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Pricing-to-Market and Exchange Rate Pass-Through in the U.S. Broiler Meat Export Markets[1]

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Abstract

The conventional estimation method of the pricing-to-market (the PTM) model in the international trade literature is a within model of panel regression of export prices on exchange rates with time and country dummies. Previous studies have found a significant coefficient parameter in exchange rate variable, which is only indicative of short-run pricing-to-market for multiple export destinations rather than long-run pricing behavior. This paper examines a long-run pricing-to-market for U.S. broiler meat export markets, using "between" panel specification. Findings indicate that the U.S. pricing-to-market behavior of exporters is both transient and persistently long. These results clearly imply that the implementation of a long-run pricing-to-market strategy in the U.S. broiler meat exports mitigates the rising imbalance between the domestic production and consumption via incomplete exchange rate pass-through.

Keywords: pricing-to-market, broiler meat export, within regression, between regression, panel data

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Introduction

The U.S. is the largest poultry producer in the world (Davis et al. 2013). However, one of the concerns that some poultry firms have is the potential imbalance between rising U.S. domestic production and stagnant domestic consumption and its detrimental impact on domestic producer prices. This would also have a major ripple effect on prices and overall poultry revenues as domestic consumption accounts for approximately 80% of their production.

Price analysis has long been one of dominant subjects in agricultural commodity markets. Continuous research on the competitiveness of the export price appears as one of the important focus points of the literature in international economics. In a free market and pure floating exchange rate system, broiler export prices will be the same for all destinations. There will be no country specific effects, and changes in the bilateral exchange rates will not affect bilateral export prices.

On the other hand, in an oligopoly market, an exporter with market power may not pass through exchange rate changes into export prices because of concerns about market shares. Thus, exporters with market power might implement a "long-run pricing-to-market strategy" to keep their market shares on the international market intact or increasing by keeping their foreign price constant despite an appreciation or depreciation of the domestic currency (i.e., incomplete exchange-rate-pass-through).

In theory, "there are two critical assumptions underlying the ability to exercise noncompetitive pricing across markets: first, the markets must be separated in space, time, form or some other dimension. This separation must be maintained so that there is no possibility for arbitrage. Secondly, the response of demand to price changes must differ between markets so that the link between prices and marginal revenues varies in the different markets" (Griffith and Mullen 2001, 324). In the broiler export trade, these assumptions may well be met.

Several models[2] have been developed to examine price behavior of firms with monopoly power across export destinations (Krugman 1987; Dornbusch 1987; Knetter 1989). These models have been used to determine if exporters exercise pricing-to-market in several empirical studies (Carew 2000; Griffith and Mullen 2001; Miljkovic et al. 2003). Earlier research used a two-way fixed effects (or within) regression model in which an exchange rate variable is used to measure

[2] Before a new trade theory was introduced into the industrial organizational literature, the conventional approach to measure market power was the Lener's index. Lener's index is a ratio of mark-up of price to marginal cost. However, the estimation of the actual marginal cost to calculate the Lerner's degree of monopoly power is quite challenging and accounting data are not appropriate to measure marginal cost (Fisher and McGowan 1983).

Krugman (1987), the founding father of the new trade theory, popularized a simple specification of the bivariate relationship between export prices and exchange rates to examine the pricing-to-market behavior of exporters, based on the theory that an exporter with market power can keep its destination-specific import prices unchanged or raise it when an importer's currency appreciates relative to the exporter's currency or vice versa. The advantage of the Krugman's PTM model is its simplicity of specification and interpretation. This study follows his convention by employing two variables: export price and exchange rates.

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the exchange rate pass-through for an individual importing country with two dummy variables being used to capture common time effect and country effect. General interpretation of significant exchange rate coefficients in the traditional two-way within model is that exchange-rate changes are associated with markup variation that is specific to each destination market. At the same time, the country control variable is assumed to capture different quality and markup across markets that do not vary over time, while the time control variable is used to capture the change in markups that is common-across-markets.

Econometrically, the single two-way within specification regresses the country-specific deviations from the mean (an average across countries) of the dependent variable on the country-specific deviations from the means of the independent variables. Therefore, the exchange rate coefficient obtained from a single country-level within regression should be interpreted as an estimate of a short-term or transient noncompetitive pricing, because the specification is focused on movements away from the estimates of complete exchange pass-through from year to year. Thus, the use of the single within model is not warranted to examine "long-run pricing-to-market strategy" of noncompetitive exporters, which requires a time-average component in estimation.

Baltagi (2005, 21) and more recently, Chernenko and Faulkender (2011) suggested an alternative approach to the conventional two-way within model for long-run analysis. They argued that a "between" specification in panel data provides an estimate of long run pricing behavior of pricing-to-market. Their argument is based on the fact that a between specification in a panel data analysis regresses the mean (an average across time) of the dependent variable on the means of the independent variables over the entire sample period. Hence, a coefficient estimates in the exchange variable from the between regression yields an appropriate estimate for a time-averaged long-run pricing across export destination markets.

The primary objective of this study is to examine a long-run as well as a short-run pricing-to-market for U.S. broiler meat exporters, using within regression and between regression. Within regression results show how broiler meat exporters implement short-term pricing-to-market behavior. On the contrary, the between regression results display how broiler meat exporters execute their long-run pricing strategy through exchange rate pass-through. One of the contributions of this paper is the introduction of between regression, which is a new attempt to examine long-run pricing-to-market in U.S. poultry meat exports.

U.S. Broiler Meat Exports

Over the period of 1990 to 2011, U.S. broiler exports have experienced a tremendous surge in volume from 1.1 billion pounds in 1990 to 7.0 billion pounds in 2011 (U.S. Commerce 1990-2011). This growth was the result of larger shipments to traditional markets such as Canada and Mexico; the opening of trade to countries such as Russia, China, and Cuba; and the development of new markets for U.S. broiler products in Asia, the Middle East, and Africa.

The growth in volume of U.S. broiler exports has not been a steady progression. With access to the Russian market, exports grew rapidly in late 1990's and reached 5.5 billion pounds in 2001

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(U.S. Commerce 1990-2011). However, with Russia placing restrictions on imports, overall exports later declined and it was six years before total exports exceeded the 2001 level.

Changes in export demand have different impacts on prices for various broiler parts. Sales of breast meat, either bone-in or boneless product, are almost exclusively a domestic product and are not greatly impacted by export demand. A much greater percentage of parts such as leg quarters and wings are exported and therefore their prices are more directly affected by varying export demand.

Annual average prices for broiler leg quarters have ranged from $0.19 per pound in 1999 to $0.47 per pound in 2011 (USDA-AMS 1990-2011). A good example of the impact of changes in exports on broiler parts prices is in the 2001-2002 period. At this time, leg quarter shipments were the largest portion of overall broiler exports, with Russia being the primary market. With exports expanding especially to the Russian market, prices for leg quarters averaged $0.28 per pound in 2001 and prices averaged over $0.30 per pound in the second half of the year (USDA-AMS 1990-2011). However, when Russia placed restrictions on broiler imports from the United States, prices for broiler exports fell sharply. In 2002, the average price for leg quarters declined to only $0.20 per pound (USDA-AMS 1990-2011). Prices for leg quarters only gradually increased in the following years as increased domestic production and declining shipments combined to limit price increases.

Prices for wings varied widely in the period 2000 to 2011 after being relatively stable in the previous decade. In 2003, wing prices averaged $0.77 per pound, but with increased exports to China and growing domestic demand, the average price rose 44 percent to $1.11 per pound in 2004. Wing prices then varied strongly in the next several years with the average price falling in both 2005 and 2006 before again increasing sharply to $1.23 per pound in 2007 (up 41 percent from the previous year.

With the largest single broiler export product being frozen leg quarters, overall unit prices for exports have been heavily influenced by changes in this price. In the first several years of the 1990's, overall unit values for all broiler exports were relatively stable, averaging in the low $0.40's per pound (USDA-ERS). With large increases in U.S. production placing downward pressure on prices, average unit values fell to around $0.30 per pound in the early 2000's. Partially, this was a response to the decrease in leg quarter exports and the steep fall in their price in 2002 pushed average unit values to only $0.29 per pound (USDA-ERS). Since 2002, average unit prices for all broiler exports have been gradually rising with the average unit value reaching $0.52 per pound in 2011 (USDA-ERS).

In a recent publication, Davis et al. (2013) assessed the growth of U.S. poultry meat exports and attributes the surge in U.S. broiler exports to world economic growth, the continued concentration of population growth in urban centers, and the value of the U.S. dollar relative to currencies in importing countries. Out of these factors, this study further examines a bivariate relationship between U.S. exchange rates and poultry trade prices to explain U.S. dominance in the broiler exports.

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Literature Reviews

Understanding the factors affecting price and exchange rate behavior between international and domestic trading partners is an important concept that impacts the viability of countries' national income and companies' profitability. Although traditional trade theory of law of one price predicts a complete pass-through exchange rate into trade prices, a battery of empirical studies on agricultural commodity exports reported evidence against the theoretical predictions. Poultry companies and other meat industries are paying close attention when importing countries' local product price does not correspond to fluctuations in exchange rates.

Studies that analyze price and exchange rate pass-through are thoroughly discussed in the pricing-to-market (PTM) literature involving various agricultural commodities from different countries. Pick and Park (1991) applied the PTM model to examine the competitive structure of U.S. agricultural exports: wheat, corn, cotton soybean, and soybean meal and oil. Their empirical results indicated that the U.S. firms have not exercised price discrimination across destination markets for cotton, corn, and soybeans. In order to examine the pricing behavior of Canadian and U.S. argi-food exporters, Carew (2000) selected wheat, pulse, and tobacco that differ in institutional market arrangements and demand characteristics. He employed the PTM model and confirmed the evidence of pricing-to-market for both the U.S. and Canadian exporters.

The PTM model has also been applied to meat products in numerous studies including (Swift 2000; Miljkovic et al. 2003; Zhao et al. 2011). Swift (2000) examined the pass-through of exchange rate changes to prices of Australian dairy and livestock exports. Their findings reveal that the pass-through of Australian dairy export prices is complete, but there is an inconsistent relationship between exchange rates and prices for other livestock products.

Miljkovic et al. (2003) examined the impact of exchange rate pass-through and price discrimination from a U.S. meat export prices perspective. Their findings suggested that there were several incomplete exchange-rate pass-through that took place in meat trade between the U.S. and other countries. Findings for this study also suggested that trade liberalization, particularly GATT, had a positive impact on U.S. beef and poultry export prices.

Zhao et al. (2011) analyzed price pass-through for beef cattle prices. They noted that in an efficient market, feeder cattle prices should be products of present feed prices and future fed cattle prices. Findings from their study suggest that fed cattle price accounts for about 93% of complete pass-through. They also found that increases in corn price had a negative impact on feeder cattle price with pass-through of about 87% of the corn price change.

Exclusive estimation method of the PTM in the earlier studies is a within specification of panel regression that is only to provide a short-run pricing behavior in export destination markets. For complete analysis, this study introduces a between specification of panel to document a long-run pricing-to-market strategy of U.S. broiler exporters. In addition, this paper compares and contrasts a within model and a between model in terms of estimating a short-run and a long-run non-competitive pricing in the broiler export markets.

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Model Development

A body of literature on pricing to market model of Krugman (1987), Dornbusch (1987) and Knetter (1989) (hereafter KDK model) and their econometric methods were reviewed initially. These economic models are important and essential in that they yield an econometric model to estimate the PTM model for short-run analysis.

Consider an exporter who has market power and can use exchange rate changes in order to "price to market." Then, assume that this exporter maximizes profit by selling poultry to *N* foreign destinations, each with a unique demand function. Also, presume that this exporter can behave as a monopolist, segmenting markets and adjusting export prices to bilateral exchange rate changes. Note that demand in each market (Q_{it}) is represented as,

(1) $Q_{it} = f(E_{it}P_{it})\, v_{it}$, $i = 1, \ldots, N$ and $t = 1, \ldots, T$,

where P_{it} is price in terms of the exporter's currency, E_{it} reflects the market specific exchange rate in period *t*, where the observations corresponding to the prices in country *i* are the market-specific exchange rate, and zero when there is no trade. v_{it} is a random variable that may shift demand in market *i* in period t.

The exporter's cost is given by

(2) $C_t = C\left(\sum Q_{it}\right)\delta_t$, $t = 1, \ldots, T$,

where C_t measures costs in the exporter's domestic currency units, which are summed over all destination markets, and δ_t is a random variable that may shift the cost function (e.g., changes in input prices) in period *t*. Substituting equation (1) for Q_{it} in equation (2), the maximization problem becomes

(3) $\text{Max } \Pi = \sum\left[P_{it} f(E_{it}P_{it})v_{it}\right] - C\{\sum[f(E_{it}P_{it})v_{it}]\}\delta_t$.

Differentiating equation (3) with respect to P_{it} and expressing in terms of elasticities, the first order conditions are

(4) $P_{it} = c_t\left(\dfrac{\varepsilon_t^i}{\varepsilon_t^i - 1}\right)$, $i = 1,\ldots, N$ and $t = 1,\ldots,T$,

where c_t is the marginal cost ($\dfrac{\Delta C}{\Delta Q}$) of production in period *t* and ε_t^i is the demand elasticity for imports in importing country *i* in period t. Equation (4) states that the price discriminating monopolist will equate marginal cost to marginal revenue in each market.

If the elasticity of demand in the importing country is not constant, then changes in the bilateral exchange rate between the exporter and the importer will cause the optimal markup to change. When demand schedules are less convex than a constant elasticity schedule, elasticity of demand

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increases with increases in price or vice versa (Knetter 1989)[3]. Markups of price over cost fall when the exporter's currency appreciates.

Pick and Park (1991) states that mark-up: $\frac{P_{it} - MC}{P_{it}} = -\frac{1}{\varepsilon_t^i}$ For the competitive firm, MR= P = MC, the right hand side equation equals zero, which means that the elasticity of demand in the right hand side equation should be infinitely large (e.g., price taker).

To test whether exporters can vary prices across destinations or with changes in exchanges rates, they define an empirical model:

(5) $\ln P_{i,t} = \alpha + \sum \phi_t x_t + \sum \lambda_i x_i + \sum \beta_i \ln E_{i,t} + u_{i,t}$, i = 1, …, N and t = 1, … , T, where

$P_{i,t}$ is the export unit value to market destination country i in period t; x_t is a dummy variable to cap the exporting country; ϕ_t measures the time effect corresponding to the t periods; λ_i measures the country effect corresponding to the individual i destination markets; β_i measures the exchange rate pass-through for the individual i countries; and $u_{i,t}$ is error term.

The two-way within regression model in equation (5) examines export pricing behavior across destination markets. The identifying assumptions are that λ_i measure the country effect corresponding to the individual i destination markets and that β_i measure the exchange rate pass-through for the individual i countries, while $u_{i,t}$ is error term. However, if exporting countries use changes in exchange rates only for a long-run pricing-to- market strategy, not for short-run pricing-to-market, but then it is no longer clear how to interpret the empirical findings of Yumkella et al. (1994) and Griffith and Mullen (2001).

The paper proposes an alternative and direct panel analysis for estimating a long-run pricing-to-market strategy: a between estimator. Econometrically, a within estimator estimates short-run effects, because it is based on the time series component of the data. The within estimator regresses the country-specific deviations from the mean of the dependent variable on the country-specific deviations from the means of the independent variables as such:

(6) $\ln(p_{i,t} - \frac{1}{T}\sum P_i) = \alpha + \beta \ln(E_{i,t} - \frac{1}{T}\sum E_i) + u_i$, i = 1, …, N and t = 1, …, T,

where β = a measure of noncompetitive pricing, because the estimator focuses on movements away from the estimates of complete exchange pass-through from year to year price. E_{it} reflects the market specific exchange rate in period t, where the observations corresponding to the prices in country i are the market-specific exchange rate, and zero otherwise.

In practice, one can take several steps to make equation (6) easily estimable. For example, take the data on individual country i as in

(7) $P_{i,t} = \alpha + \beta E_{i,t} + v_i$, i = 1, …, N and t = 1, … , T,

[3] As a strong assumption suggested by an anonymous reviewer, all the importers might have the same demand schedules, but are different location on it, because of other non-homothetic demand shifters.

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Next, average the data across time by summing both sides of the equation for each country and dividing by the number of periods, T. Then, subtract the time-averaged equation from equation (7) and take logarithm to the both sides. These elaborate steps yield an estimable single equation (6) for the entire panel data. It is a usual practice in estimating panel data models that one is more interested in the coefficients of the explanatory variables and not the individual intercept parameters (Hill et al. 2008, 395). In this study, an econometric software package, E-views was used to estimate equation (6).

On the other hand, the between estimator (cross sectional only) measures the long-run effects; it tells us the price discrimination. It regresses the mean of the dependent variable on the means of the independent variables as follows:

$$(8) \quad \ln(\frac{1}{T}\sum p_i) = \alpha + \beta \ln(\frac{1}{T}\sum E_i) + u_i, \; Ii = 1,\ldots, \mathrm{N},$$

where β = a measure of pricing-to-market across export destination markets due to estimation of cross-sectional variables over the long- run, E_i reflects the market specific exchange rate of exporting country *i* on time average.

Results from country-level within regression can be interpreted as explaining transient pricing-to-market practices, since the specification focus on movements away from the estimate of the firm's constant unit export price. The coefficients generated by this specification explain which country variables are associated with deviations from the firm's average position. On the other hand, a significant coefficient in the exchange variable in the between estimator is more likely to be associated with a long-run pricing-to-market strategy. A coefficient of -1 on the exchange variable indicates a complete exchange rate pass through; 0 shows no pass-through. A coefficient between these two numbers suggests incomplete pass-through, indicating evidence of pricing-to-market. This decomposition enables us to show an individual evidence for a short-run pricing-to-market practice and a long-run pricing-to-market strategy separately. These dichotomized empirical results have not been documented in the previous monotonic pricing-to-market (PTM) research.

Our hypothesis is motivated by the literature and theory which suggests that the long-run impact on economic variables matters. All the previous pricing-to-market research in panel analysis used a within effects model, which only produces an estimate for a short-run pricing-to-market practice. Moreover, a significant short-run pricing-to-market estimate is not warranted to fully describe a long-run pricing strategy in which expanding market shares might be one of solutions to a rising imbalance between U.S. domestic broiler production and domestic consumption.

Data

The U.S broiler industry ships its meats to 109 countries (FAS, USDA). Among these export destinations, 36 countries are selected for this study. Although ideal panel data should include all the export destination countries, sufficient long panel and data continuity renders about one third of the universe useable for analysis. These 36 countries accounted for over 75% of total U.S. export broiler trade. Annual export value ($) and export volume (1,000 kg) for the selected countries are obtained from the USDA/FAS website at http://apps.fas.usda.gov/gats/default.aspx.

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The data span from 1990 to 2011. Exchange rates in direct quotations (U.S. dollars per a foreign currency) are obtained from International Financial Statistics. The study adopts a panel analysis used by Baltagi (2005) and Chernenko and Faulkender (2011). It employs a within and a between specifications in panel data to appropriately capture pricing behavior of U.S. broiler meat exports to the selected destination markets.

Empirical Results

The paper decomposes pricing-to-market activities into their cross-sectional (between regression) and time-series components (within regression). The significant negative coefficient in the within specification in Table 1 indicates that incomplete exchange-rate pass-through occurs for U.S broiler meat exports. Export prices are adjusted upward by 4.6% for a 10% appreciation of the U.S. dollar relative to the foreign currencies. A significant "between" exchange rate coefficient parameter (*p*-value = 0.025 not reported in Table 1) indicates that the broiler meat exports persistently exercise non-competitive pricing. In the long run, exporters would adjust their prices upward by only 0.54% for a 10% appreciation of the U.S. dollar relative to the foreign currencies. The mix of the short-run pricing practice and the long-run pricing-to-market strategy across U.S. export destinations could explain the ample growth of U.S. broiler meat exports during the sample period. For managers and policymakers, this study suggests that U.S. broiler meat exporters have been making a considerable effort to expand their international markets, and its long-run pricing-to-market strategy appears to work through incomplete exchange rate pass-through.

Table 1. Within and Between Estimations for Impacts of Exchange Rates on U.S. Broiler Meat Export Prices: 1990-2011

	α		β		r^2
OLS	-0.0904		-0.0531		0.07
	(-4.97)	**	(-7.71)	**	
Within	-0.6604		-0.4562		0.49
	(-7.37)	**	(-7.26)	**	
Between	-0.0446		-0.0541		0.11
	(-0.74)		(-2.34)	**	

Note. Coefficients are elasticities and numbers in parentheses are t-statistics. ** indicates a statistical significance level of 5%.

In fact, expanding market-shares of U.S. broiler meat exports by implementing incomplete exchange rates pass-through has been a strategically viable plan, given the rising imbalance between U.S. domestic broiler production and consumption. Between 1997 and 2012, U.S. broiler meat production rose by 35.8%, from 12.2 mmt in 1997 to a high of 16.6 mmt in 2012; on the contrary, domestic per head broiler consumption showed a tepid growth of 12.5% from 32.4 kg per head to 36.5 kg per head during the same period.

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Discussion

The conventional econometric model to examine exporter's price behavior across its destinations is a two-way within model of panel regression of exchange rates on export prices with time and country dummies. Findings of a significant coefficient parameter in the exchange rate variable on the conventional within model ought to be interpreted as evidence of short-run pricing-to-market only. On the other hand, between specification produces a parameter estimate for long-run pricing-to-market behavior.

This study found statistically significant coefficients in the within and the between model, indicating that the pricing-to-market of U.S. broiler exporters across their export destinations are both transient and persistently long. These results add further evidence of pricing-to-market behavior in the exchange rate pass-through literature. Furthermore, the negative significant coefficients in both the within and the between models agree with what Davis et al. (2014) found and suggest that U.S. broiler meat exporters offer broiler meat at a partially-exchange-rate adjusted price to defend its market share in the selected destination markets, followed by a strong appreciation of U.S. dollar relative to the currencies of the importing countries.

The potential imbalance between rising U.S. domestic production and stagnant domestic consumption could be a major concern, because a stagnant domestic consumption tends to put a downward pressure on price. In 2013, the U.S. accounted for about 23% of the world's broiler meat exports, while Brazil accounted for about 24% (GTIS 2015). U.S broiler meat exporters operating in oligopoly markets perceive export volumes rather than export prices to be their strategic variable to accommodate an outgrowth of domestic production. On average, the U.S. broiler meat exporters exercise a price-to-market strategy in their export markets, monetizing differential incomes and demand elasticities across export destination markets. Information on pricing-to-market behavior in the long-run as well as in the short-run could prove to be beneficial to the poultry industry because it allows for better timing of decisions given volatile exchange rate changes.

Lastly, this study shows that the outgrowth problem of U.S. broiler meat production has generated ample opportunities to U.S. broiler meat exporters. In other words, by implementing a long-run pricing-to-market strategy, U.S. exporters, who operate in the oligopoly market, have managed to mitigate a rising imbalance between the domestic production and consumption via incomplete exchange rate pass-through. In general, it is expected that if broiler export demand rises, domestic consumers will pay higher prices for broiler meat, which implies that producers will experience gains, while consumers will lose in the analysis of welfare.

Examination of a long run pricing-to-market in poultry export markets also has several merits in implications for policy. First and foremost, policy makers must be careful when evaluating policy impacts; policies may be ineffective in the short run but in the long run proved to be effective. Therefore, policy evaluation procedures should not be implemented too soon. Secondly, policy makers who are aware, a priori, that impacts vary across time, can better time their decision making if differences between long and short run impacts are known. Finally, policy makers can use these differences to dampen short run expectations on part of business and consumers who will be influenced by exchange rate changes.

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