive behavior.

Consider an exporter who markets his product in N different markets, with demand in each market represented as follows:

$$q_{it} = f_i(p_{it}e_{it})v_{it}, \tag{1}$$

where q_{it} is the quantity demanded by market i in period t, p_{it} is the export price in the seller's currency in period t, e_{it} is the buyer's currency per unit of the seller's currency, and v_{it} is a demand shifter. The exporter's cost function is given as follows:

$$C_t = C\left(\sum q_{it}\right)\delta_t, \tag{2}$$

where C_t denotes cost in home currency, summed over all export markets, and δ_t represents a random variable, such as changes in input prices, that may shift the cost function.

Combining equations (1) and (2) reveals the firm's profit maximization:

$$\pi(p_1, \ldots, p_n) = \sum_{i=1}^{N} p_i q_i(e_i p_i) - C\left\{\sum_{i=1}^{N} q_i(e_i p_i),\ w\right\}. \tag{3}$$

The first-order conditions for profit maximization indicate that the firm will allocate output levels across destination markets to equate marginal revenue in each market with the common marginal cost. Thus, export prices charged to each destination market are comprised of the product of the common marginal cost and a destination-specific markup denoted by

$$p_i = MC\left\{\frac{\eta_i}{\eta_i - 1}\right\}, \quad i = 1, \ldots, N, \tag{4}$$

where η_i is the price elasticity of demand faced by the exporter in the destination market. Equation (4) suggests that the seller's price in home currency is influenced by the perceived elasticity of demand in various foreign markets which, in turn, is affected by price competitiveness in the world market (Hung, Kim, and Ohno).

Following Knetter (1989), we tested whether the Canadian and U.S. wheat, pulse, and tobacco markets are consistent with perfect and imperfect market competition by means of a fixed effects model,[4] specified as

$$\ln(p_{it}) = \theta_t + \lambda_i + \beta_i \ln(e_{it}) + u_{it}, \tag{5}$$

where $\ln(p_{it})$ is the log of the exporter's price in market i and period t, θ_t denotes time effects, λ_i equals destination country effects, β_i is the exchange rate parameter, $\ln(e_{it})$ is the log of the destination-specific exchange rate, and u_{it} is a regression disturbance term.

Under competitive market conditions, a firm will set prices equal to a common marginal cost for similarly defined products. The time effects provide an exact measure of

[4] Other approaches to distinguishing between competitive and imperfect market conditions involve explicit structural models of demand and supply for a country's exports to foreign markets (Aw).

marginal cost, capturing the common price in each time period (Goldberg and Knetter 1997). For such a market structure, prices are little affected by bilateral exchange rates ($\beta_i = 0$) and country effects ($\lambda_i = 0$).

Under imperfect competition, there are two possibilities by which exchange rates and country effects may influence exporters' price markups. One possibility is to have market segmentation and price discrimination across markets. Under price discrimination with constant elasticity of demand in each foreign market, the price charged to each export destination is a fixed markup over marginal cost. Thus, price changes in each destination market will be influenced by both time (θ_t) and country effects (λ_i). The former provides an exact measure of marginal cost, while the latter measures differences in markup relative to a base country. Though exchange rates will not affect the exporters' optimal markup ($\beta_i = 0$), country effects that measure markups are likely to vary across destination markets ($\lambda_i \neq 0$).

The second possibility is to have imperfect competition and nonconstant elasticity of demand in foreign countries. For such imperfect markets, import demand elasticities will vary with exchange rate changes. Time effects (θ_t) may not provide an exact measure of marginal costs, since they may capture also any changes in the common markup. The optimal markup strategy for a price-discriminating monopolist is therefore influenced by exchange rate changes ($\beta_i \neq 0$) which, in turn, will affect prices differently in overseas markets. Thus, statistically significant parameter values (e.g., λ_i, β_i) in equation (5) will pinpoint evidence of price discrimination and market segmentation in foreign markets.

Apart from identifying the degree of price discrimination across destination markets, the theoretical framework also attempts to separate demand and cost influences associated with exchange rate pass-through in order to gain a better understanding of commodity markets (Gagnon and Knetter). An understanding of exchange rate pass-through[5] requires separating the contribution of foreign demand characteristics on price markups from those driven by cost. According to Pompelli and Pick, exchange rate pass-through to foreign markets may also be influenced by quantitative restrictions and tariff structures imposed by import countries.

Changes in the exporter's currency relative to the currency of a given foreign buyer will affect exchange rate pass-through in two ways. First, it affects the marginal cost through changes in input prices, and second, through the elasticity of foreign demand in destination markets. The combination of both effects determines the speed of exchange rate pass-through in foreign markets. This is shown by taking the logarithm of equation (4) and differentiating it with respect to input prices, export prices, and exchange rates. The resulting equation is

$$\ln(p_{it}) = \mu_i + (1 - \beta_i)\ln(MC) - \beta_i \ln(e_i) + u_{it}, \tag{6}$$

where the magnitude of β_i hinges on the level and rate of change of the foreign demand elasticity, and μ_i is a destination-specific intercept term for $\{N - 1\}$ countries. A time dummy variable (θ_t) can capture cost changes on prices.[6] Equation (6) indicates that, for

[5] Exchange rate pass-through denotes the overall effect of exchange rate changes on foreign country import prices. Incomplete exchange rate pass-though may be due either to price-discriminatory behavior by exporters or to exchange rate shocks on the marginal cost of sellers (Gagnon and Knetter).

[6] The possibility that products could be physically differentiated provides no certainty that marginal cost will be common across export markets and therefore permits price discrimination to occur under the assumption of proportionate marginal costs (Goldberg and Knetter 1997).

a given destination market, exchange rate and marginal cost changes will have a symmetric effect on export prices denoted in the importer's currency.

Under the hypothesis of price discrimination and constant elasticity of demand, changes in marginal cost will affect export prices proportionately. In cases where demand elasticities are not sensitive to exchange rate changes, export prices will be unresponsive to exchange rate changes ($\beta = 0$). In contrast, where price discrimination is likely and demand functions may differ across markets, export price responses will be more sensitive to exchange rate changes ($\beta \neq 0$).

Panel Data and Modeling Strategy

The principal agri-food products included in this study are wheat, pulse, and tobacco.[7] These products differ with regard to the level of aggregation and the institutional marketing arrangements used to merchandise them in overseas markets. Export unit values for wheat, pulse, and tobacco for the 1980–94 period are computed from export value and export volumes of agri-food commodities shipped by Canada and the U.S. to principal destinations. Annual export unit values were derived from the following sources: (*a*) Statistics Canada, "Merchandise Trade Database"; (*b*) Agriculture and Agri-Food Canada (AAFC), "Agri-Food Trade Database"; (*c*) Statistics Canada, "Exports by Commodity and Destination"; and (*d*) U.S. Department of Agriculture (USDA), *Foreign Agricultural Trade of the United States* (*FATUS*).

The annual exchange rate series (i.e., buyer currency per unit of seller currency) is defined as the average nominal rate deflated by the consumer price index in destination markets. Both exchange rates and consumer prices are sourced from various years of the International Monetary Fund's *International Financial Statistics Yearbook*. To capture the effect of government policies, such as the U.S. Export Enhancement Program (EEP) for wheat and the U.S. Agency for International Development (USAID) food aid assistance program (PL-480) for pulse, several dummy variables were included in the U.S. estimated model. EEP bonuses allocated by wheat exporters to foreign markets were sourced from Agriculture and Agri-Food Canada's "International Market Bureau Database," and corresponding information on recipient countries for food aid assistance programs was provided by Shapouri. EEP recipient countries in this study were Venezuela, Bangladesh, Algeria, Egypt, Morocco, Tunisia, the Philippines, and China, while USAID food aid assistance recipients were India and Mexico.

For this analysis, we employ the new Im, Pesaran, and Shin (IPS) unit root test based on panel data. The panel procedure pools cross-section time-series data and evaluates the hypothesis that exchange rates and export prices contain a unit root versus the alternative that they are stationary.

In order to test for unit roots, let us consider a sample of N countries observed over T time periods. Suppose the stochastic process, z_{it} is generated by a first-order autoregressive process given as

$$z_{it} = (1 - \varphi_i)\mu_i + \varphi_i z_{i,t-1} + \varepsilon_{it}, \quad i = 1,\ldots,N; \; t = 1,\ldots,T, \tag{7}$$

[7] Commodity harmonized system codes for Canada include the following: wheat: 1001.10 and 1001.90; pulse (e.g., dry peas, lentils): 0713; and unmanufactured tobacco: 2401. The U.S. harmonized system codes are described in the USDA's *Foreign Agricultural Trade of the United States* (*FATUS*) annual report (online at http://www.ERS.USDA.gov/db/FATUS).

which can be expressed alternatively as

$$\Delta z_{it} = \alpha_i + \beta_i z_{i,t-1} + \varepsilon_{it}. \tag{8}$$

Therefore, the null hypothesis of a unit root is given as H_0: $\beta_i = 0$ for all i, against the alternative hypothesis H_1: $\beta_i < 0$ ($i = 1, 2, \ldots, N_1$); $\beta_i = 0$ ($i = N_1 + 1, N_1 + 2, \ldots, N$). Thus, the t-bar statistic, which is based on the average of the ADF t-statistic, is given as follows:

$$\bar{t}_{NT} = \frac{1}{N}\sum_{i=1}^{N} t_{iT}, \tag{9}$$

where t_{iT} is denoted as the individual t-statistic for the null of a unit root. Im, Pesaran, and Shin computed the exact sample critical values of the $\bar{t}_{NT}$ statistic via Monte Carlo stochastic simulations. (For interested readers, these critical values are presented in appendix table A1.) In the case where the null of a unit root exists, the t-bar statistic has a standard normal distribution for $N \to \infty$ and $T \to \infty$, and for $N/T \to k$, for any finite positive constant k. IPS show that the t-bar statistic has better finite sample properties compared with the Levin and Lin panel unit root test. In addition, the t-bar test allows the data-generating process to vary across countries in terms of the ADF coefficients and error structures (McCoskey and Selden).

To allow for disturbances to be correlated across panels, IPS adjusted their testing procedure by assuming that ε_{it} is composed of two random components, given as

$$\varepsilon_{it} = \theta_t + \eta_{it}, \tag{10}$$

where θ_t is a time-specific common effect that allows for a degree of dependency across each panel, and η_{it} is an idiosyncratic random effect which is independently distributed across each panel. To invoke the panel unit root test, IPS suggested removing the effect of the common component term (θ_t) by subtracting the cross-section means from both sides of equation (8). The results of the IPS panel unit root test are presented in table 1.

When variables are stationary there is no need to difference the data when estimating fixed effects models. Knetter (1995) estimated his PTM model in first differences because most of his variables were found to be nonstationary. With regard to our empirical model, we estimated equation (5) in levels using the SAS PROC GLM procedure (SAS Institute, Inc.) since the panel unit root test revealed our variables were stationary. To avoid singularity problems, one country effect and one time effect were omitted from equation (5). The evidence of price-discriminatory behavior on the part of Canadian and U.S. exporters is presented in tables 2–3 for wheat, tables 4–5 for pulse, and tables 6–7 for tobacco.

Compared to equation (5), a slightly different hypothesis is postulated in equation (6), which separates the demand side effects related to export price adjustment. This is accomplished by imposing cross-equation and within-equation restrictions on the parameters of equation (6). The latter restriction constrains marginal cost and exchange rate changes to have an equivalent effect on prices. The nonlinear model is estimated by SAS PROC NLIN METHOD (SAS Institute, Inc.) against an alternative linear model where the effect of exchange rate changes may differ across countries, and changes in marginal cost are transmitted to every foreign market. The results for Canadian and U.S. wheat are shown in table 8.

Table 1. Panel Unit Root "*t*-Bar" Test Statistics for Export Prices (*P*) and Real Exchange Rates (*EX*) for Canada and the U.S., 1980–94

A. CANADA

	No Time Trend			With Time Trend		
Variable	Wheat	Pulse	Tobacco	Wheat	Pulse	Tobacco
	(N = 9)	(N = 11)	(N = 9)	(N = 9)	(N = 11)	(N = 9)
P	-5.393* [1]	-3.081* [1]	-6.870* [5]	-4.994* [1]	-0.153 [1]	0.701 [5]
EX	-0.691 [1]	-1.244 [1]	1.762 [5]	0.608 [1]	2.091 [1]	-3.332* [5]

B. UNITED STATES

	No Time Trend			With Time Trend		
Variable	Wheat	Pulse	Tobacco	Wheat	Pulse	Tobacco
	(N = 13)	(N = 9)	(N = 15)	(N = 13)	(N = 9)	(N = 15)
P	-3.147* [5]	-2.267* [0]	-1.791 [0]	1.442 [5]	-1.489 [0]	-3.343* [0]
EX	-4.017* [5]	-2.282* [0]	-4.247* [0]	-0.981 [5]	2.977* [0]	-1.174 [0]

Notes: An asterisk (*) denotes rejection of the presence of unit roots at the 5% significance level. N = number of countries in the sample. Numbers in brackets refer to number of lag differences. (The exact critical values of the *t*-bar statistic computed by Im, Pesaran, and Shin are presented in appendix table A1.)

Results and Discussion

The results from the IPS panel unit root test suggest that it is possible to reject the presence of a unit root for most commodity export prices, especially for regressions excluding a time trend (table 1). However, exchange rates were found to be stationary for all U.S. traded commodities, while Canadian tobacco was the only traded product where exchange rates were found to be stationary. These results may help clarify some of the earlier PTM work that alluded to export prices and exchange rates having a unit root. Despite the improvements that have been made by the recently developed panel unit root test, it suffers from a few limitations (McCoskey and Selden). First, the IPS approach may ignore problems of heteroskedasticity that variables may display over time. Second, the IPS test assumes that *t*-statistics are independent across countries, and thus may be susceptible to structural breaks in the data.

The results for the fixed effects PTM model are provided in tables 2–7. Table 2 reveals evidence of price-discriminatory behavior by Canadian wheat exporters in selected markets. Canadian wheat differs in marketing arrangements and the level of heterogeneity. For example, Canadian wheat consists of various classes (e.g., Canadian western red spring, durum) and grades, with roughly 70% of it marketed by the Canadian Wheat Board (CWB) ("Grain Marketing: The Western Grain Marketing Panel Report"). The results in table 2 show that four country effects and four exchange rate coefficients are statistically significant at the 10% level, thereby confirming evidence of market segmentation in foreign markets.

Canadian wheat exporters' opportunistic pricing strategy heightened the effect of exchange rate changes on foreign currency prices in Italy, the UK, Japan, and Bangladesh (table 2). It is apparent that Italian and Japanese importers were securing

Table 2. The Impact of Real Exchange Rates and Country Effects on Canadian Wheat Export Prices

Destination Market	Country Effects		Exchange Rates	
	Coefficient	t-Value	Coefficient	t-Value
U.S.	—	—	-0.075	-0.34
Italy	-1.503*	-2.00	0.228*	2.23
UK	0.435*	5.31	0.339*	2.49
Belgium	0.082	0.20	0.039	0.36
Japan	-0.689*	-1.71	0.194*	2.44
China	0.077	0.31	0.050	0.25
Bangladesh	-1.289	-1.44	0.429*	1.66
Iran	0.264	1.49	-0.040	-1.18
Algeria	0.608*	2.71	-0.158	-1.44
	$F = 4.99$, $P = 0.0001$		$F = 2.14$, $P = 0.0322$	
		$R^2 = 0.76$		

Notes: An asterisk (*) denotes significance at the 10% level. F = F-statistic and P = probability significance level.

Table 3. The Impact of Real Exchange Rates and Country Effects on U.S. Wheat Export Prices

Destination Market	Country Effects		Exchange Rates	
	Coefficient	t-Value	Coefficient	t-Value
Japan	—	—	-0.160*	-2.41
Italy	0.191	0.31	-0.134*	-1.65
Belgium	-0.140	-0.34	-0.192*	-2.21
China	-0.617	-1.50	-0.264*	-1.99
Indonesia	-2.273*	-1.70	0.187	1.12
Philippines	-0.798	-1.46	0.0004	0.001
South Korea	0.671	0.92	-0.229*	-2.12
Bangladesh	2.304*	3.00	-0.877*	-4.47
Morocco	-0.505	-1.17	-0.211	-1.50
Tunisia	-0.925*	-2.66	-0.217	-1.01
Algeria	-0.725*	-1.67	-0.066	-0.68
Egypt	-0.873*	-2.46	-0.112*	-1.72
Venezuela	-1.245*	-1.99	0.135	1.06
EEP[a]	Coefficient = -0.128*, t-Value = -4.75			
	$F = 3.01$, $P = 0.0008$		$F = 3.04$, $P = 0.0005$	
		$R^2 = 0.86$		

Notes: An asterisk (*) denotes significance at the 10% level. F = F-statistic and P = probability significance level.
[a] EEP denotes U.S. Export Enhancement Program.

relatively lower prices for Canadian wheat than U.S., UK, and Algerian importers. Wheat imports into Italy have risen since the mid-1970s, and currently Italy is the second largest net importer after Japan among high income countries (International Maize and Wheat Improvement Center). The majority of Italian wheat imports from Canada are durum. One would have expected to observe some evidence of market segmentation in Algeria and Iran, two countries that have traditionally been recipients of export credit from the Canadian government. Interestingly, our results were not supportive of the view that Canadian wheat exporters price to market to stabilize foreign currency prices in order to maintain their market share. This was very evident in the results reported by Pick and Carter in three destination markets (Japan, USSR, and China). Such findings probably are related to differences in the invoice currency decisions of exporters.

The individual F-tests for the inclusion of country effects and exchange rates are statistically significant, reaffirming the view that the CWB price discriminates by charging different prices for wheat in separate markets and extracting most of the rent it can from each market. Veeman suggested that Canadian wheat price disparities in overseas markets may be due to positive features of grain quality and marketing services, rather than the exertion of market power by the CWB.

The results for U.S. wheat shown in table 3 indicate a stronger case for imperfect market competition and price stability in the importer's currency. This is consistent with research findings reported by Patterson and Abbott, who observed that the discriminatory pricing behavior of U.S. grain exporting firms was related to U.S. market share, total export volume, and import market size. Unlike the marketing of Canadian wheat, U.S. wheat is marketed by private traders to a large number of North African and South East Asian countries. Among major exporters, the U.S. accounts for 35% of world wheat export trade and is the major supplier to Japan, the Philippines, and Pakistan. The U.S. ranks behind Canada in supplying wheat to the foreign markets of South Korea and China. In Africa, most wheat shipments are to the Mediterranean countries of Egypt, Morocco, and Algeria ("Grain Marketing: The Western Grain Marketing Panel Report").

Table 3 shows that, as a result of an appreciated dollar, U.S. exporters adjusted price markups to offset the effect of exchange rate changes on foreign currency prices in more than 50% of the destination markets. Similar findings are reported by Pick and Park, who found evidence of price-discriminatory behavior in sales to South Korea, Egypt, Venezuela, and the Philippines. Our results reveal that U.S. wheat exporters earned higher prices in Japan and Bangladesh than in Indonesia, Venezuela, Tunisia, Algeria, and Egypt. The pricing pattern to Japan may be partly explained by Japanese feed wheat quota policy that has treated U.S. exporters preferentially over Canada (Alston, Carter, and Jarvis). Export Enhancement Program effects are found to be statistically significant, confirming the dampening impact EEP has on wheat prices. Goldberg and Knetter (1998) showed that the price-lowering effect of EEP tended to be more pronounced in North African countries. According to Pick and Carter, the EEP dummy coefficient separates the impact that subsidies have on wheat prices, and avoids attributing market segmentation behavior exclusively to PTM strategies.

Price markup adjustments for the Canadian pulse trade indicated evidence of price discrimination in less than 50% of the destination markets (table 4). Conventional PTM behavior of stabilizing foreign currency prices took place in only the Japanese market. In Belgium, the Netherlands, and Spain, Canadian exporters tended to seek greater

Table 4. The Impact of Real Exchange Rates and Country Effects on Canadian Pulse Export Prices

Destination Market	Country Effects		Exchange Rates	
	Coefficient	t-Value	Coefficient	t-Value
U.S.	—	—	-0.365	-0.92
Italy	1.866	1.33	-0.236	-1.23
UK	0.003	0.02	-0.267	-1.05
Belgium	-3.855*	-5.15	0.987*	4.81
France	-0.415	-1.04	0.297	1.38
Germany	-0.141	-0.96	0.094	0.46
Netherlands	-0.758*	-4.40	0.378*	1.73
Spain	-3.073*	-3.54	0.647*	3.64
Japan	1.008	1.35	-0.273*	-1.85
Venezuela	-0.325	-0.36	0.044	0.17
Colombia	0.293	0.17	-0.091	-0.30
	$F = 7.32$, $P = 0.0001$		$F = 5.70$, $P = 0.0001$	
	$R^2 = 0.77$			

Notes: An asterisk (*) denotes significance at the 10% level. F = F-statistic and P = probability significance level.

Table 5. The Impact of Real Exchange Rates and Country Effects on U.S. Pulse Export Prices

Destination Market	Country Effects		Exchange Rates	
	Coefficient	t-Value	Coefficient	t-Value
Canada	—	—	-0.690*	-4.08
Italy	1.889*	2.29	-0.301*	-2.64
UK	-0.277*	-2.79	-0.0003	-0.01
Spain	0.307	0.62	-0.146	-1.41
Japan	2.279*	5.05	-0.534*	-5.84
India	-2.041*	-2.14	0.413	1.27
Australia	-0.100	-1.08	-0.186	-0.97
Mexico	0.141	0.80	-0.266*	-2.16
Venezuela	-0.289	-0.45	-0.044	-0.26
PL-480[a]	Coefficient = -0.047, t-Value = -0.74			
	$F = 4.98$, $P = 0.0001$		$F = 6.77$, $P = 0.0001$	
	$R^2 = 0.86$			

Notes: An asterisk (*) denotes significance at the 10% level. F = F-statistic and P = probability significance level.
[a] PL-480 refers to public law governing the USAID food assistance program.

monopoly rent by magnifying the effect of exchange rate fluctuations on importer prices. The practice of segmenting markets and charging lower prices in the European countries than in the U.S. was evident in several countries.

Price discrimination appears to be partly related to export volume shipments to overseas markets. Over the last 10 years, larger export volumes have been shipped to several European countries than to the U.S. or Japan. For Japan, export shipments are mostly for food (Agriculture and Agri-Food Canada 1999). The USITC claim that the Canadian pulse sector is relatively more competitive than the U.S. in third-country markets may be supported in part by the relatively lower prices European importers have paid for Canadian exports relative to U.S. buyers (table 4).

The results for U.S. pulse trade suggest evidence of price discrimination in less than 50% of the destination markets (table 5). The findings indicate U.S. pulse exporters price discriminated and adjusted price markups to ensure that foreign currency prices were little affected by exchange rate changes. This was particularly evident for Canada, Italy, Japan, and Mexico. The U.S. tended to price its products lower in India and the UK than in Canada, Italy, and Japan.

The U.S. accounts for a relatively small share of the world pulse export market, which has been declining over recent years. U.S. export share has dropped from 27% in 1980, to 8% in 1996 (Food and Agriculture Organization). Between crop years 1980/81 and 1996/97, U.S. exports of dry peas and lentils have fluctuated erratically with no discernible trend. Volume exports have declined from 195,413 metric tonnes in 1980/81 to 136,018 metric tonnes by 1996/97 (U.S. Department of Agriculture 1998). Unlike Canada, a larger share of U.S. exports of dry peas is classified as food quality pulses rather than feed quality. An increasing portion of U.S. exports of dry peas and lentils are concessional sales under Public Law 480 (USITC). Our results indicate that food aid assistance programs such as PL-480 do not have a price-dampening effect on prices as was evident for EEP. Results reported by Skully suggest that PL-480 acts as an implicit export subsidy for targeted wheat buyers.

Table 6 describes how country effects and exchange rate changes have shaped Canadian tobacco price markups. The evidence of price discrimination and market segmentation is not overpowering in most destination markets. The significant negative exchange rate coefficients in France, the Netherlands, and Finland suggest that the percentage change in the price of tobacco imports was smaller than the relative change in exchange rates of the Canadian exporter. Given the relative abundance of world tobacco supplies, our research findings reveal that Canadian exporters are willing to reduce their profit margins to absorb some of the impact of exchange rate variations. This is further reinforced by evidence of market segmentation in foreign markets where Canadian tobacco was priced higher in several European and Australian countries than it was in the U.S. market. The lower pricing of tobacco by Canadian exporters in the U.S. market could be a strategy designed to capture greater market share against the competition of lower prices provided by nontraditional suppliers such as Brazil.

The results for the U.S. tobacco trade suggest that noncompetitive pricing is not a predominant market strategy in most foreign markets (table 7). U.S. exporters in response to exchange rate changes stabilized foreign currency prices only in Thailand, while in Canada and Egypt they optimized their pricing policy by amplifying the effect of exchange rate changes on importers' prices. U.S. exporters were found to be pricing tobacco higher in Thailand, Australia, and several European countries than they were

Table 6. The Impact of Real Exchange Rates and Country Effects on Canadian Tobacco Export Prices

Destination Market	Country Effects		Exchange Rates	
	Coefficient	t-Value	Coefficient	t-Value
U.S.	—	—	0.090	0.22
UK	0.126	0.88	-0.082	-0.31
Belgium	0.631	0.79	-0.158	-0.74
France	1.607*	3.74	-0.963*	-4.24
Germany	0.210	1.32	-0.026	-0.12
Netherlands	0.460*	2.47	-0.395*	-1.71
Finland	1.337*	3.53	-0.755*	-3.33
Singapore	0.255	1.43	0.179	0.65
Australia	0.413*	3.00	0.208	0.57
	$F = 3.91$,	$P = 0.0005$	$F = 5.12$,	$P = 0.0001$
		$R^2 = 0.68$		

Notes: An asterisk (*) denotes significance at the 10% level. F = F-statistic and P = probability significance level.

Table 7. The Impact of Real Exchange Rates and Country Effects on U.S. Tobacco Export Prices

Destination Market	Country Effects		Exchange Rates	
	Coefficient	t-Value	Coefficient	t-Value
Canada	—	—	0.509*	2.25
Italy	-0.282	-0.25	0.115	0.75
UK	0.574*	4.41	-0.166	-0.85
Belgium	0.694	1.14	-0.014	-0.09
Germany	0.834*	5.93	-0.219	-1.32
Netherlands	0.885*	5.52	-0.273	-1.54
Denmark	0.843*	2.61	-0.143	-0.93
Spain	1.522*	2.22	-0.138	-0.99
Sweden	0.627*	1.81	-0.065	-0.38
Switzerland	0.713*	5.81	-0.099	-0.64
Thailand	3.307*	2.95	-0.799*	-2.33
Philippines	1.307	1.49	-0.137	-0.49
Japan	0.636	1.02	0.015	0.13
Australia	0.721*	5.17	-0.044	-0.17
Egypt	-0.120	-0.94	0.516*	4.40
	$F = 8.28$,	$P = 0.0001$	$F = 2.70$,	$P = 0.0010$
		$R^2 = 0.69$		

Notes: An asterisk (*) denotes significance at the 10% level. F = F-statistic and P = probability significance level.

in the Canadian market. Pricing tobacco lower in Canada than in other countries may reflect a strategy designed to capture market share, since nontraditional exports (e.g., Zimbabwe, China, Brazil) to Canada have increased over the years. Previous research has shown that the loss of competitiveness of U.S. tobacco leaf exports to Australia was attributed to country-specific factors such as changes in the Australian tobacco content policy and a switch to lighter cigarettes (Beghin and Hu). The authors concluded that tobacco price differentials between the U.S. and its competitors could not solely explain the loss of competitiveness of U.S. tobacco shipments to Australia.

Pricing to Market Model Extensions

Results from the nonlinear and linear wheat models are presented in table 8. PTM behavior by Canadian wheat exporters was evident in Italy, the UK, China, and Japan. This policy response may be due to the larger number of competitors with which Canadian exporters are confronted when selling wheat to foreign markets. Candidly stated, Canadian exporters clearly are willing to absorb small changes in the foreign currency price of wheat in response to exchange rate changes. While the magnitudes of coefficients were not similar across model specifications, PTM elasticities were relatively larger in China than for other export markets. For example, a 10% appreciation of the Canadian dollar relative to the Chinese Yuan implied an 8% reduction in the markup of wheat export price.

The results for U.S. wheat trade (table 8) indicated a positive markup adjustment in most markets across model specifications. In response to exchange rate changes, U.S. wheat exporters are willing to increase their profit margins and capture monopoly rent in four overseas markets. The unrestricted model provided a larger number of significant PTM coefficients in 75% of the destination countries, with most of them having a positive sign.

This extension of the PTM model shows that the relationship between markups and exchange rate changes on foreign buyer prices differs between Canadian and U.S. wheat exporters. These differences may be related to changes in wheat quality and classes of wheat exported by Canada and the U.S., or country-specific factors in import country tariff and nontariff policies that influence common-currency price differentials existing across countries.

Summary and Conclusions

This study tested the time-series properties of the data and examined the relationship between exchange rate changes and export prices of wheat, pulse, and tobacco exported by Canada and the U.S. in foreign markets. Specifically, the study determined how exchange rate variations affected price markups and marginal costs for similarly defined commodities exported in common and dissimilar markets. A framework that considers multiple transactions and exploits the variation in panel data was employed to separate the effect of price markups and cost changes by means of a fixed effects model.

Panel unit root tests indicated that common-currency price differentials existing across countries may be associated with temporary rather than permanent exchange rate changes. These results are consistent with recent studies in the literature (MacDonald; Coakley and Fuertes) purporting to support long-run purchasing power parity (PPP) where exchange rates are mean-reverting.

Table 8. Restricted and Unrestricted Price Adjustment Results for Equation (6): Canadian vs. U.S. Wheat

	CANADIAN WHEAT				U.S. WHEAT			
	Restricted		Unrestricted		Restricted		Unrestricted	
Country	β (Std. Err.)	DW (R^2)	β (Std. Err.)	DW (R^2)	β (Std. Err.)	DW (R^2)	β (Std. Err.)	DW (R^2)
U.S.	0.036 (0.12)	2.89 (0.49)	0.140 (0.21)	2.27 (0.35)	—	—	—	—
Italy	-0.129* (0.07)	1.64 (0.75)	0.009 (0.01)	1.53 (0.70)	0.109* (0.06)	1.67 (0.66)	0.021* (0.004)	1.28 (0.58)
UK	-0.153* (0.09)	1.94 (0.69)	-0.251* (0.08)	0.94 (0.31)	—	—	—	—
Belgium	0.019 (0.07)	1.48 (0.71)	0.039* (0.01)	1.44 (0.65)	0.035 (0.07)	1.49 (0.56)	0.027* (0.01)	1.46 (0.55)
China	-0.808* (0.35)	1.72 (0.75)	0.049 (0.04)	1.89 (0.56)	0.021 (0.33)	1.64 (0.62)	-0.074* (0.02)	1.57 (0.59)
Japan	-0.113* (0.06)	1.31 (0.76)	0.039* (0.01)	1.29 (0.79)	0.144* (0.05)	0.95 (0.88)	0.027* (0.006)	0.43 (0.61)
South Korea	—	—	—	—	0.135* (0.08)	1.80 (0.89)	0.012* (0.005)	0.87 (0.74)
Indonesia	—	—	—	—	0.037 (0.20)	2.07 (0.67)	0.012* (0.004)	2.35 (0.72)
Philippines	—	—	—	—	-0.038 (0.10)	2.06 (0.90)	0.031* (0.01)	1.76 (0.86)
Algeria	0.102 (0.09)	1.53 (0.65)	0.099* (0.02)	1.68 (0.59)	-0.074 (0.09)	0.66 (0.88)	0.004 (0.01)	0.70 (0.82)
Tunisia	—	—	—	—	-0.330* (0.01)	2.10 (0.78)	0.252 (0.25)	1.50 (0.73)
Morocco	—	—	—	—	0.008 (0.10)	1.91 (0.84)	-0.035* (0.01)	2.13 (0.86)
Iran	0.051* (0.03)	2.46 (0.54)	-0.004 (0.01)	2.06 (0.29)	—	—	—	—
Egypt	—	—	—	—	0.003 (0.05)	1.20 (0.85)	-0.080* (0.04)	0.90 (0.81)
Bangladesh	-0.149 (0.14)	1.35 (0.79)	0.032* (0.01)	1.63 (0.79)	0.189* (0.10)	2.04 (0.73)	-0.003 (0.01)	1.19 (0.59)
Venezuela	—	—	—	—	0.084 (0.15)	2.09 (0.47)	0.058* (0.009)	2.49 (0.52)

Note: An asterisk (*) denotes significance at the 10% level.

The conventional PTM model provided evidence of market imperfection and price discrimination in several destination markets for all agri-food markets. There was greater support for noncompetitive pricing behavior for U.S. wheat markets. In general, most Canadian exporters, apart from tobacco, adjusted price markups to amplify the effect of exchange rate fluctuations on foreign buyer prices. In contrast, U.S. exporters tended to offset the effect of exchange rate changes by revising their prices to ensure stability of foreign currency prices for agri-food products. However, incorporating the hypothesis that exchange rates and costs can have a symmetric effect on prices provided evidence of PTM behavior and local currency price stability in Canadian wheat markets such as Italy, the UK, China, and Japan. For U.S. exporters, they tended to increase their profit margins and amplify the effect of exchange rate changes on buyer agri-food prices.

Some factors which may affect export pricing behavior and that warrant further research may include incorporating market structural variables, such as seller concentration in empirical models (Patterson and Abbott). Furthermore, since most of the PTM literature has focused on reduced-form equations, perhaps future research direction should explore structural models of demand and supply (Aw), and examine sources and determinants of market power and the role that trade measures and government intervention policies may play in influencing multiple market price differentials across markets.

A neglected area in the PTM literature has been the role of exchange rate market arrangements. The results of this study indicated that Canadian and U.S. exporters were shipping agri-food products to both developed and developing countries. These countries have varying exchange rate regimes—ranging from countries that pegged their currencies to the U.S. dollar to those that have managed exchange rate systems.

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References

Agriculture and Agri-Food Canada. "Agri-Food Trade Database" and "International Market Bureau Database." Ottawa, Ontario, Canada, 1980–94.

———. "Lentils, Chick Peas, and Durum Wheat." *Agriculture and Agri-Food Canada Biweekly Bulletin* 12,9(21 May 1999).

Alston, J. M., C. A. Carter, and L. S. Jarvis. "Discriminatory Trade: The Case of Japanese Beef and Wheat Imports." Paper presented at Pacific Economic Cooperation Conference: Agricultural Policy, Trade, and Development Task Force, Seoul, Korea, 1989.

Athukorala, P., and J. Menon. "Pricing to Market Behavior and Exchange Rate Pass-Through in Japanese Exports." *Econ. J.* 104(1994):271–81.

Aw, B.-Y. "Price Discrimination and Markups in Export Markets." *J. Develop. Econ.* 42(1993):315–36.

Beghin, J., and F. Hu. "U.S. Tobacco Exports to Australia." *Amer. J. Agr. Econ.* 77(1995):259–67.

Canada-U.S. Joint Commission on Grains. *Canada-U.S. Joint Commission on Grains: Final Report*, Vol. 1. Winnipeg, Manitoba, Canada, October 1995.

Coakley, J., and A. M. Fuertes. "New Panel Unit Root Tests of PPP." *Econ. Letters* 57(1997):17–22.

Food and Agriculture Organization of the United Nations. "FAOSTAT." FAO Database. Online at http://apps.fao.org.

Froot, K. A., and P. D. Klemperer. "Exchange Rate Pass-Through When Market Share Matters." *Amer. Econ. Rev.* 79(1989):637–54.

Gagnon, J. E., and M. M. Knetter. "Markup Adjustment and Exchange Rate Fluctuations: Evidence from Panel Data on Automobile Exports." *J. Internat. Money and Fin.* 14(1995):289–310.

Goldberg, P. K., and M. M. Knetter. "Good Prices and Exchange Rates: What Have We Learned?" *J. Econ. Lit.* 35(1997):1243–72.

———. "Causes and Consequences of the Export Enhancement Program for Wheat." In *The Effects of U.S. Trade Protection and Promotion Policies*, ed., R. C. Feenstra, pp. 273–96. Chicago: University of Chicago Press, 1998.

"Grain Marketing: The Western Grain Marketing Panel Report." Winnipeg, Manitoba, Canada, 1996.

Gron, A., and D. L. Swenson. "Incomplete Exchange Rate Pass-Through and Imperfect Competition: The Effect of Local Production." *Amer. Econ. Rev.* 86(1996):71–76.

Holmes, M. J. "Does Purchasing Power Parity Hold in African Less Developed Countries? Evidence from a Panel Data Unit Root." Econ. Res. Pap. No. 98/21, Dept. of Econ., Loughborough University, 1999.

Hung, W., Y. Kim, and K. Ohno. "Pricing Exports: A Cross-Country Study." *J. Internat. Money and Fin.* 12(1993):3–28.

Im, K., M. Pesaran, and Y. Shin. "Testing for Unit Roots in Heterogeneous Panels." Dept. of Appl. Econ., University of Cambridge, England, 1997.

International Maize and Wheat Improvement Center. "World Wheat Facts and Trends 1995/96: Understanding Global Trends in the Use of Wheat Diversity and International Flows of Wheat Genetic Resources." Mexico, 1996.

International Monetary Fund. *International Financial Statistics Yearbook.* IMF, Washington DC, various years.

Kasa, K. "Adjustment Costs and Pricing to Market: Theory and Evidence." *J. Internat. Econ.* 32(1992): 1–30.

Knetter, M. M. "Price Discrimination by U.S. and German Exporters." *Amer. Econ. Rev.* 79(March 1989): 198–210.

———. "Exchange Rates and Corporate Pricing Strategies." Work. Pap. No. 4151, National Bureau of Economic Research, Cambridge MA, 1992.

———. "International Comparisons of Pricing-to-Market Behavior." *Amer. Econ. Rev.* 83(1993):473–86.

———. "Is Export Price Adjustment Asymmetric? Evaluating the Market Share and Marketing Bottlenecks Hypotheses." *J. Internat. Money and Fin.* 3(1994):55–70.

———. "Pricing to Market in Response to Unobservable and Observable Shocks." *Internat. Econ. J.* 9(1995):1–25.

Krugman, P. "Pricing to Market When the Exchange Rate Changes." In *Real Financial Linkages Among Open Economies*, eds., S. W. Arndt and J. D. Richardson, pp. 49–70. Cambridge MA: MIT Press, 1987.

Levin, A., and C. F. Lin. "Unit Root Tests in Panel Data: Asymptotic and Finite Sample Properties." Discus. Pap. No. 92-23, Dept. of Econ., University of California, San Diego, May 1992.

MacDonald, R. "Panel Unit Root Tests and Real Exchange Rates." *Econ. Letters* 50,1(1996):7–11.

Marston, R. C. "Pricing to Market in Japanese Manufacturing." *J. Internat. Econ.* 29(1990):217–36.

McCoskey, S. K., and T. M. Selden. "Health Care Expenditures and GDP: Panel Data Unit Root Test Results." *J. Health Econ.* 17(1998):369–76.

Ohno, K. "Export Pricing Behavior of Manufacturing: A U.S.-Japan Comparison." *International Monetary Fund Staff Papers* 36(1989):550–79.

Patterson, P. M., and P. C. Abbott. "Further Evidence on Competition in the U.S. Grain Export Trade." *J. Industrial Econ.* 62(1994):429–37.

Pick, D. H., and C. A. Carter. "Pricing to Market with Transactions Denominated in a Common Currency." *Amer. J. Agr. Econ.* 76(1994):55–60.

Pick, D. H., and T. A. Park. "The Competitive Structure of U.S. Agricultural Exports." *Amer. J. Agr. Econ.* 73(February 1991):133–41.

Pompelli, G. K., and D. H. Pick. "Pass-Through of Exchange Rates and Tariffs in Brazil-U.S. Tobacco." *Amer. J. Agr. Econ.* 72(1990):676–81.

SAS Institute, Inc. *SAS User's Guide, Version 6*, 2nd ed. Cary NC: SAS Institute, Inc., 1993.

Saxonhouse, G. R. "Do Japanese Firms Price Discriminate in North America?" *World Economy* 17(1994): 87–99.

Shapouri, S. Chief of Food Insecurity, USDA/Economic Research Service, Washington DC. Personal communication, 1999.

Skully, D. W. "Price Discrimination and State Trading: The Case of U.S. Wheat." *Eur. Rev. Agr. Econ.* 19(1992):313–29.

Statistics Canada. "Exports by Commodity and Destination." Catalogue No. 65-004. Ottawa, Ontario, Canada, various years.

———. "Merchandise Trade Database." Ottawa, Ontario, Canada, various years.

U.S. Department of Agriculture, Economic Research Service. Unpub. dry peas and lentils export data. USDA/ERS, Washington DC, 1998.

U.S. Department of Agriculture, Foreign Agricultural Service. *Foreign Agricultural Trade of the United States (FATUS).* Various years, 1980–94. Online at http://www.ERS.USDA.gov/db/FATUS.

U.S. International Trade Commission (USITC). "Dry Peas and Lentils: Conditions of Competition Between the United States and Canada in Third-Country Markets." Pub. No. 2627, USITC, Washington DC, 1993.

Veeman, M. "Who Will Market Western Canada's Grain?" *Can. J. Agr. Econ.* 46(1998):1–16.

Yumkella, K. K., L. J. Unnevehr, and P. Garcia. "Noncompetitive Pricing and Exchange Rate Pass-Through in Selected U.S. and Thai Rice Markets." *J. Agr. and Appl. Econ.* 26,2(1994):406–16.

Appendix:
Critical Values of the IPS *t*-Bar Statistic

Table A1. Im, Pesaran, and Shin's Exact Critical Values of *t*-Bar ($T = 15$) Statistic

	Regression w/Intercept			Regression w/Intercept and Trend		
N	1%	5%	10%	1%	5%	10%
10	-2.24	-2.02	-1.90	-2.88	-2.66	-2.54
15	-2.10	-1.92	-1.83	-2.74	-2.57	-2.47

Source: Im, Pesaran, and Shin (1997, table 4).