PRICING TO MARKET AND INTERANTIONAL TRADE EVIDENCE FROM US AGRICULTRUAL EXPORTS

DISSERTATION

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By

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ABSTRACT

This dissertation examines whether US exporters of agricultural commodities, including wheat, beef, pork, corn, soybean and lettuce, price to market in both a monopolistic and an oligopolistic framework. US exporters' pricing behavior in the world market can be revealed by the relationships between US export prices and exchange rates only after other relevant variables are taken into account.

In a static monopolistic framework, considering the seasonality characteristics of prices and costs of agricultural products, a seasonal error correction model (SECM) is estimated. This study is the first one to apply the concepts of seasonal cointegration and seasonal common trends in the study of pricing to market (PTM). In cases where seasonal cointegration is rejected by the hypothesis test, a vector error correction model (VECM) is used to account for the non-stationary property of the data. The fixed-effects model of Knetter (1989; 1995) is also estimated to show any discrepancies between the results of the cointegration model and the fixed-effects regression. The results from the cointegration method confirm strong imperfect competition and destination-specific characteristics of PTM behavior. Specifically, US agricultural exporters are more likely to magnify the impact of exchange rate changes for exports to Japan, Canada, and the Philippines, while trying to absorb fluctuation in exchange rates in order to stabilize local currency prices for exports to South Korea, Mexico, Singapore, and Hong Kong. Different price responses imply that under depreciations of the US dollar, exports to the former group of countries will increase but have a smaller effect on improving the US trade balance than in the case of perfect competition, while exports to the latter group of countries will increase by a relatively small percentage, which results in an ambiguous impact on the US trade balance.

In an oligopolistic framework, an effort has been made to tackle the most controversial issue in the study of PTM, that is, whether the nominal or real exchange rate is more significant in influencing pricing decisions. This study successfully distinguishes different roles of the two exchange rates in export pricing strategies by introducing the level of the nominal exchange rate and the first difference of the real exchange rate in the estimation equation. The results, using the destination-aggregated data of US agricultural exports, show that imperfect competition exists in US wheat, beef, pork, and corn export markets. For beef, pork, and corn exports, the objective of US exporters is to keep local currency prices stable, which to some extent mitigates the export-enhancing effect of depreciations of the US dollar. The exceptional case is US wheat exports, in which a large increase in exports results from depreciations of the US dollar. Taking into account the huge export subsidies that US wheat exporters receive from the US Export Enhancement Program (EEP), US agricultural exporters tend to keep price-stabilizing strategies unless strong financial support from the government is available. Therefore, the depreciation of the US dollar is not sufficient for improving the US agricultural trade balance without governmental export supports.

From the long run perspective, the nominal exchange rate has no effect on export prices of soybeans and lettuce, but a significantly price-mitigating effect of the nominal exchange rate exists with respect to short run adjustment. The real exchange rate exhibits a strong price-enhancing effect on export prices in most selected products except wheat, after the effect of the nominal exchange rate is taken into account. This result strongly supports my hypothesis that the real exchange rate works as an indicator of the export product's international competitiveness in determining export prices.

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CHAPTER 1

INTRODUCTION

1.1 Problem statement

Until the early 1970s, the Bretton Woods system was effective in controlling and maintaining the currency exchange rate among countries within a fixed value in terms of gold. In the face of increasing criticism, as a result of increased speculative flows of currency and lack of freedom for countries to pursue their own monetary and fiscal policies, however, the system broke down in 1971-73. Large exchange rate fluctuations among the major world currencies following this collapse have stimulated heated discussion about the effect of exchange rate changes on trade prices, inflation rates and trade balances. Meanwhile, in order to mitigate adverse effects of increased exchange rate risks, governments have resorted to increased protectionism, i.e., economic policies of restricting trade between nations through methods such as tariffs on imported goods, quotas, and anti-dumping laws. Protectionism has led to different kinds of measures and policies to protect home producers and consumers.[1] As a result, free trade across countries has been interfered with. Price transmission across countries and the competitive structure of the international market have also become more complicated.

[1] For example, the US Meat Import Act of 1979 established an overall import quota to restrict US beef imports. Japanese automobile companies were subject to voluntary export quotas in the United States (1981-1994). Japan used a tariff-rate quota (TRQ) system for rice imports from 1999.

The traditional Keynesian approach, widely used to resolve international price transmission problems, has been known to generate price-level inertia in terms of the domestic currency (producer's currency) rather than the foreign currency (buyer's currency) (Dornbusch 1976). [2] This price inertia is usually called 'producer currency pricing' (PCP) since prices are stabilized in the producers' currency, at least in the short term. Domestic currency devaluation will generate an immediate foreign price decrease. The lower prices of exported goods facing foreign consumers will lead to a re-direction of global demand in favor of domestic products. According to the same rule, domestic consumers will face higher prices of imported goods in their devalued currency, which will shift domestic demand away from imports toward domestically produced tradables and non-tradables. The reallocation of both domestic and world demand, the so-called expenditure-switching effect of exchange rates, tends to improve the current account and mitigate the relative price movement.

The sluggish adjustment in the US current account balance following depreciation of the dollar from its 1985 peak, however, was inconsistent with this traditional Keynesian supposition. The short-to-medium-run stickiness of individual prices in terms of local currency has often been observed in empirical studies. This pricing behavior has been termed as 'local currency price stability' (LCP)[3], as opposed to the traditional 'producer currency pricing' (PCP), which means prices are set or sticky in the currency of the buyers and do not change at high frequencies. In this case, exchange rate depreciations will simply induce an income redistribution which raises home income relative to foreign income and raises demand of home consumers for home and foreign goods alike. Thus there is no mitigating reallocation of demand away from foreign goods.[4]

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[2] In order for consistent understanding about varied terms for trading partners in the international market, it should be emphasized that the exporting country is also called the home or domestic country (market), and the importing country is also called the foreign, destination, or local country (market).

[3] See, for example, Krugman (1987), Knetter (1989), Marston (1990), and Betts and Devereux (1996, 2000), among many others.

[4] See, for example, Betts and Devereux (1996), Obstfeld and Rogoff (2000), and many other studies.

The difference among the above propositions about effects of exchange rate changes really hinges on the relationship between exchange rates and trade prices. With regard to the equilibrium trade prices in the international market, one widely accepted reference point is that under perfect competition, the prices of homogeneous tradables are the same with costless transportation (the law of one price, thereafter LOP), or prices change in a constant proportion to each other with a relatively stable transportation cost (relative law of one price). More recent empirical studies, however, have shown that the prices of traded goods appear to have been relatively insulated from short-run exchange rate volatility, and confirmed the absence of substantial transmission of exchange-rate-induced price changes from one country to another, which leads to the systematic departure from the LOP.

In order to accommodate this inertia response of prices to exchange rate volatility, international economists have promoted a sequence of more complex models of international price behavior, in which the LOP has been subject to various modifications. By introducing the terminology 'pricing to market' (thereafter PTM), Krugman (1987) made one of the most significant contributions. He stated that if exporters have some market power and markets are segmented, they may charge differential prices for the same product over different destination markets relative to exchange rate movements and the local demand structure in a particular importing country.[5] Although Krugman (1987) does not provide a definitive formulation of the effect of PTM, he does point out that PTM is an economic theorem that incorporates effects of exchange rates on trade prices, market power, market segmentation, and price discrimination. His idea has inspired numerous international economists to study how these important yet different economic concepts integrate and coordinate with each other. Furthermore, they have been trying to

[5] In the case with fully flexible nominal prices, PTM has no aggregate implications for any kinds of shocks. However, the most recent work in the new open economy macroeconomics has been built on a PTM-LCP paradigm. One exception is Obstfeld and Rogoff (2000) in which the domestic-currency and foreign-currency prices of home goods are assumed equally flexible in principle. But domestic wages are rigid, so that markup pricing turns out to involve rigidity in the domestic-currency prices of home goods. This model allows PTM. Even though the authors do not conclude that their model is better than the recently popular PTM-LCP alternative, they show that observed correlations between terms of trade and exchange rates are more consistent with their tradition assumptions about nominal rigidities than the popular alternative based on LCP.

offer a reasonably convincing definition of PTM and to apply this definition to specific models in order to explain the stylized facts in international markets. How then has the PTM theorem been developed to accommodate these economic terms? What new findings can be derived from the application of PTM to the international trading system?

The price denomination of agricultural traded goods is flexible in practice. There is no presumption or predominant rule for price stickiness in international agricultural trade. Therefore, any results for international price transmission of agricultural commodities are an empirical matter, which requires more careful and detailed examination. Meanwhile, even though PTM has been characterized by imperfect competition and product differentiation, it is worthwhile to study exports of agricultural products - not only because exchange rates have been argued to be major determinants of agricultural trade flows since Schuh (1974), but also non-tariff barriers (NTB) or quantitative restrictions, such as import quotas, health and safety regulations and import licensing restrictions, have quite often applied in agricultural international trade (Bhagwati 1996). These restrictions, whether treated as causing an import premium or included as the reason for structural changes in the price adjustment process in response to exchange rate changes, will definitely be able to furnish exporters some market power to price discriminate, and complicate analysis of export pricing behavior and result in product-specific and destination-specific results and interpretations. So has the PTM theorem been enhanced or weakened empirically by its application to international agricultural trade?

1.2 Significance of the Study

This analysis will build on recent work on PTM and extend it in several ways. First, this study will focus on US international agricultural trade because the United States is not only a typical representative of large trading countries, but one of the most significant countries whose agricultural trade is often dominated either by state trading agencies with monopoly power or by a few large firms (Patterson *et al* 1996). It is, therefore, not surprising to expect US agricultural exporters to have the ability to adjust their trading prices in international markets according to changes in relative costs resulting either from changes in production costs or from exchange rate fluctuations.

Second, Knetter's (1989; 1993; 1995) monopolistic PTM model will be extended by a new concern with non-stationary stochastic seasonality in this empirical analysis. If the data are characterized by seasonal unit roots, not just the unit root, simple seasonal adjustments or other methods proposed to deal with non-stationary data may lose a significant part of valuable information about seasonal fluctuations, resulting in mistaken inference about economic relationships between time series data. Therefore, a seasonal error correction model (SECM), which is specifically designed to deal with stochastic seasonality, will be utilized based on the confirmation of seasonal unit roots and seasonal cointegration. This study is the first one to apply the concepts of seasonal cointegration and seasonal common trends in the study of PTM. In cases where seasonal cointegration is rejected, a vector error correction model (VECM), which succeeds in the revelation of long-run and short-run relationships among non-stationary variables, will be used.

Third, an oligopolistic PTM model will be applied, in which a new way to separate the effect of nominal and real exchange rates is proposed. [6] Based on the belief that the nominal exchange rate has an immediate effect on changes in relative price levels, while the real one measures the competitiveness (or productivity) of one particular product in the international market, the two exchange rates play different roles in affecting export price decisions. The effect of the nominal exchange rate, therefore, captures the PTM effect. Changes in the real exchange rate, rather than the level of the real exchange rate, are assumed to be one of important factors affecting exporters' perception about how the particular commodity's competitiveness (or productivity) may move with time. So this term does not directly measure the degree of PTM, but does affect pricing decisions by changing the competitive position of an export commodity. According to this setting, the most controversial issue in the study of PTM, that is, whether the nominal or real exchange rate is more significant in influencing pricing decisions, has been successfully solved. In addition, this setting can avoid the high correlation problem in estimation between contemporaneous levels of two exchange rates.

[6] Oligopolistic PTM models are mainly from Athukorala (1991), Menon (1992; 1995; 1996), and Athukorala and Menon (1994; 1995).

1.3 Organization of the Study

What follows is divided into 6 parts. Chapter 2 presents the theoretical background for the empirical analysis of PTM. In this chapter, some basic concepts related to exchange rates and prices are clarified, and two types of theoretical models, static and dynamic, are introduced in order to understand the relationship between market structure and underlying reasons for PTM. A summary is also included in this section of how different exchange rate measures determine the criterion for the existence of PTM, as well as the timing and magnitude of the effect of exchange rate changes. Chapter 3 discusses the two types of theoretical models of PTM and derives the equations used in estimation. The objective of the first equation derived is to examine the evidence for PTM in US agricultural exports using destination-specific data and the appropriate cointegration methods. The second equation derived serves to treat nominal and real exchange rates separately using relatively high frequency trade-weighted (destination-aggregated) data for effective prices and exchange rates. A summary of previous studies of PTM utilizing a framework similar to this paper follows in chapter 4. Discussion of the data and methodology selection are carried out in chapter 5. Chapter 6 presents the estimation results, and a summary and conclusions are offered in the final chapter.

CHAPTER 2

THEORETICAL BACKGROUND

Integrated versus segmented markets and perfect versus imperfect competition are fundamental characteristics in describing a market. Their differences hinge on the concept of price discrimination. Two popular definitions for price discrimination are by Pigou (1932) and Stigler (1987) (cited in Goldberg and Knetter 1997). Pigou defines price discrimination as different prices for identical goods paid by different consumers, while Stigler sees price discrimination in terms of different ratios of prices to marginal costs charged for two or more similar goods. [7] Stigler enriches Pigou's definition by adding at least two more elements. First, while Pigou makes the strict assumption about identical products, which has usually been violated in empirical tests; Stigler allows the comparison between goods with different product qualities or different cost ingredients. Second, while Pigou succeeds in differentiating market integration from market segmentation without any concerns about market power, the existence of price discrimination according to Stigler's definition will lead to the confirmation of market segmentation, as well as imperfect competition.

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[7] Pigou (1932) categorizes discrimination behavior into three groups, first/second/third degree price discrimination. The first means that prices vary by customer. The second implies that prices vary according to quantities sold, and the third denotes the case in which prices vary by location or by customer segment.
Png (2002) suggests an alternative taxonomy. His division includes complete discrimination, direct segmentation, and indirect segmentation. The first group is characterized by each user's marginal benefit being equal to marginal cost of the item. The second category includes the case in which sellers can condition price on some attribute, such as age or gender, which directly segments the buyers. The last group means sellers rely on some proxy, such as package size, usage quantity, coupon, to indirectly segment buyers.

When the international market is studied, the two sets of market structure characteristics and their relationships become more complicated. The integrated market does not necessarily imply perfect competition in the world market because it can also coexist with imperfect competition. If a monopolistic seller, who would apply a markup-plus-cost pricing strategy, faces well-organized buyers from different countries, price differences across countries can be eliminated in the case of negligible transportation costs across different national markets. On the other hand, market segmentation does not necessarily lead to imperfect competition between two trading countries. [8] The relationship between goods prices and exchange rates becomes the keystone to comprehending the connection among these terms. The idea of 'pricing to market' (PTM) actually originated from this relationship, with export prices chosen to represent the goods prices. The existence of PTM confirms not only segmented markets and imperfect competition in the related markets, but also an important pattern of market behavior – price discrimination. In a segmented market with imperfect competition, price discrimination can always be the representative pricing strategy.

This chapter includes three parts. First, three important topics originating from the relationship between goods prices and exchange rates will be briefly reviewed. This will help readers distinguish the study of PTM from the perplexing literature about goods prices and exchange rates. Second, the PTM model is explored in detail on the basis of static and dynamic frameworks in order to offer a comprehensive analysis of the underlying reasons for PTM. Third, the most controversial term in studying PTM, the exchange rate, is investigated.

2.1 Goods Prices and Exchange Rates

In discussing the relationship between goods prices and exchange rates, it is important to distinguish three popular topics – the law of one price (LOP) or purchasing power parity (PPP), exchange rate pass-through (ERPT), and pricing to market (PTM). The main difference among these three arises from research motivation as articulated by Goldberg and Knetter (1997). The motivation of LOP or PPP research is the integration

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[8] More detailed discussion about the relationships can be found in Goldberg and Knetter (1997), and Brauer (2003).

of the global economy. On the other hand, studying ERPT is aimed at understanding the adjustment process of the balance of payments and domestic inflation. The study of PTM is motivated by revealing information about the competitive structure in international markets. However, they share the same components of empirical regression equations, that is, price series as dependent variables and exchange rates as part of a set of independent variables. This comes directly from the equation formulation; however, this commonality is not enough to reveal the underlying relationships among the three topics. Goldberg and Knetter (1997) suggest the rejection of LOP results in the study of ERPT and PTM. Thus, ERPT and PTM are two sides of the same coin, with the difference that ERPT is studied from the importers' perspective, while PTM is from the exporters' perspective. [9]

LOP is defined as the same common-currency selling price for identical goods in different countries. When individual prices are replaced with aggregate price levels, the LOP becomes purchasing power parity (PPP). Empirically, failure to reject LOP across different national markets confirms market integration. It is easy to understand the rejection of PPP because of the inclusion of autarky prices of non-traded goods into aggregate price levels. Even though the autarky prices may be correlated contemporaneously, there is no way to guarantee that consumers pay the same prices for identical goods since firms in various markets have different technologies and pay different wages to workers. A large body of evidence spanning several decades concludes that LOP does not hold closely either, even for fairly disaggregated commodity categories (Rogoff 1996). The failure of LOP partly results from the component of non-tradable ingredients, such as rent, distribution service, and advertising, incorporated into consumer prices for tradable goods. Border effects and nominal currency movements are also important in bringing about international price discrepancies.

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[9] Some researchers define the terms PTM and incomplete exchange rate pass through (EPT) in a different way from what I use in my paper. For example, Larue (2004) point out that PTM is referred as the effect of the exchange rate on the ratio of export and domestic prices, while EPT is defined as the impact of the exchange rate on the export price.

ERPT is defined as the percentage of the change in the exchange rate that gets reflected in importing prices as expressed in the local (importer's) currency. "Complete" ERPT implies that exchange rate changes are absorbed entirely into import prices. This has been also called PCP in the literature, since corresponding prices in the producers' currency remain constant. Less than proportionate changes in import prices relative to changes in exchange rates is called "incomplete" ERPT. Incomplete ERPT, however, is not sufficient evidence against market integration. For example, an appreciation of the US dollar will decrease the dollar prices of US imports; more US demand for importing goods will increase world demand since US is a large country in the world market. World prices will increase no matter whether an integrated or segmented international market has been assumed. Therefore, the final dollar price of US imports will fail to fall as much as the appreciation rate of the US dollar, giving rise to incomplete ERPT. In empirical studies, incomplete ERPT is usually regarded as proof of the existence of market power and markup adjustment at the industry level, although this interpretation is not completely beyond doubt. Another important concern for studies of ERPT is the effect of a depreciation of the importers' currency on domestic inflation. If foreign exporters do not increase their prices in the importers' currency, a declining currency will not contribute to continuing inflation.

Krugman (1987) has termed the phenomenon characterized by exporters' price discrimination across different destination markets according to local demand conditions, because of exchange rate movements, as 'pricing to market' (PTM).

If accurate measures of marginal costs are included in exporters' pricing decisions, perfect competition and the related pricing rule of price-equal-to-marginal cost implies that there should be no correlation between exchange rates and export prices in the exporters' currency. [10] If exporters hold some market power in a particular destination market, an exchange rate change may induce export price adjustments, indicating the

[10] Here the accurate measure of marginal cost includes not only production cost, which has usually been assumed common for all importers and variant with the production scale, but also includes the destination-specific added cost, feasibly arising either from transportation, marketing, and distribution, or from tariff, quantity and safety limitation with regard to traded products. Within the destination-specific added cost, the former part has been either assumed relatively constant or variable with production scale in the literature, whereas the latter part has usually been regarded premium-equivalent constant cost.

existence of PTM, as well as price discrimination and imperfect competition. PTM focuses on exports from a single source, which can mitigate departure from the identical goods assumption in tests for price discrimination. Different export prices across importing destinations for the same product obviously indicate that the world market is segmented for this product. Thus, the study of PTM, as Krugman (1987) states, “properly understood almost certainly involves both imperfect competition and dynamics” (Page 49).

Furthermore, the study of PTM has a better chance of controling for the effect of firms’ opportunities for hedging foreign exchange risks than ERPT. Exporters from different countries face different foreign exchange markets, especially those from developing countries in which foreign exchange markets are typically less developed and less liquid, thereby limiting the power to control exchange risks. PTM studies start from one export origin which makes all exporters share the same basket of hedging instruments to control risks. When the common cost factors of goods for domestic consumption and export demand are considered, domestic prices should be correlated with export prices. This linkage, however, may in fact be very weak depending on the fraction of export demand in domestic consumption. So studying PTM cannot offer straightforward evidence for the effect of exchange rates on domestic inflation.

2.2 Pricing to market (PTM) and exchange rates

Relative prices change across national markets more evidently and frequently as a result of bilateral exchange rate changes than technology, production scale, or demand structure changes. This is because exchange rates fluctuate on a daily basis, while changes in the latter part are a long-term phenomenon and actually negligible in the short term. Also, exchange rate changes barely result in any short-run changes in product quality or market structure, which can justify the basis for comparative static analysis. In the literature, consumer prices across countries, chosen as relative prices, lead to the study of LOP or PPP, while export prices lead to the study of the PTM problem. The study of PTM brings about the need to resolve the following practical problem. An exchange rate change, for example the US dollar depreciation against the Japanese yen, lowers US unit labor costs and export prices in yen. Why in this case, will US exporters charge a higher dollar price for exports to Japan relative to other trading partners?

The cost component of export commodities can be the starting point to understanding PTM (Froot and Klemperer 1989). If some of exporters' costs of advertising, selling, and distributing in one specific foreign market are denominated in the foreign currency, domestic currency depreciation will make exporters sell their goods at higher prices in this specific market compared to other foreign markets.[11] Another viewpoint to understanding PTM is quantity constraints that restrict trade across national borders. In this case, once exporters reach the quota limit and, therefore, have no way to sell more, they may find no need to lower their prices when their exchange rate appreciates. Profit margins measured in the local currency will be increased to absorb exchange rate changes. If local currency prices are already at the maximum of what local consumers are willing to accept, a small depreciation of the home currency will not increase local-currency export prices, implying a decrease in home-currency prices.

The dominant literature studying the effects of exchange rates on trade prices basically comes from two perspectives, static and dynamic. The main difference between these two types of models rests in whether an exchange rate change is believed to temporarily or permanently affect exporters' pricing decisions (Krugman 1987). In static analyses, neither the actual nor expected duration of the exchange rate change affects the extent of PTM. Different models of industrial organization have been used to discover disparate facets of PTM. Variation in the impact of exchange rates hinges on three factors (Dornbusch 1987): world market framework (integrated or separated for a particular traded commodity), the extent of substitution between domestic and foreign varieties, and market organization (competitive, monopolistic or oligopolistic, Cournot or Bertrand competition, etc). In dynamic models, exporters make pricing decisions based on their

[11] Gil-Pareja (2003) takes into account the role of invoicing currency by dividing the exchange rate into two groups that use the exporter's or importer's currency for invoicing. His results about the European car market show that local currency price stability is a strong and pervasive phenomenon across products independently of the invoicing currency.

expected long-run costs rather than on their temporary lower costs during a period of strong domestic currency. Although the dynamic approach is more intuitively reasonable, most empirical studies focus on the static assumption of exchange rate effects because of its simplicity in formulation and empirical testing.

2.2.1 Static framework

2.2.1.1 Monopolistic competition

The effect of PTM has been widely studied within a model of monopolistic competition and market segmentation, in which exporters are assumed to determine selling prices and quantities for both domestic and foreign markets according to the corresponding demand structures. In a monopolistic model, the typical pricing rule is that marginal revenue equals marginal cost, which implies that prices charged for different markets are a product of (destination-specific) marginal cost and a markup. So exchange rate changes can affect price from two channels, one from the production side by their effect on the marginal cost, the other from the demand side by their effect on the markup. [12]

First, the case, in which the marginal cost is common for all destination markets but varies over time, is considered. If exporters believe that a destination market is perfectly competitive, the law of price equal to marginal cost will make negligible the effect of exchange rate changes on goods prices, implying no PTM. If the destination market is monopolistic, different demand structures (i.e., different demand elasticities with respect to local currency prices) in local markets may have different implications for price responses to exchange rate changes. The assumed demand frameworks may include constant elastic demand (CES), and more (less) convex demand than CES. Under CES, prices will not fluctuate with exchange rates since demand elasticities are constant over prices, in which a zero effect of exchange rates on trade prices is expected. If the demand

[12] See for instance, Krugman (1987), Hooper and Mann (1989), Knetter (1989), Marston (1990), Athukorala and Menon (1994) and Faruqee (1995), and many others.

is less convex than CES, demand elasticities increase with price. A depreciation of the importing country's currency will raise demand elasticities, and then the reduced optimal markups will result in decreased prices in the exporting country's currency. This connection will be opposite if the demand structure is more convex than CES.

Second, different marginal costs are also reasonable in empirical studies, which even with a CES demand structure, the effect of exchange rates on trade prices still exists. Since exporters have a certain degree of control over their prices in each foreign destination market because of product differentiation or other market imperfections, it is not surprising or unrealistic to suppose that exporters have at least some information about different kinds of costs related to the specific importing markets, and are willing to include them in their pricing decisions. In this case, two more comments about marginal cost have to been made. First, marginal cost has been defined not only to include production cost, which can be treated as common for products destined for all foreign markets, but also include transportation cost, distribution, advertising and servicing costs, and the cost premium from tariff or quantity restraints, which should be regarded as destination-specific. Second, in terms of the second group of costs, if they are treated as constant with trade volume, they are different across destination markets, but common over time. In this case, the relative law of one price holds, which results in no effect of PTM. This is the usual way to deal with the cost (or price) premium from tariff or quantity limits. It is more natural, however, to assume costs of transportation, distribution, advertising and servicing are not only destination-related, but also fluctuate with trade volume. So this part of costs varies across destinations and over time.

If production costs are separable according to destination markets, the pricing behavior under a CES demand structure is similar to that under common costs and differential markups. An appreciation of the home currency against one foreign currency will increase the local price in the foreign country and lower the foreign demand for home exports. If costs are assumed to be convex, which means marginal costs increase with trade volume, home producers can lower export prices in units of home currency in order to offset the price increase in terms of the foreign currency. This implies part of the effect of exchange rate changes will be mitigated. In this case, exporters still prefer local price stability, just as firms stabilize local-currency prices by reducing markups during periods of an appreciating home currency. Whereas when costs are concave, in which marginal costs decrease with trade volume, the enhanced effect of home currency devaluation on prices in the local currency can be anticipated due to decreased marginal transport costs. [13]

If so-called 'search costs' are included in transportation cost, which is the costs related to the process that buyers and sellers can find the right match in international markets, homogeneous products should be differentiated from heterogeneous products according to different roles search costs would play. Higher exchange rate volatility may add more noise to price signals, and hence make transactions more costly. For homogeneous products, such as corn, price is the main decision factor to determine trading transactions. For heterogeneous products, such as television sets or cars, however, trading partners make selling or purchasing decisions based not only on prices but additional characteristics, such as brand. So the search costs for heterogeneous goods include more entries than for homogeneous goods. Based on this concern, Faruqee (1995) concluded that home prices of homogeneous products exhibit a greater linkage with those of foreign competitors than heterogeneous products do, and that intraindustry trade shows a greater destination-specific adjustment than intersectoral trade.

2.2.1.2 Oligopolistic competition

There is no general model of oligopoly in the literature. The most common assumption about oligopolistic market structure is Cournot (quantity) or Bertrand (price) competition. A simple Cournot market was analyzed by Dornbusch (1987) for a homogeneous commodity. In his paper, US exporters' pricing in a foreign market, for example Japan, was discussed. There are n domestic suppliers and n^* foreign firms with respective sales of q and q^* per firm. Aggregate supplies of these firms, $Q = nq + n^*q^*$, sum to market demand, which is a linear function $Q_d = a - bp$, where p is the Japanese

[13] There are also some boundaries about price differentials across countries depending on the level of transport or adjustment costs, beyond which 'gray markets' exist, the same as the arguments about 'gray markets' in the case of markup adjustment.

yen price. The US dollar exchange rate represented by the amount of Japanese yen per unit of dollar is denoted by *e*. So *p/e* is the dollar price offered by US exporters. With *w* and *w** representing unit production costs for domestic and foreign suppliers, the equilibrium price for the homogeneous commodity is obtained by:

$$p = (nw + n^* ew^*) / N + a / bN$$
$$N \equiv n + n^* + 1$$

A dollar appreciation (an increase in *e*) will lower US firms' marginal revenue in US dollars without changing the marginal dollar cost, which leads to decreased foreign sales and increased domestic sales. The elasticity of the dollar price with respect to the exchange rate is $\varepsilon = (n^* / N)(ew^* / p) - 1$. Since both terms in $(n^* / N)(ew^* / p)$ are fractions (the relative number of foreign firms and the ratio of marginal costs of US suppliers to dollar prices), then a dollar appreciation will result in a less than proportionate decrease in the dollar price of exports. The result relies on the assumed linear demand function. If a general function form is allowed, then the price elasticity changes into $\varepsilon = [n^* /(N - \theta)](ew^* / p) - 1$ where θ is the elasticity of the slope of the inverse demand curve. Since θ is positive or zero, the elasticity of the dollar price of exports could be negative, zero, or positive depending on the particular demand function, i.e. , its convexity.

The standard Bertrand assumption was applied by Fisher (1989) in a study of the price effect of exchange rates. In this partial equilibrium model, identical firms in each country produce a homogeneous good with constant marginal cost and make pricing decisions based on anticipated exchange rate changes. The firms are assumed to announce binding offer prices before the exchange rate is realized, and then world demand will be allocated to the best offer adjusted by the real exchange rate. The basic conclusion is that the price effect depends upon the exchange rate regime, as well as domestic and foreign market structures. Under a regime of fixed exchange rates, with periodic readjustment, producers are able to use their market power to set prices when exchange rates move in their favor. If the domestic market is monopolistic relative to the foreign market, a depreciation of the domestic currency, which favors domestic producers, will result in higher prices charged by domestic producers and have an inflationary effect. Under a floating exchange rate system, if the domestic market is monopolistic relative to its foreign counterpart, domestic producers will apply a lower degree of expected PTM. This implies that part or all of expected fluctuations in the exchange rate are spread to foreign consumers. If the domestic market is relatively competitive, expected PTM will be higher, which implies that domestic producers absorb more changes in exchange rates into their own profit margins. Fisher concluded that in general the degree of PTM is lower if the home market is monopolistic or if the foreign market is competitive. Empirically, under Bertrand competition, market share is an important factor in affecting the extent of the effect of exchange rate changes. [14]

2.2.2 Dynamic framework

Dynamic explanations for PTM can be categorized according to whether dynamics are from the supply side or the demand side. The adjustment of production to a new demand level can be assumed to have time lags and the faster the adjustment, the higher is the adjustment cost. This is very evident in agricultural production that has strong seasonal patterns. If changes in the value of the domestic currency are thought of as temporary, exporters may believe it is not worthwhile to expand production to meet the higher demand. In the current period, exporters can charge higher prices in the domestic currency due to demand exceeding supply. The other way is to assume that dynamic elements are from lagged adjustments of demand in destination markets. The increased demand in the next period resulting from current devaluation of the exporters' currency may change exporters' pricing behavior in the current period if exchange rate changes are regarded as temporary.

[14] Feenstra, Gagnon and Knetter (1996) use a Bertrand differentiated products model to derive a theoretical relationship between exchange rate pass-through (ERPT) and market share that is defined to be the ratio of the exporting country's sell to total sales in a particular destination market. The relationship between pass-through and market share is significantly nonlinear: the pass-through is lowest when the source country's market share is around 40 percent and highest when market share approaches 100 percent, which is easy to understand since a higher market share means a stronger market power. For small and intermediate market shares, the degree of pass-through is very sensitive to the functional form of demand.

2.2.2.1 Supply-side concerns

In supply-side models, one significant factor is sunk cost. Firms typically have to make initial investments to adapt their products to foreign markets. These investments usually take the form of marketing, advertising and distribution networks, and production facilities specifically designed for local markets or for bringing foreign products into conformity with local health and safety regulations. Firms may take a wait-and-see approach and respond differently to short-run and permanent movements in exchange rates. [15] Entry-exit decisions once taken, however, cannot be easily reversed when exchange rates change and permanently alters the degree of competition in the market.

Baldwin (1988) proposed a beachhead-effect model, in which a prospective entrant would compare its discounted profits if it based on the fixed market-entry cost to make its entry-decision, and an incumbent firm would stay in the market if the anticipated revenues could exceed variable costs. His results showed that if costs are sunk, large exchange rate shocks, even temporary ones, will alter the domestic market structure by inducing more entry. Large exchange rate changes, therefore, lead to parameter shifts in standard estimated trade equations and have persistent real effects, unlike small shocks which will not. The entry-exit decisions were also explored by an "option" approach with consideration for different implications of variable costs and fixed costs (Dixit 1989; Krugman 1989). An exporting firm is assumed to own an option to leave the export market and a firm that does not currently engage in exporting has an option to enter the market. The decision to enter or exit depends on three costs, fixed costs, variable costs, and costs related to exercising the option. The costs of keeping the option increase with the volatility in exchange rates. The exporting firm is more willing to stay in the market and the non-exporting firm more willing to stay out of the market facing an increased change of exchange rates.

[15] This wait-and-see approach is also defined as "hysteresis" model in the literature. More about "hysteresis" models can be found in Baldwin and Krugman (1986) and Baldwin (1988).

Akerlof and Yelen (1985) developed the concept of menu costs, which implies that it is costly for firms to change prices. A two-period pricing strategy is discussed. Firms' expectations about the second-period exchange rate change plays a key role in determining both first-period and second-period prices. If expected changes in the second-period exchange rate are not big enough to induce expected extra profit to cover menu costs, firms will not implement a price change in the first period. The same rule is also applied to second-period pricing decisions.

2.2.2.2 Demand-side concerns

From the demand side, there are at least four possible explanations to account for PTM in the literature: reputation, consumer allegiance, consumer switching costs, and consumer search frictions.

Reputation is one straightforward reason for explaining PTM, as emphasized by Krugman (1987). Exporters absorb a part of exchange rate fluctuations into export prices in the home currency and therefore, stabilize prices in currencies of destination markets in order to build their reputation in destination countries. This is understandable since consumers may believe products with relatively stable prices are more mature, which can increase consumers' brand loyalty. How much exporters will adjust their own export prices depends on market structures in each destination country perceived by exporters.

Consumer allegiance, which is quantified as market share by exporting firms, can be treated as the purpose of firms' investment. This was extensively analyzed by Froot and Klemperer (1989) in a two-period demand-side oligopolistic model. Expected future exchange rate fluctuations may change the value of current market shares. A temporary depreciation of the US dollar increases the value of current, relative to future, yen profits expressed in the dollar. When the dollar value is temporarily low, US firms will find investing in market share less attractive and will instead prefer to let their current profit margins grow. Dollar export prices, therefore, will be higher than in a static oligopoly framework. In fact, the expectation that the US dollar will appreciate over time may erode future profits in the local currency so much that US firms will raise their dollar prices by a larger percentage than the rate of dollar depreciation in the current period, resulting in increased yen prices. Permanent dollar depreciations, however, do not create such incentives. Since both current and future costs of US firms fall under permanent dollar depreciations, US firms will compete more vigorously in the foreign market, unambiguously driving current yen prices down. Indeed, prices may fall more than in the static oligopoly model. When yen prices fall more than decreases in dollar value, export prices in US dollar will also decrease, which gives us a positive effect of exchange rates on dollar export prices.

Consumer switching costs are an important factor in affecting consumers' product brand decisions. If customers are consuming products with high switching costs, they are actually captive to these products and less sensitive and more impervious to competitive pricing efforts. Firms trying to enter markets where the switching costs are high may have a difficult time. Barriers to entry may include non-tariff trade barriers, patents, or technological advantages, all of which play a significant role in developing pricing strategies[16]. Firms in industries where these barriers to entry are high, tend to be in a better position to remain relatively high prices and profits without fear of competition.

Consumer search frictions were proposed by Alessandria (2004) to interpret that impacts of local market conditions on firms' pricing decisions have been underestimated in many previous studies. In Alessandria's model, consumers need to spend time and money to find satisfactory commodities. Local consumers have more information about product qualities, store locations, and services of home commodities, so consumer search frictions are less for local goods than for imported goods. If local consumers anticipate the cost of searching for a new product exceeds the amount of money or time they are willing to spend, or exceeds the gain they can achieve from consuming the new product, they will stick to the current product choice. With full knowledge of consumer search patterns, local firms will take advantage of this cost benefit and their products will be charged a higher price than similar imported goods. The search frictions are different than

[16] Smith (2002) applied market expansion and market power concepts to study the effect of patent rights on trade for three US disaggregated drug industries. Market expansion effects infer that strong foreign patent rights expand the range of potential markets available to US exporters, which can reduce costs because of larger scale production. Market power effects infer that strong foreign patent rights ensure, at least temporarily, a monopoly over the protected technologies, which can allow US exporters to increase their unit price to extract monopoly rents.

the above consumer switching costs in two ways. First, with the existence of search frictions, consumers need to try many times to reach the satisfactory firm, since firm choices are random. Consumers are assumed to gain benefits only by switching the type of firms, i.e., from local to importing firms, and vice versa. So "the expected cost of switching to a different type of firm exceeds the cost of switching firms." Second, different directions of searching lead to asymmetric effects on expected costs since local firms can be chosen with a higher probability in the local market. Two effects, which are changes in the composition of low-cost and high-cost firms in each country resulting from exogenous production shocks and changes in the elasticity of substitution between home and foreign goods caused by consumer search frictions, together make firms endogenously vary their markups, which will result in PTM and persistent deviation from LOP.

2.2.3 One more comment: asymmetric responses to currency devaluation and revaluation

A number of studies have investigated asymmetric price responses to appreciations and depreciations of the exporter's currency in PTM, which is the well-known "ratchet effect".[17] The reasons for the justification of asymmetric responses in the literature, however, actually counteract each other.[18]

First, if exporters choose market shares in their export markets as the main concern for their pricing decisions, rather than temporary profits, they may try to maintain market shares when their currency appreciates, and increase market shares with home currency depreciations. The adjustment of export prices, therefore, will be larger during home currency appreciations than depreciations, which results in a higher degree of PTM during periods of appreciations. Second, if quantity constraints exist in export

[17] The combined effect of economic conditions (phases of the business cycle) and directions of exchange rate movements on export pricing is also considered in empirical analyses, for example, Gil-Pareja (2001). If the destination country is in recession, exporting firms may be reluctant to raise their prices or even decrease local-currency prices for fear of losing their shares in this specific foreign market facing an depreciation of own currency. During periods of expansion in foreign markets, exporters may take advantage of exchange rate changes to increase their own-currency export prices, even under own currency appreciations.

[18] See, for example, Ohno (1989), Marston (1990), Khosla (1991), Knetter (1994), Goldberg (1995), Gil-Pareja (2001), and Mahdavi (2002).

markets, which may result either from quota limits or insufficient investment, exporters will find no way to increase sales even when exchange rates are devalued. Exporters may tend to adjust their export prices more in their currency depreciations than in appreciations. Third, downward price rigidities, which implies that home currency prices are easier to increase and harder to decrease, are supposed to be another important reason for asymmetric price responses. A larger price response to home currency depreciations will result, with less adjustment occurring during appreciations. The latter two effects actually mitigate the first effect described above. In empirical studies, evidence for this asymmetry still remains inconclusive.

2.3 Alternative definitions of exchange rates and exchange rate variability

In considering the impact of flexible exchange rate patterns on trade prices, three groups of terminology about exchange rates require clarification in order to accurately understand the actual roles that exchange rates would play. [19]

First, the nominal exchange rate should be differentiated from the real exchange rate. In most theoretical models, the real exchange rate and its volatility have been the focus, as opposed to the nominal exchange rate. The two are related but distinct theoretical concepts since the real exchange rate is the nominal one corrected by inflation differentials. But they do not show much difference in the practical world since they tend to move closely together given the stickiness of domestic general prices. The nominal fluctuation of one currency will be offset at least partially by the inflation differentials, so a certain percentage change of nominal exchange rates may lead to a smaller degree of change in real exchange rates. Given the same magnitude in the movements in the two exchange rates, the real exchange rate generates higher uncertainty, which may lead to a larger impact on international trade. In empirical studies, the difference between the two exchange rate changes is usually very small in the short term but becomes more significant in the long term. So nominal and real exchange rates play different roles when the time dimension is involved in the analysis.

[19] See more discussions in Mussa (1978), Lanyi and Suss (1982), Pindyck (1982), Meese and Rogoff (1983), Meltzer (1985), de Grauwe and de Bellefroid (1987), Hodrick (1989), Donnenfeld and Zilcha (1991), Chowdhury (1993) , Maloney (1999), Cho, Sheldon and McCorriston (2002), Clark *et al.* (2004).

Another explanation for different roles of nominal and real exchange rates according to short-run and long-run situations originates from the economic agents' decision process. In the short run, firms are assumed unable to alter factor inputs in order to take advantage of movements in the exchange rate, which leaves production costs affected directly by the nominal exchange rate. If exporters import intermediate inputs from a country whose currency is depreciating, for example, there will be some offset against declining export revenue in the form of lower input costs. The nominal exchange rate, therefore, is more relevant for the economic agents' pricing decision than the real exchange rate. In the long run this assumption can be relaxed, especially for advanced economies in which well-developed forward markets would reduce exporters' exposure to unforeseen movements in exchange rates. Firms can adjust part or all factors of production in response to movements in exchange rates. Thus the increased price variability and average output will result. (Pindyck 1982). In this sense, exchange rates measured in real terms are the more significant economic factor to affect international trade. Most empirical studies, however, have shown that choices between the two exchange rates do not affect the statistical results significantly.

Second, predicted changes in exchange rates need to be distinguished from unanticipated fluctuations. In the literature, it is supposed that predicted changes in nominal exchange rates can be easily hedged away by insurance or other hedging instruments. Whereas, unanticipated fluctuations lead to temporary changes in trade prices, however this effect can be reversed in the long run once firms have a chance to do so. Predicted changes in real exchange rates, however, lead to permanent changes in trade prices. Unpredicted long swings in real exchange rates, which have been called "sustained misalignment" in the literature, are generally difficult to buy insurance against because of lack of sufficient observations to compute probability distributions of these exchange rate changes (Meltzer 1985). So they are the most significant type of uncertainty in affecting trade prices. Therefore, it has usually been held that the effect of predicted volatility in the nominal exchange rate may diminish regardless of the time span, and only in the short run, the effect of unanticipated fluctuations in the nominal exchange rate can matter. Any type of fluctuation in the real exchange rate can have a real effect on trade prices no matter what time span is assumed. [20]

In order to appropriately account for the impact of exchange rate risk on trade prices, the predicted exchange rates should be chosen carefully in order to measure the uncertainty in exchange rates as accurately as possible. In most empirical studies, the *ex-post* exchange rate variability has been considered, rather than the *ex-ante* variability related with the forecasted exchange rate over the future period. As pointed out by Mussa (1978), Meese and Rogoff (1983), internal difficulties make an exchange rate change unanticipated, which means it may not make much difference whether *ex-ante* or *ex-post* measures of variability is used. Furthermore, when the observed exchange rate variability increases, errors in forecasting the exchange rate may also increase (de Grauwe and de Bellefroid 1987). Actually, there is no consensus on the appropriate method to measure the unexpected changes in exchange rates. The scope of analysis will dictate to some extent the type of measure used (Dell'Ariccia 1999). [21]

Third, bilateral exchange rates should be distinguished from effective exchange rates. The effective exchange rate of a particular country, which measures how that currency moves against the currencies of all its trading partners, provides a proxy of system-wide exchange rate variations. Uncertainty concerning movements in bilateral exchange rates can affect bilateral trade flows and prices, and the system-wide exchange rate uncertainty is also an important contributing factor. The reasons can be explained as follows. First, effective exchange rates can reveal more information about international competitiveness and the effect of exchange rates on trade balance than bilateral exchange rates. Therefore, effective exchange rates are preferable from a macroeconomic perspective. Second, the economic terms that exporting firms directly observe in the

[20] The representative study is Marston (1990) in which these fluctuations are theoretically differentiated.

[21] One possible prediction of the future spot rate is the forward rate. Autoregressive conditional heteroskedasticity (ARCH)/generalized ARCH (GARCH) models have also been used to generate predicted values of exchange rate. Dell'Ariccia (1999) used four different measures of exchange rate uncertainty: the standard deviation of the first difference of the logarithm of the monthly bilateral nominal exchange rate, that of the real exchange rate, the sum of the squares of forward errors, and the percentage difference between the maximum and minimum of the nominal spot rate.

practical world are bilateral exchange rates, not the effective exchange rates constructed by economists, but any movement of exchange rates in offsetting directions can mitigate the overall pressure of exporting firms from exchange rate risks. As pointed out by Lanyi and Suss (1982), exchange rate uncertainty facing an individual firm is an average of the variability of all bilateral exchange rates. For example, a US trading firm engages in international trade with a wide range of countries. If one bilateral exchange rate of the United States with respect to a particular trading country keeps relatively constant, but there are large exchange rate variations in the value of the US dollar with respect to all other trading countries, the importance of exchange rate uncertainty has been underestimated by only looking at the bilateral exchange rate movements. [22] When the relationship between exchange rates and trade prices is studied, careful consideration has to be given to choices of bilateral and effective exchange rates (or their respective variability).

[22] De Grauwe and de Bellefroid (1987) include the variability of effective exchange rates as an extra explanatory variable in their analysis of the effect of exchange rates on international trade, and their results suggest that the system-wide uncertainty from the volatility of real exchange rates is an important additional explanation for the slowdown in the growth of international trade.

CHAPTER 3

MODELS OF PRICING TO MARKET (PTM)

Dominant empirical studies about PTM are based on a static framework. Static models of PTM are classified into monopolistic and oligopolistic models according to the markup determination. In monopolistic models, the demand elasticity in each destination market is the only determinant for markup and firms do not need to consider other competitors' behavior, [23] whereas, in oligopolistic models, to establish optimal pricing strategies, firms must be cognizant of how firms' price and output decisions affect not only consumers' price sensitivity, but the price elasticity of substitute products. A significant number of studies hypothesize competitive and demand pressures in both home and world markets as determinant factors for markup under oligopoly competition, with different economic terms assumed to represent the two types of pressures. [24]

Representative monopolistic and oligopolistic models will be investigated in this chapter, and in each model, one empirical equation will be p roposed. The two proposed equations will then be applied to my study of US agricultural exports. In the strand of monopolistic models, based on the full discussion about the country-specific and time-specific PTM equation proposed by Knetter (1989), I return to the original idea of marginal costs represented by suitable indices in order to fully take into account the properties of time series data. In the strand of oligopolistic models, based on the analyses of sequential studies on PTM, I propose a practical way to differentiate the effect of the nominal (effective) exchange rate from that of the real (effective) exchange rate on

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[23] See, for example, (Knetter 1989; 1993; 1995), Marston (1990), Faruqee (1995), and many other studies.
[24] See, for example, Dornbusch (1987), Froot and Klemperer (1989), Mann (1989), Hooper and Mann (1989), Athukorala (1991), Menon (1992; 1995; 1996), Athukorala and Menon (1994) and many other studies.

exporters' pricing strategies. This differentiation really depends on the hypothesis of different roles of nominal and real (effective) exchange rates in export pricing decisions. The former equation will be applied to the destination-specific data, while the latter one will be applied to the destination-aggregated (trade-weighted) data. Therefore, I call the former estimation as destination-specific estimation and the latter as destination-aggregated estimation.

3.1 Monopolistic models

3.1.1 Representative models

The most widely used theoretical framework for PTM studies is a monopolistic price-determination model, in which a monopolistic exporter sells to N foreign destinations, indexed by *i* (Knetter 1989; 1993; 1995). The firm's profit is generally determined by:

$$\prod(P_1,....,P_N) = \sum_{i=1}^{N} P_i Q_i(E_i P_i; V_i) - C\left(\sum_{i=1}^{N} Q_i(E_i P_i; V_i), W\right) \qquad (1)$$

where *P* is the selling price in the exporter's currency, *E* is the exchange rate expressed in units of the buyer's currency per unit of the exporter's currency, *Q* is quantity demanded by the buyer which is assumed to be a function of the price in the buyer's currency, *EP*, and a demand shifter *V*, *W* is an index of input prices in units of the exporter's currency, and *C* is the total cost function. The first order conditions for profit maximization imply that the exporting firm equates the marginal revenue to the marginal cost of sales in each market. Alternatively, the export price to each destination is the product of a destination-specific marginal cost and a destination-specific markup:

$$P_i = \lambda_i CP_i \qquad i = 1...N \qquad (2)$$

where the arguments of markup, λ, and marginal cost, *CP,* are suppressed. A change in the exchange rate of country *i* can affect the price charged to country *i* in two ways: by affecting either the marginal cost of the exporting product (through changes in quantity or input prices) or the markup charged by exporters. Knetter (1989) emphasized that both effects of changes in marginal costs and markups determine exchange rate pass-through (ERPT), while PTM refers to the second effect only. So the first step for a successful empirical analysis of the PTM problem is to discriminate fluctuations in markups from fluctuations in marginal costs.

The markup is determined by the exporter's perception about how the local demand responds to local-currency price changes. Therefore the markup is given by:

$$\lambda_i = -\eta_i / (-\eta_i + 1) \qquad (3)$$

where η_i is the absolute value of demand elasticity with respect to the local-currency price in destination market *i*. One important assumption about production cost is whether it is destination-specific or common across different destination markets. The majority studies on this topic assume that the commodity is identical across destination markets, which implies that the marginal cost fluctuates with exchange rate changes, but is independent of destination markets (thus there is no subscript for the marginal cost in equation 2). This common production cost is compared to the fluctuating markup that is believed to be destination-specific, and does not reflect the behavior of export prices to other destination markets. This is how fluctuations in markup can be discriminated from changes in marginal cost. Then the export price equation (2) becomes:

$$P_i = CP * \left(\frac{-\eta_i}{-\eta_i + 1} \right) \qquad (4)$$

This model has been widely applied in empirical studies of PTM. The representative ones are Knetter (1989; 1993; 1995) and Marston (1990). Various economic terms have been used to represent the demand shifter *V* and the input index *W*. Varied definitions about PTM are provided, resulting in certain differences in theoretical assumptions, hypothesis testing, and the actual equations used in estimation. The most practical definition of PTM is from Knetter (1989) who defined the PTM effect as the partial derivative of home-currency export prices with respect to exchange rates, without differentiating between nominal and real exchange rates. Marston (1990) shared the same logic for PTM behavior; however, the partial derivative of changes in the ratio of export to domestic prices with respect to changes in real exchange rates is defined as the degree of PTM. Marston (1990) believes that nominal and real exchange rates play different roles in the exporter's pricing decisions. Real exchange rate changes are able to affect permanent changes in the pricing behavior, while nominal exchange rate changes are unexpected and only have a temporary effect, which will be corrected if the exporting firm has a chance to adjust prices.

Both Knetter (1989; 1993; 1995) and Marston (1990) base their analyses on a partial-equilibrium framework. The exporter's actions are assumed to have no effect on exchange rates, which is a standard assumption in the literature. This assumption can be, at least partially, justified by the disaggregated data. Also, the exporting firm is assumed to treat other influencing factors as exogenous, for example marginal cost. [25] However, there are two channels by which the marginal cost is affected by exchange rate changes. One is from changes in marginal costs resulting from changes in the commodity output (or demand). The other is from changes in costs of imported intermediate inputs because of changes in the value of the home currency. If the intermediate cost decrease resulting from appreciations of the home currency is significant, the partial derivative of changes in home-currency export prices with respect to exchange rate changes exceeds the actual degree of PTM. The reason is that part of the price decrease caused by the lower cost is mistakenly accounted for by the exporter's strategic pricing adjustment, i.e., to decrease home-currency prices when facing own currency appreciations. If the home currency depreciates, the increased intermediate cost will be included as part of price increase if the effect of exchange rates on intermediate costs is ignored. Therefore the markup adjustment is overestimated and the PTM effect is once again exaggerated.[26]

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[25] Papell (1994) considers both exchange rates and prices as determined endogenously and the exchange rate is co-integrated with its "fundamentals". He finds relatively small effects on national price levels, including PPI, CPI, and the GNP deflator, for the G-7 countries.

[26] Cheung *et al.* (1997) estimate a four-equation system, including input price, export price, export quantity to US, and import quantity from US, to consider the direct pass-through (DPT) and indirect cost adjustment (ICA) effects of exchange rate changes on Taiwan's export prices. The ICA effect is important because in Taiwan most of intermediated inputs for exported goods are imported. Their findings support the view that exchange rate changes have the DPT effect by strategic pricing; also have the ICA effects that work through input price on export prices. The contradictory effect really helps to understand Taiwan's persistent trade imbalance with the United States despite the depreciation of the dollar.

Knetter (1989) estimated the following fixed-effects equation of export prices across destinations for a particular industry:

$$p_{it} = \phi_t + \varphi_i + \beta_i e_{it} + \varepsilon_{it} \qquad (5)$$

where the upper case represents the level of corresponding variables and the lower case represents the natural logarithmic form of the corresponding variables throughout the paper. Here p is the price in units of the exporter's currency measured at the port of export, ϕ_t is a set of time effects, φ_i is a set of destination country effects, e is the exchange rate in units of the importer's currency per unit of the exporter's currency, ε is a random disturbance term, i indexes destination, and t refers to time period.

Three forms of market behavior can be inferred from the estimated parameters of (5). First, for the null hypothesis of perfect competition where prices equal marginal costs, export prices are the same across destinations, i.e., φ_i and β_i are zero. Changes in marginal costs over time are measured by the time dummy variable ϕ_t. Second, there may be price discrimination across markets, but the price elasticity of the residual demand curve is assumed constant for each destination market, i.e., φ_i can differ across markets, but all β_i are zero. Third, there is price discrimination, and the price elasticity of the residual demand curve is assumed to be non-constant, generating non-zero values for β_i, i.e., the change in the importer's local price causes a change in the price elasticity of demand, and then a change in the markup. The expected sign of β_i, negative (positive), will depend on whether demand is less (more) convex than a constant elasticity demand function. A negative coefficient is consistent with Krugman's (1987) original idea of PTM, while a positive coefficient implies that the exporter is amplifying the exchange rate effect.

Marston (1990) considered a model in which a monopolistic firm sells in the domestic market at a home-currency price P_{it} and in the export market at a foreign-currency price Q_{it}. The export-domestic price margin, X_t, is defined as the ratio of export to domestic prices of the same good, so $X_{it} = S_{it}Q_{it}/P_{it}$. Here S_{it} is the nominal exchange rate, and *i* and *t* are destination and time indexes. Two assumptions are applied, one in which the exporting firm sets foreign-currency prices for period *t* based on information available at *t*-1, and another in which real/ nominal exchange rates have the property of random walk. Depending on their different impacts on pricing behavior, Marston (1990) separates unanticipated changes from planned changes in exchange rates. The following equation was derived:

$$\Delta x_{it} = \alpha(\Delta s_{it} - \Delta s_{it-1}) + \beta\Delta r_{it-1} + \gamma_1\Delta(w_t / p_t) + \gamma_2\Delta(p_t^m / p_t) + \gamma_3\Delta y_t + \gamma_4\Delta z_t \quad (6)$$

where $x_{it}=ln(X_{it})$, $\Delta x_{it} = x_{it} - x_{it-1}$, and similarly for other variables in the equation. And r_{it-1} is the real exchange rate, w_t/p_t and p_t^m/p_t are the real wage and the real price of raw materials in the domestic country (deflated by the domestic general price p_t), and y_t and z_t are real incomes in the domestic and foreign countries. The coefficient of Δr_{it-1}, β, is the PTM elasticity that measures the permanent response of export-domestic price margins to real exchange rate changes. There is no difference between this model and Knetter's (1989) model in terms of inferences about this coefficient, especially when the relationship between the value of PTM coefficient and market structures is built. A non-zero coefficient confirms the existence of PTM, and a negative (positive) coefficient corresponds to a demand structure that is less (more) convex than the CES demand. Nominal exchange rate surprises, $\Delta s_{it} - \Delta s_{it-1}$, only have a transitory effect on price margins, which will be later reversed. Then the observed changes in price margins can be attributed to two sources: permanent changes in price margins resulting from changes in real exchange rates, and temporary changes in price margins led by nominal exchange rate surprises. This method, as stated by Marston (1990), is able to rule out the effect of market perturbation on pricing behavior and reveal the underlying factors for pricing decisions.

These two models have some empirical inconsistency when the degree of PTM is actually estimated. If demand curves in home and foreign markets have constant demand elasticities (markup elasticities are equal to zero), and marginal costs are constant with output, both Knetter's (1989) and Marston's (1990) PTM coefficients are zero. If demand structures are still CES, but marginal costs increase with output, depreciation of the domestic currency will increase marginal costs because of increased sales. Then a similar increase in domestic and export prices in the home currency that equals the rise in marginal costs will result. PTM according to Knetter's (1989) definition exists in this case since export prices fluctuate with exchange rate changes; however, by Marston's (1990) definition, the same degree changes in marginal costs get cancelled out by the export to domestic price ratio. In order for Marston's (1990) PTM to occur, the markup must vary with price.

If the demand curve is less convex than the CES demand curve, a rise in price reduces the markup of price over marginal cost and a fall in price increases the markup. [27] The decrease in the foreign-currency export price following the appreciation of the foreign currency increases the markup charged to this specific foreign market. The corresponding export price increases relative to the domestic price, which implies that Marston's (1990) PTM coefficient is negative. If marginal costs are constant, there is no significant difference between Knetter's (1989) and Marston's (1990) analyses in terms of the direction and extent of PTM effect. However, if marginal costs increase with output, the production cost increases because of the increased demand of the foreign country. The domestic price also increases, which results in a decrease in the domestic markup. This increased production cost can, at least partially, offset the decrease in the foreign-currency price. Then the foreign markup will increase less, or even decrease. So PTM coefficient according to Knetter's (1989) definition can be positive or negative, but Marston's (1990) coefficient is always negative.

In Knetter (1995), a symmetric restriction on markup adjustments in response to changes in exporter's marginal costs and changes in destination specific exchange rates was applied, and the following equation was estimated. [28]

$$\Delta p_{it} = (1+\beta_i)\phi_t + \beta_i \Delta e_{it} + \varepsilon_{it} \qquad (7)$$

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[27] This case encompasses demand curves more linear than the constant elasticity demand curve, for example, linear demand.

[28] Goldberg and Knetter (1999) estimated a residual demand equation based on the assumption of a double-log demand function form, $\ln p_{mt}^{ex} = \lambda_m + \eta_m \ln Q_{mt}^{ex} + \alpha_m' \ln Z_{mt} + \beta_m' \ln W_{mt}^{N} + \varepsilon_{mt}$, where Q^{ex} the quantity exported by the export group, z demand shifters for the destination market, and W^{N} cost shifters for the main competitors.

But since exchange rates tend to be much more variable over time than production costs and product prices, changes in exchange rates are more likely to be absorbed into profit margins by exporting firms than changes in costs or prices. This restriction, therefore, is less likely to be sustainable.

From the above discussion, it is obvious that exogenous and common marginal costs are two important presumptions in derive the final empirical equations; however, it is more practical to allow for different marginal costs to each destination market. Faruqee (1995) tackled this problem in a CES demand framework with the assumption that costs are separable for goods to different destinations.

In a CES demand framework, constant markups will block the channel of markup adjustments from which changes in export prices result. Faruqee (1995) allowed destination-specific costs in his model based on the justification that different product specifications and different governmental regulations enable producers to price discriminate given exchange rate changes. Faruqee's definition of PTM is not different from Knetter's (1989) and Marston's (1990) definitions, but Faruqee distinguishes his study with three theoretical propositions about the relationship between PTM determination and industry characteristics. First, two different, but related, determination equations for intersectoral and intraindustry trade are derived. For intersectoral trade, the optimal export price in units of the home currency will be affected by the exchange rate, foreign money, domestic consumer prices, and foreign industry prices for this product, while for intraindustry trade, foreign consumer prices replaces foreign industry prices in affecting the optimal export price. Second, the pattern of industry specialization determines how the relationship between domestic and export prices responds to exchange rate changes. A higher degree of linkage between domestic and foreign prices may prevail under intraindustry trade than under intersectoral (cross-industry) trade. Consequently, export prices exhibit a greater responsiveness to exchange rate fluctuations and a greater degree of PTM under two-way trade. The third difference lies in different patterns of changes in the degree of PTM. Generally the degree of PTM declines under intersectoral trade with the elasticity of substitution among competitive products, but inclines under intraindustry trade. For intersectoral trade, since industry varieties are close substitutes, price setters become more concerned with prices of other home producers and less concerned about foreign competitors when the elasticity of substitution increases. Exporters will show a smaller degree of PTM. While for intraindustry trade, since industry competitors become close substitutes, price setters will put more weights on prices of foreign industry competitors in making their export price decisions. As a consequence, changes in the home-currency export price display a greater responsiveness to exchange rate fluctuations.

3.1.2 Proposed empirical equation

Due to the popularity of Knetter's (1989) model, in my subsequent empirical analysis I treat estimation of (5) as a benchmark. However, there are some weaknesses to using (5) that need to be recognized. One, as noted by Knetter (1989) and emphasized in Goldberg and Knetter (1997), export unit values are not sufficiently detailed to ensure that product qualities are identical across all export destinations. Consequently, using only one time-specific effect as a measurement of marginal costs for various export destinations is questionable, impairing the explanatory power of λ. And while the use of a time-specific effect to capture changes in marginal cost avoids the potential biases caused by using cost indices as a proxy for marginal cost, to exclude such cost indices may also generate biased results. For example, if costs are non-stationary or seasonal stochastic, then different results can be obtained for the significance of β_i when using a cost index compared to using the time-specific constant that is deterministic.

Therefore, the following estimable relationship may be more practical by taking logarithms of (2) and using the first-order Taylor series approximation of the function ln$(\eta_i / \eta_i - 1)$ (Knetter 1995), and collecting terms,

$$p_{it} = \beta_{0i} + \beta_{1i} e_{it} + \beta_{2i} cp_i + \varepsilon_{it} \qquad (8)$$

Where β_0 is a destination-specific intercept that captures the constant terms in the Taylor series, cp_t is a cost index, designed to capture common changes in cost over time, and all other terms have the same definition as in (5). In terms of interpreting the parameter β_2, if the cost index cp_t is an exact measure of marginal cost and the estimated value of β_2 is significantly different from 1, there is evidence for imperfect competition. However cp_t is a cost index, so its levels and hence β_2 are arbitrary and no inferences can be drawn about the extent of competition.

In estimating (8), three cases can be identified where β_1 will not be significantly different from zero. First, with a single competitive market for exports, cp_t and β_2 measure the effect on export prices of common cost movements over time, and β_0 captures the effect on export prices of any product differentiation by destination, assumed constant over time. Second, if the market is integrated, but firms act imperfectly competitively, cp_t and β_2 measure the effect on export prices of common cost movements over time and a common mark-up, while β_0 captures the effect of any product differentiation by destination as well as any country-specific asymmetric effects of cost and markup movements on export prices, again constant over time. Third, if the price elasticity of the residual demand curve is constant, cp_t and β_2 measure the effect on export prices of common cost movements over time, while β_0 captures the effects of both product differentiation by destination and any country-specific mark-ups, both effects being constant over time.

A final case can be noted where the coefficient β_1 is significantly different from zero, implying behavior consistent with PTM across destination markets. As with the model presented in (5), the expected sign of β_1, negative (positive), will depend on whether demand is less convex (more convex) than a constant elasticity demand function. In addition, cp_t and β_2 measure the effect on export prices of common cost movements over time, and β_0 captures the effect of product differentiation by destination, assumed constant over time.

3.2 Oligopolistic models

3.2.1 Representative models

Another widely applied theoretical framework for PTM studies is an oligopolistic model with a cost-plus pricing strategy, which differs from the monopolistic model mainly in markup determination. The profit-maximization pricing rule for a typical export firm under oligopolistic competition can be written as:

$$P_i(1+\frac{\theta_i}{\eta_i}) = CP_i(W,Y) \qquad i=1 \ldots N \qquad (9)$$

where P denotes the selling price in the exporter's currency, θ is the conjectural variation elasticity, η is the demand elasticity which is negative, both of which depend on exporters' perceptions of the response of competitors and consumers to exporters' price and output decisions. CP is the marginal cost, and W is a vector of input prices used in the production of output Y, i is an index for destination markets. The degree of oligopoly power in a market is measured by the ratio of conjectural elasticity to demand elasticity. Perfect competition results when under demand is perfectly elastic and/or the conjectural variation elasticity is zero. Under monopoly, the conjectural variation is 1, which leads to equation (4).

Based on equation (9), the perception about how exporting firms compete with competitors in terms of price and quantity adjustments becomes the decisive factor for the conjectural variation and markup. Most related literature from international economics and industrial organization has been trying to propose justifiable and practical hypotheses about the interaction among all incumbent firms in the market based on the specific cases they study. Dornbusch (1987) considered the strategic interaction among competitive firms through conjectural variations in a Bertrand oligopoly model. Each individual firm is assumed able to affect the industry price, so that each firm's pricing decisions derived are represented by a price reaction function, which depends on both own and competitors' prices, conjectural variations, and production costs. Froot and Klemperer (1989) analyzed a simple two-period duopoly competition model, in which firms compete on prices. Competitors' prices again play the same role as own prices in term of pricing decisions. Hooper and Mann (1989) assumed that the markup is variable and in response to both competitive pressures in the specific destination market and demand pressures in all markets combined. A mark-up model of price determination was also explored in Athukorala (1991) and Menon (1992), in which capacity utilization of exporting firms is the proxy for demand pressures (home and foreign markets combined), and the gap between foreign competitors' price in the exporter's currency and the exporter's production cost measures competitive pressures. [29] In Athukorala and Menon (1995), the demand pressures are measured by the index of new orders, with no change made on the demand pressures proxy.

The general formulation for the determination of export prices in the oligopoly market can be written as:

$$P_i = CP * \lambda_i (WP / CP * ER, CU) \qquad (10)$$

where *WP* is the foreign competitors' price in the foreign currency, *ER* is the exchange rate quoted in the foreign currency, *CP* is the domestic production cost, and *CU* is capacity utilization. Firms have much more control over production capacity in the long run than in the short run (Forman and Hunt 2005). If so, capacity utilization should have a positive impact on pricing strategies in the short run. For example, firms operating at full capacity are able to spread fixed costs over more units, thereby achieving greater flexibility in developing pricing strategies.

From a capacity utilization perspective, if the partial effect of exchange rate (changes) on export prices (changes) is defined as the PTM effect, this partial derivative will overestimate the exporters' strategic markup adjustment in the case that marginal costs are treated exogenously. A depreciation of the exporters' currency, decreased *E*, may increase foreign demand and hence tighten the exporting firms' capacity utilization. Production is usually assumed to increase more quickly than capacity. If exporting firms believe they are approaching the potential capacity, they can take advantage of their greater market power by increasing markups. So the partial effect of exchange rate

[29] Capacity utilization variable in Menon (1992) is constructed as the ratio of the level of real manufacturing output to the trend level of such output for each commodity category. The trend output is estimated by fitting a semi-logarithmic time trend to the real output series.

changes on export prices not only captures the negative effect of depreciated exchange rates on export prices, but also measures the positive effect of increased capacity on export prices. On the other hand, decreased market demand due to an appreciation of the domestic currency depresses the exporters' capacity utilization. Exporting firms are willing to cut markups to maintain sales and market share, and also to maintain output and capacity utilization. In this case, the partial derivative again overestimates the effect of PTM.

So more general models that take into account both direct and indirect effects of exchange rate changes on export prices are preferred. Athukorala and Menon (1994) tried to distinguish the PTM effect from the cost-changing effect of exchange rate changes. They introduced one independent cost equation that measures the cost effect of exchange rate changes, besides the export price equation, and combined these two effects together to measure the accurate degree of PTM.[30] Their results showed that to neglect the cost effect will over-estimate the actual PTM effect.

Capacity utilization is a concept that measures the extent to which a nation or a firm actually uses its installed productive equipment. Thus it refers to the relationship between the actual output produced and the potential output that could be produced with installed equipment. Because it is rarely possible to accurately measure the potential output, capacity utilization is only a rough estimate of actual capacity usage. Capacity utilization by definition is really an industrial or manufacturing concept, whose role in agricultural production remains questionable. There is also no established way to calculate it in agricultural production since there are more important factors except installed equipment to determine the process of agricultural production. Therefore, capacity utilization in some empirical studies has been neglected.

Hung *et al.* (1993) applied Hooper and Mann's (1989) model to consider a representative exporting firm's pricing behavior. The price elasticity of demand, η, depends on price competitiveness in the world market, which is defined as the relative

[30] In this paper, costs are determined by capacity utilization in the intermediate goods sector, the nominal effective exchange rate for intermediate imports, the cost of intermediate imports used in the intermediate goods sector, and the productivity-adjusted labor costs in the intermediate goods sector.

price P^c / P , where P^c is the competitors' price in the home currency. Thus $\eta = \eta(P^c / P, Z)$. Here *Z* summarizes all other factors affecting the elasticity. Menon (1995; 1996) also used a markup model. The profit margin is hypothesized to depend on competitive pressures in the domestic market, and the exchange rate. The gap between the price of import-competing goods (*PD*) and the exporters' production cost (*CP*) is used as proxy for competitive pressures. The import-decision effect of domestic demand conditions is also captured by *PD*. Thus the profit-maximization price is determined as follows:

$$P_i = CP * \lambda_i (PD / CP * E) \qquad (11)$$

Based on the above discussion about price effects of exchange rates under oligopolistic competition, the empirical equation takes the following form. Let lower-case letters denote natural logarithms: [31]

$$P_{it} = \beta_0 + \beta_1 e_{it} + \beta_2 wp_{it} + \beta_3 cp_t + \varepsilon_{it} \qquad (12)$$

The coefficient β_1 captures the effect of PTM, just as in the monopolistic model, which is interpreted as the measure of the extent to which firms absorb exchange rate changes into profit margins in order to adjust the home-currency export price. Here *i* and *t* again represent destination and time.

If exporters are price takers, they cannot influence the market price, but must take or leave it. All studies mentioned above under the oligopolistic competition framework suppose that β_1 is equal to 1 in perfect competition and changes in the exchange rate will be fully absorbed into profit margins so that prices in the foreign currency remain unchanged (net of any effect of exchange rate changes on input costs). This supposition contradicts with Knetter's (1989) hypothesis about zero effect of exchange rates on export prices in perfect competition. I agree with Knetter's (1989) inference about the relationship between the value of the coefficient β_1 and market structures. Actually, the pricing rule in this case will be reduced to price equal to

[31] If capacity utilization is included, the equation becomes: $p_{it} = \mu_i + \alpha wp + \beta_i e_{it} + \gamma_i cp + \delta cu + \varepsilon_{it}$. Because my study focuses on US agricultural products, I believe capacity utilization is an inappropriate explanatory variable in the system.

marginal cost, and in the short run, the price taker will expand output until marginal revenue (price) is just equal to marginal cost. Therefore, changes in the exchange rate will be fully reflected in marginal cost changes leaving a negligible effect of exchange rate changes on export prices. So $\beta_1 = 0$. At the other extreme, if the exporter does not face any competition in the world market, then the impact of changes in exchange rates will be restored to Knetter's (1989) model with no need to consider the reaction of competitors.

3.2.2 Proposed empirical equation

In Knetter's (1989) monopolistic model, world competitors' pricing behaviors can be ignored in the system, however, in oligopolistic models, competitors' behavior plays a significant role in influencing exporters' pricing objectives and strategies. In this case, when exporters sell products across foreign countries, they will face product-specific and destination-specific competition, which poses tremendous data requirements in order to carry out empirical estimation. Here I follow Menon's (1995; 1996) idea that the price for measuring competitiveness from other competitors is the price of import-competing goods (*PD*). Since exporters from the same country face the same import-competing goods price, this setting can spare much on the data requirements and make the empirical estimation possible. This import-competing price is an destination-aggregated concept in the sense that different importing sources are not differentiated from each other, therefore, other variables in the system, including export prices and exchange rates, are preferred also taking an aggregate form. One available choice is the so-called trade-weighted prices and exchange rates. Studies based on bilateral nominal (real) exchange rates can reveal more detailed information about destination-specific trading and pricing; however, they also have some limitations. The lack of consideration about other trading partners' impact results in a certain degree of bias in terms of the PTM effect. For example, if Japan's import demand of US products increases substantially, export prices to Japan will climb. If Japan is a big trading partner of the US, the increased price will have a significant positive effect on prices of export products to other destinations. This happens not only because of a price-chain effect but also of a quantitative restriction effect of a temporary fixed total output for export. Meanwhile opposite fluctuations of exchange rates of different trading countries may provide exporters opportunities to balance their gains and losses automatically without any intention to make markup and price adjustments. It is, therefore, worthwhile to allow implications of competitive and (or) demand pressures for the markup decisions and to consider the PTM effect based on effective (trade-weighted) export prices, nominal and real effective exchange rates. This method allows me to consider not only product-specific characteristics, but also to include the impact of all trading partners.

One more explanatory variable, the real effective exchange rate (REER), is included to determine the markup. The reasons for its inclusion are multiple. First, even though nominal and real (effective) exchange rates do not show much difference in the magnitude of their fluctuations in the short term, this difference becomes more significant in the long term. So if the long run relationship between export prices and exchange rates is measured, differentiating the two exchange rates becomes necessary. Generally, the same magnitude of changes in the real (effective) exchange rate will lead to a larger price response than in the nominal (effective) exchange rate.

Second, nominal and real (effective) exchange rates play different roles in price determination.[32] The nominal (effective) exchange rate is employed by exporters to estimate nominal price differences between two similar products with different producing or consuming destinations. Its changes will be immediately and directly transformed into level changes of nominal prices. Costs of imported intermediate inputs will also be affected directly by nominal (effective) exchange rate changes, at least in the short run, since exporting firms are unable to adjust their imported inputs as quickly as exchange rate changes. Thus what really matters in firms' profit and cost appraisal is the nominal (effective) exchange rate, while real prices may be affected more significantly by the real (effective) exchange rate.

Third, when nominal and real effective exchange rates are considered, it is usually held that country's international competitiveness is measured by the real effective exchange rate, which means not only the nominal effective exchange rate but domestic and foreign price movements (inflation rates) influence country competitiveness. For

[32] See, for example, Marston (1987; 1990), and many other studies.

example, when the nominal effective exchange rate of the US dollar remains unchanged, the relative competitiveness of US goods increases when the inflation rate of other rival trading countries surpasses that of US. The purpose of nominal effective exchange rate changes is to restore real effective exchange rates, i.e., to restore previous levels of traded goods' competitiveness. The product-specific real effective exchange rate, therefore, can represent the international competitiveness of a particular export product. Any change in this rate can measure how a product's relative competitive position moves with time. Furthermore, the movement in real (effective) exchange rates, as stated by Marston (1987), has been primarily caused by productivity growth. The product-specific real effective exchange rate, therefore, can also reveal information about productivity growth for a particular commodity. The role of real effective exchange rate is similar to productivity technology, which will shift the exporters' supply curve to affect pricing decisions rather than nominal prices that result in position movements on the fixed supply curve. Based on the above concerns, I choose to include effects of both nominal and real (effective) exchange rates in export pricing decisions, unlike most researchers who do not differentiate them.

However, changes in nominal and real (effective) exchange rates are highly correlated, which makes it difficult to empirically separate their effects on export prices. Then how can this differentiation be accomplished in empirical analyses? Based on the above concerns, I choose to include the first order difference of the real effective exchange rate, rather than its level, into the equation in order to conquer the singularity problems of nominal and real exchange rates in estimation. The following general equation for export prices determination is derived.

$$P_t = CP_t * \lambda(PD_t / CP_t * NEER_t, \Delta REER_t) \qquad (13)$$

where effective export prices are set to have arguments of the price of import-competing goods (*PD*), the domestic production cost (*CP*), the nominal effective exchange rate (*NEER*), and the change in real effective exchange rate (*REER*). The empirical equation involves variables expressed in lower case representing the natural logarithm.

$$p_t = \beta_0 + \beta_1 neer_t + \beta_2 \Delta reer_t + \beta_3 pd_t + \beta_4 cp_t \qquad (14)$$

Nominal and real effective exchange rates, therefore, can influence export prices through different channels. Exporting firms make pricing decisions based on the nominal effective exchange rate, and then the effect of the nominal exchange rate on export prices measures the degree of PTM. The inference about pricing behavior and market structure derived from the value of the partial derivative β_1 is not different from all above equations in this chapter. A significant non-zero coefficient β_1 confirms price discrimination and PTM. And a negative (positive) coefficient β_1 is in line with a market structure less (more) convex than CES. The change in the real effective exchange rate is an indicator of the export product's international competitive advantage. A positive change in REER means positive productivity growth or competitiveness have increased, which allows exporters to charge a higher export price, while a negative change will force exporters to consider lowering the price because of negative productivity growth or a fall in competitiveness. So the effect of REER on export prices is expected to be positive.

The nominal effective exchange rate enters equation (14) as the level of current period, while the real effective exchange rate enters the equation as the level difference between current period and last period. The two terms are unlikely to be highly correlated, so it is possible to distinguish empirically between different effects of nominal and real effective exchange rate changes on PTM behavior. One point that needs to be emphasized is that the model is static. We do not consider whether firms set export prices based on information available in the last period or in several previous periods, or based on expectation about how exchange rates fluctuate in the future. This model cannot differentiate between effects of permanent real effective exchange rate misalignment from nominal effective exchange rate surprises. The only previous study, which has theoretically differentiated the two effects, is Marston (1990). However, Marston (1990) assumed that firms set export prices in the foreign currency based on the information from last period. This assumption is not suitable for US agricultural products, which is the focus of my study, since US exporters usually set prices in the US dollar.

CHAPTER 4

REVIEW OF THE LITERATURE

In the previous chapter, PTM models were classified into two categories, monopolistic and oligopolistic models, by the existence of competitors' influences. Knetter's (1989; 1995) monopolistic models have the admitted advantage of minimal data requirements for hypothesis testing. But the effect of exchange rates on export price discrimination may have been exaggerated if the estimation is only based on data for export prices and exchange rates. Alternative methods using more market structure information, for example oligopolistic models, therefore are suggested. Even though oligopolistic models are not comprehensive enough to capture all influencing factors, they can offer more insights into the exporters' pricing decisions. I will not separate the selected literature into two parts, monopoly and oligopoly, however. My main objective for this chapter is trying to review the significant findings of previous studies related to the pricing behavior of US exporters, especially agricultural exporters. Other representative findings for pricing behavior of US competing export countries, such as Canada, German, Australia and Japan, are also included for comparison.

The agricultural trade literature is characterized by the role of policy and government agencies with market power. *A priori*, PTM may be expected to exist in agricultural exports, especially for the US which is representative of countries with a large volume of agricultural trade and large trading firms. The previous empirical literature on PTM has shown that, first, the hypothesis of a competitive market is rejected in most cases of US agricultural exports; second, different price discrimination patterns of US agricultural exporters are found across export commodities and destination countries. Both evidence for and against PTM have been found in previous studies, e.g., Knetter (1989, 1995), Pick and Park (1991), Pick and Carter (1994), Patterson, Reca and Abbott (1996), and Park and Pick (1996), Carew and Florkowski (2003), Miljkovic *et al.* (2003)

In the earliest empirical study by Knetter (1989), six 7-digit US export products that are believed to be homogeneous including dried onions, bourbon, orange juice, and breakfast cereal, are studied. Strong evidence against the competitive market model and the law of one price are found. For US exporters, export prices are rather insensitive to exchange rate fluctuations, and when price adjustment occurs, it may frequently amplify the effect of exchange rate changes on local currency prices. On the other hand, German export prices for eight export products, including beer, sparkling wine, and white wine, appear to be much more sensitive to exchange rate fluctuations. German exporters make price adjustments to stabilize local currency prices in the destination market. More cases of violations of the invariance of export prices to nominal exchange rates rather than to real exchange rates are detected. The author argues that this is puzzling, since the price-adjusted real exchange rate should have had more correlation with changes in export prices than the nominal exchange rate whose changes primarily represent inflation variations across countries.

Pick and Park (1991) apply Knetter's (1989) model to US cotton, wheat, corn, soybean, and soybean meal exports, and find little evidence of PTM, except in the wheat export sector. However because of the US Export Enhancement Program (EEP) for wheat exports, the authors attribute this imperfect competition to government support policies, not to firms with market power. Patterson, Reca and Abbott (1996) find discriminatory pricing in US chicken exports to Canada, Mexico, Netherlands Antilles, Columbia, the Netherlands, Hong Kong and Japan based on Knetter's (1989) fixed-effects model. In addition, negative and significant exchange rate coefficients are found for Canada and the Netherlands, providing support for PTM in those markets. [33] However, their results also demonstrate that product quality differences may explain most of the price

[33] Brown (2001) analyzed Canadian canola exports, price discrimination being identified for three export destinations, Japan, US and Mexico, and PTM in the case of Japan.

discrimination in the particular destination markets. [34] Miljkovic *et al.* (2003) point out that US meat industry participants become more sensitive to variations in exchange rates because exports are becoming increasingly important for US livestock and poultry producers. They try to quantify the impacts of relative exchange rates on US beef, pork and poultry export prices. In addition, the impacts of GATT and the North American Free Trade Agreement (NAFTA) agreements on export prices are considered. The results indicate PTM occurs for several destination countries. Trade liberalization under GATT has positive impacts on US beef and poultry export prices.

Knetter (1995) implements a symmetric restriction in a PTM study, that is, the effects on export prices of marginal costs and exchange rate changes are constrained to be identical. The results from German and US exports of selected products show that PTM behavior is more pronounced in German export pricing than in US export pricing, and German PTM behavior is more evident in beer and chemical products exports than it is in large automobiles. Knetter attributes this low degree of PTM in the US to the effect of value changes in the US dollar on production levels and input prices. Following Knetter (1995), Park and Pick (1996) impose this symmetry restriction in their analyses of US wheat exports. Their results indicate that in six of eight countries in the sample (Egypt, Japan, Korea, the Philippines, Taiwan and Venezuela), the exchange rate coefficients are negative and significant. For the other two countries, the People's Republic of China and the Soviet Union, the coefficients are negative but not significant, which the authors argue is not surprising given the nature of the exchange rate data used in the analysis. The results also confirm the significant negative effects of the EEP on destination-specific wheat exports, especially for Egypt and the Philippines.

A weakness of the Knetter (1989; 1995) PTM model is the failure to fully account for the competition among firms. Pick and Carter (1994) extend Knetter's (1989) model to consider influences of both foreign-exporter and home-exporter exchange rates on the home exporters' pricing decisions. The international wheat market with two main

[34] The representative study that directly includes the quality issue into the PTM problem is Irandoust (1998). He uses hedonic regressions relating the price of cars on the Swedish car market to the characteristics of these car models, including length, width, weight, and horsepower. His results reveal that car price adjustments are responsive to changes in exchange rates, costs, and quality based on the usage of the hedonic regression relating prices to car characteristics.

competing countries, the United States and Canada,is studied with the US as the home exporting country. US exporters not only consider their exchange rate with respect to the destination country, but also the US/Canadian dollar rate (same for Canadian exporters). Imperfect competition is confirmed in both US and Canadian wheat exports. US exporters are found willing to include the US/Canadian exchange rate in their pricing decisions for exports to most of selected destination markets (five of seven cases). This pattern is much less significant for Canadian exporters (only one case). A dummy variable is introduced into the US export equation to capture the effect of US EEP. A significantly negative effect of EEP is found in the estimation.

Carew and Florkowski (2003) employ a panel unit root test for annual exchange rates and export prices, and apply Pick and Carter's (1994) model to the study of US and Canadian wheat, pulse and apple exports. The regression results show Canadian wheat exporters price discriminate in most destination markets, however, they tend to magnify the effects of exchange rate changes on local-currency prices unlike the offsetting effect found in Pick and Carter (1994). The Canadian/US exchange rate has a less significant effect on Canadian wheat exporters' pricing decisions. The export credits implemented by the Canadian Wheat Board (CWB) have a negative and statistically significant effect on wheat prices, which confirms that export credits do have a price-dampening effect. The regression results for US exports show that US exporters tend to offset the movement in exchange rates in most selected destination markets. Again the Canadian/US exchange rate is not an important factor for pricing decisions of US wheat exporters. The effect of the US EEP is negative and statistically significant, which is consistent with the price-lowering effect reported by Pick and Carter (1994).

Canadian pulse producers are found to be more dependent on trade than US counterparts. The effect of the Canadian/US exchange rate is significantly positive for every destination market in Canadian pulse exports, whereas this evidence is much less significant in US exports. US pulse exporters are more likely to stabilize the local-currency export prices than Canadian counterparts.

Canadian apple exporters tend to be more sensitive to the Canadian/US exchange rate because of the vast majority of Canadian apple exports being to the US; while US apple exporters show a strong pattern of price discrimination and a tendency to stabilize local-currency export prices. The authors argue that part of the differences in pricing behavior between Canadian and US exporters can be explained by pricing policy, product quality differences and the relative importance of international trade for both economies. A larger proportion of Canadian domestic production is exported to foreign markets, so maintaining and expanding export quantities is the main objective for Canadian exporters. US exporters, especially for wheat, face a larger domestic demand market, so their focus on export markets is price rather than quantity. Consequently US exporters are more sensitive to exchange rate changes than Canadian exporters.

One direct way to accommodate competition among incumbent firms is to apply an oligopolistic model with a cost-plus pricing strategy. Mann (1986) suggests a cost-plus pricing rule; that is, export price is a summation of production cost and a profit margin. The analysis has focused on what extent changes in export prices should be accounted for by margin or cost changes. His results on aggregate data for US import and export prices, show that the profit margins and pricing behavior of US exporters seem less affected by exchange rate changes, and that exporters to the US market reduce profit margins as the dollar depreciates. Khosla (1991) follows Mann's (1986) pricing rule to measure the extent to which Japan exporters adjust their yen export prices in response to an exchange rate change. Materials industries, characterized by product homogeneity, have low degrees of PTM while final goods industries, where product differentiation is pervasive, reveal high degrees of PTM. The results, controlled for cost changes, indicate a rise in the degree of PTM is more pronounced in materials industries than in final goods industries even though the former still have lower degrees of PTM.

Hooper and Mann (1989) include distributed lags on the explanatory variables to get the short-run and long-run effects of exchange rates, and conclude that exchange rate changes have no perceivable effect after five to seven quarters. Initially, US firms are more likely to squeeze their profit margins when the US dollar appreciates. According to this pricing strategy, the foreign-currency export prices, thus, do not increase as much in the short run. In the long run, profit margins are restored to desired levels, so dollar export prices build up gradually over time. Swift (2004) applies the Hooper and Mann (1989) model to examine the effects of exchange rate changes on prices of Australian exports of milk products, cheese, beef, sheep-meat and hides and skins. A dynamic long-run relationship in all potentially endogenously determined variables (export price, world price, production cost and exchange rate) is assumed in the model. The results indicate that dairy exports might operate in competitive markets, but no long-run relationship exists between exchange rates and prices for livestock products. [35]

There are many other ways to incorporate competitors' behavior in the pricing decisions of exporting firms, for example, by residual demands (Goldberg and Knetter 1999), by consumer preferences (Bergin and Feenstra 1999, 2000), and by market shares (Adolfson 1999).

Goldberg and Knetter (1999) measure the intensity of competition faced by a group of exporters by the residual demand elasticity they face collectively. Based on the argument of exchange rate fluctuations as a relative cost shifter to allow identification of residual demand, the authors derive an equation for export prices including arguments of export quantity, real GDP and wholesale price index in destination market, competitor's labor cost and exchange rate. The method is applied to US exports of linerboard paper. Strong evidence of imperfect competition in the destination market of Australia is revealed, which is a very small market where US firms face almost no competition from other competitors. Bergin and Feenstra (1999, 2000) introduce translog consumer preferences, in which the expenditure share for each good is inversely related to its relative price and through which strategic interaction is introduced. Each firm considers the pricing decisions of other firms when determining their own optimal markup. As a result, price discrimination was found. Based on market share as an indication of firms' market power, Adolfson (1999) investigates the transmission of exchange rate changes into Swedish export prices and the importance of market share for price determination. Because marginal costs are likely to change due to cost changes of imported inputs

[35] More studies that rely on oligopolistic model setting are Hung et al. (1993), Athukorala and Menon's (1994), Menon's (1996), Hanninen and Toppinen (1999), Kikuchi and Sumner (2002), Mahdavi (2002), and Doyle (2004).

resulting from movements in the exchange rate, he allows for feedback effects among the variables, export price, marginal cost, market share, exchange rate and the price of substitutes. The estimation results from an error correction model indicate consistency with price discrimination. Even though the market share is important for the short run and dynamics of price determination, it does not matter for the degree of long run price discrimination. Furthermore, in terms of different degrees of homogeneity of automobiles kraft paper, no distinct disparity of the presence of PTM behavior is found for Swedish exports. [36]

[36] Hateni-j and Irandpust (2004) apply non-stationary panel cointegration methods to an aggregate data set of Swedish exports, chemical products, electronics, iron and steel, machines and manufacturing, and reveal that pricing behavior varied across industries and such variations may be related to industry-specific characteristics.

CHAPTER 5

DATA AND METHODOLOGY

5.1 Data description

Monthly data from 1989:1 to 2003:12 for US export prices of beef, pork, wheat, corn, soybean and lettuce, will be used in estimation. They are taken from USDA's *Foreign Agricultural Trade of the United States* (FATUS), which guarantees that the product divisions of exports are consistent over time. [37] Export prices are measured by unit export values for these six US agricultural products. [38] Unit export values represent more accurate actual transaction prices than price indices, and can reflect price discrimination when sellers report the value of shipments to various destinations. Most of the commodities are chosen by two criteria. The first is by the importance of their exports to the US economy. During the early 2000s, corn, soybeans and wheat ranked the first three among US field crops in both planted acreage and gross farm receipts. [39] US beef exports have kept increasing since the early 1980s, reaching 2.5 billion pounds in carcass

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[37] Beef is defined as fresh/frozen beef and veal, pork is fresh/frozen pork, wheat is un-milled wheat, corn is corn, soybeans are soybeans, although according to FATUS, soybeans ex seed (soybeans, whether or not broken, except seeds for sowing) is the subcategory of soybean, but these two have the exact same numbers over the period of interest, and lettuce is fresh lettuce.

[38] Based on the homogeneous characteristics of selected agricultural products, I assume in the dataset, destination-specific product quality changes are not correlated with destination-specific exchange rates and unit value changes frequently reflect price changes, rather than quality changes.

[39] Under the Farm Security and Rural Investment Act of 2002 (2002 Farm Act), corn, soybean and wheat producers have access to direct payments, counter-cyclical payments, and marketing loans. In addition, producers have access to subsidized crop and revenue insurance available under previous legislation. The wheat market is also affected by support programs that increase wheat use through trade promotion and food aid.

weight equivalent in 2003.[40] During the early 2000s, the US was the second largest pork exporter in the world, selling over 2 billion pounds of fresh and frozen cuts to oversea markets. And lettuce continues to top US vegetable exports. [41] The second is according to the purpose of comparing my results to previous analyses since these commodities were studied quite often in the earlier literatures. The destination choices are made according to whether there is a significant volume of shipments and data continuity for each importing country without considering currency fluctuation directions (appreciation or depreciation).

Monthly data for nominal and real exchange rates, measured as the local currency per unit of the US dollar, are obtained from the *International Financial Statistics* of the International Monetary Fund and the *Financial Statistics* of the Federal Reserve Board as summarized by USDA. The real exchange rate is calculated by multiplying the nominal exchange rate by the ratio of consumer price indices in the United States and the foreign country.

Based on equations (equations 5, 8 and 14) I use in this dissertation, some adjustments are necessary for the original monthly dataset. First, because the consideration of the stochastic seasonality property of time series variables in equation (8) and the application of seasonal cointegration methods is the most significant contribution I will make to the traditional fixed-effects model, monthly export prices and exchange rates have to be transformed into quarterly data. Here I use a simple quarterly average. Second, in estimation of equation (14), monthly data will be applied, not quarterly, and the relatively more traditional vector cointegration method will be used. [42] Because the

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[40] Since December 2003, two discoveries of BSE, one in a dairy cow which had been imported from Canada and the other in a cow native to Texas, have been reported. Beef export patterns in 2004 were altered dramatically by the BSE situation. Japan and South Korea (and various other countries) ceased all imports of US beef, while other countries re-considered their imports with strict restrictions.

[41] All data and facts are derived from assorted studies in ERS, USDA.

[42] In the monthly dataset, the destination markets (in rank order according to 2003 FY) included for US exports are as follows: for wheat exports, Japan, Egypt, Mexico, south Korea, Philippines, Taiwan, Columbia, Italy, Venezuela, Peru, Brazil, Thailand, China, and Jamaica, collectively accounting for 63 percent of the total export volume in 2003; for beef, Japan, South Korea, Mexico, Canada, Hong Kong, Saudi Arabia, Indonesia, Switzerland, Singapore, Philippines, and Germany, collectively accounting for 95 percent of the total export volume in 2003; for pork, Japan, Mexico, Canada, South Korea, Hong Kong, and Singapore, collectively accounting for 86 percent of the total export volume in 2003; for corn, Japan, Mexico, Taiwan, Canada, Egypt, Algeria, Dominican Republic and South Korea, collectively accounting for

focus of this equation is on differentiating the varied roles of real and nominal exchange rates on export prices, the greater variation in the monthly data can help accomplish this objective. [43] At the same time, the first difference of the real exchange rate eliminates its stochastic seasonality, which will lose part of the justification for the seasonal cointegration method. Using monthly data for this equation, therefore, is more attractive. In order to carry out the estimation, commodity-specific effective export prices (effective exchange rates) are constructed by taking weighted averages of bilateral export prices (bilateral exchange rates) and combining them into a single index. The weights are shares of destination-specific exports in US total exports to all selected foreign markets for a particular commodity. [44] When prices of import-competing goods (*PD*) are calculated, because there is no instance in which US imports share the same group of trading countries with US exports for all six commodities, the overall monthly unit values for US imports are chosen to represent competing prices without differentiating importing sources.

Producer price indices are taken from the Bureau of Labor Statistics (BLS), and are used as a proxy for production cost. BLS indices, which are based on survey responses of producers, tend to overstate the extent of production cost, since by asking producers the producing cost; they are likely to report a higher cost. Stigler and Kindahl (1970) argue that BLS indices understate the true variability. If so the effect of strategic

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78 percent of the total export volume in 2003; for soybeans, China, Mexico, Japan, Taiwan, Indonesia, Spain, Germany, South Korea, Netherlands, Canada, Costa Rica, collectively accounting for 85 percent of the total export volume in 2003; for lettuce, Canada, Mexico, Japan, Taiwan, Singapore and Hong Kong, collectively accounting for 98 percent of the total export volume in 2003.

[43] Larue (2004) suggests that researchers must make greater efforts to use monthly data instead of quarterly data to properly measure export price responses to exchange rate changes. However, Knetter (1995) states that lower frequencies may actually be preferred in constructing unit values since seasonal variation shipments and reporting lags may increase the amount of noise in the unit value series at high frequencies, particularly in cases where there is heterogeneity in the product category.

[44] The nominal effective exchange rate (*NEER*) is calculated by the following formula: $NEER_{it} = \sum_{j=1}^{n} \frac{NE_{jt}}{NE_{j0}} \times \frac{\omega_{ijt}}{\omega_{it}}$, NE_{jt} is the bilateral nominal exchange rate expressed in units of the currency of country *j* per unit of USD in period *t*, NE_{j0} is the same exchange rate in base period 0 (here represented by the 1988/12, December 1988), ω_{ijt} is the value of US exports of commodity *i* to country *j* in period *t*. ω_{it} is the total value of US exports of commodity *i* to all selected *n* importing countries in period *t*. The real effective exchange rate (*REER*) and effective export prices (*EP*) are constructed by the same weighting system.

price behavior (markup adjustment) on prices will be overestimated because part of production cost adjustment is neglected. One serious drawback for cost indices is that any discrepancy between the producer price index and actual production cost might be correlated with exchange rates and this correlation will bias the coefficients toward finding PTM and overstating markup adjustment, see Hooper and Mann (1989) and Goldberg and Knetter (1997). [45] But in agricultural production, there is no strong evidence for a significant component of inputs imported from abroad, especially for the US agriculture sector, unlike for example the automobile industry in which the bias is most likely to happen. Even if it exists, the measurement error resulting from the effect of imported inputs may be expected to be negligible in the case of agricultural products.

5.2 Methodology

Recent studies have pointed out several problems that deserve attention before estimation is carried out. First, contemporaneous effects are not enough to capture the actual relationship among the key variables in the study of PTM, and that future or delayed impacts should be accounted for. Second, whether the stochastic exchange rate should be treated as exogenous or endogenous is an important issue. Krugman (1989), for example, argues that part of real exchange rate volatility is generated by the weak response of international pricing and investment decisions to exchange rate movements. Betts and Devereux (1996) allow for implication of PTM for the behavior of the exchange rate and sticky local-currency nominal pricing in their analyses, and conclude that PTM is responsible for greater amplitude of real exchange rate movements to money shocks. So the impact of PTM on the exchange rate should also be allowed in PTM studies. Third, given that export (import) prices and exchange rates are typically non-stationary time series, assuming stationarity in these data series is likely to generate improper results for the relationship between them (Adolfson 1999; Swift 2004). Therefore, the data series must be tested for the presence of (seasonal) unit roots. If the

45 In Hooper and Mann (1989), US cost c^* as a function of the exchange rate and other factors (cx^*) was expressed, $c^* = -\phi e + cx^*$, and in Goldberg and Knetter (1997), $c^*(w,q,m) = c(w) + v(q,m)$, where c is the measure of costs using cost indices and v is the measurement error – the difference between true marginal cost and the cost index.

series are found to be non-stationary, whether there are (seasonal) cointegrating relations among the relevant variables exist should be taken into account. The above three questions can be perfectly solved by using a vector error correction model (VECM) and a seasonal error correction model (SECM).

The VECM can specify the long-run or underlying equilibrium relationships in the system suggested by economic theory. Moreover, the existence of such long-run conditions does not prevent the existence of short-run deviations from them. This model can define how the agents respond to the short-run disequilibrium errors in order to restore the equilibrium economic relations. This model is also able to treat all variables as endogenous and allow for feedback effects among them. However, all included variables in this model have to be integrated of degree 1, I(1), which implies that the roots of interest are precisely one and there are no other unit roots in the system. Thus differencing them will result in stationary data. If a variable such as the export price, is I(2), its inclusion is likely to generate an explosive data process instead of converging to a stationary long-run equilibrium. More important, if non-stationary stochastic seasonality, characterized by seasonal unit roots, is an important source of variation in the system, simple seasonal adjustment might lose a significant part of valuable information about seasonal fluctuations, and result in mistaken inference about economic relationships between time series data. Problems of this kind do suggest extending the concept of cointegration to consider the possibility that common roots exist at seasonal frequencies as well as the zero frequency, which results in the idea of seasonal cointegration (SECM) as discussed by Hylleberg, *et al.* (1990) (HEGY), Lee (1992), Engle, *et al.* (1993) (EGHL), Johansen and Schaumburg (1999).

Given these time series data, the stationarity and trend stationarity tests for all revelant variables are performed using Augmented Dickey-Fuller (ADF), Phillips-Perron (PP), and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests.[46] Even though these three test statistics do not show perfectly consistent results for all data series, strong non-stationarity is observed in the exchange rate series, both nominal and real. The

[46] Overall, three quarterly data series, export prices, exchange rates and producer price indices, and five monthly data series, effective export prices, effective nominal exchange rates, first difference of effective real exchange rates, import-competing prices, and producer price indices, are tested.

export unit values series for beef and lettuce exhibit strong stationarity, while the other export unit values series and the producer price series show mixed evidence. It is not possible to reject the null hypotheses of non-stationarity based on the ADF and PP test, and it is also not possible to reject the null hypothesis of stationarity using the KPSS test. As noted earlier, an assumption underlying the VECM model is that all variables are integrated of the same order, i.e., integrated of order 1. To rule out the possibility that the data are I(2), I perform a stationarity test of the first difference of all the data series. Use of the ADF test rules out the possibility of I(2) in any of our data series.

Due to the fact that there is typically strong seasonality in the prices of agricultural products, it is necessary to check for the presence of unit roots at seasonal frequencies as well as at zero frequency, for which the so-called HEGY test is applied, [47]

$$y_{4t} = \pi_1 y_{1t-1} + \pi_2 y_{2t-1} + \pi_3 y_{3t-2} + \pi_4 y_{3t-1} + \sum_{j=1}^{q} \varphi y_{4t-j} + D_t + \varepsilon_t \qquad (15)$$

where:

$$\begin{aligned} y_{1t} &= (1 + B + B^2 + B^3)x_t \\ y_{2t} &= -(1 - B + B^2 - B^3)x_t \\ y_{3t} &= -(1 - B^2)x_t \\ y_{4t} &= (1 - B^4)x_t \end{aligned}$$

Here x_t represents the original level of the data series of interest, y_t represents the transformed level of data used in estimation of equation (15). B is the lag operator with $Bx_t = x_{t-1}$. D represents determinant terms which can be a constant, seasonal dummies or a time trend, and q indicated the number of lagged terms. The simple t-statistics for $\pi_1 = 0$ and $\pi_2 = 0$ are used to test for the existence of unit root 1 and seasonal unit root -1 respectively. Since the complex roots are conjugates, a joint F-test for $\pi_3 = 0$ and $\pi_4 = 0$ is required to detect the existence of seasonal roots ± *i*. If coefficients are significantly different from zero, then the corresponding root(s) should not exist. Thus if π_1 is not significant from zero, but π_2, π_3 and π_4 are significantly different from zero, the series should be non-stationary only with unit root 1. Seasonal

[47] Only the three quarterly data series in equation (8) are checked here.

cointegration will be considered only if seasonal unit root(s) exist in the dataset. The inclusion of lags is determined by first estimating the equation with three years of lags and then excluding those lags that fail to enter significantly at 15 percent level. This approach trades off the loss of power, which results from including unnecessary lags, against the bias that results from excluding necessary lags (Beaulieu and Miron 1993). I also combine the Akaike Information Criterion (AIC), the Corrected Akaike Information Criterion (AICC), and the Schwarz Bayesian Criterion (SBC) to determine the number of lags. Results of seasonal unit roots test are very sensitive to the selection of lagged terms. More lagged terms are included when using the AIC and AICC criteria and seasonal unit roots are more likely to exist in the data. Generally, the SECM fits the data requirements, in which cointegrating relationships, not only at zero frequency but at seasonal frequencies, are what I need to derive.

By using the SECM method for equation (8), the long-run equilibrium relationship between export unit values, exchange rates and producer price indices, that is, the manner in which the three variables drift upward together, can be distinguished from the short-run dynamics, that is, the relationship between deviations of export unit values from their long-run trend and deviations of exchange rates and producer price indices from their long-run trends, not only at the zero frequency but also at seasonal frequencies. While differencing the data obscures the long-run relationship, cointegration and error correction preserves information about both forms of co-variation.

I estimate the following SECM version (Lee, 1992) of equation (8):

$$\Delta_4 x_t = \Pi_1 y_{1,t-1} + \Pi_2 y_{2,t-1} + \Pi_3 y_{3,t-1} + \Pi_4 y_{3,t-2} + \sum_{j=1}^{q} \Phi^*_j \Delta_4 x_{t-j} + \varepsilon_t \qquad (16)$$

where:

$$x_t = (p_{it}, e_{it}, cp_t)'$$
$$y_{1t} = S_1(B)x_t = (1 + B + B^2 + B^3)x_t$$
$$y_{2t} = S_2(B)x_t = (1 - B + B^2 - B^3)x_t$$
$$y_{3t} = S_3(B)x_t = (B - B^3)X_t = B(1 - B^2)x_t$$

here $\Delta_4 x_t = x_{t-4}$, q is the number of lagged terms, and B is again a lag operator. $S_1(B)$ is a seasonal filter that eliminates unit roots at all seasonal frequencies (ω = ½ and ¼), while $S_2(B)$ ($S_3(B)$) removes unit roots at frequency ω = 0 and seasonal frequency ω = ¼ (ω = ½). Therefore y_{1t}, y_{2t} and y_{3t} have unit roots only at frequency ω = 0, ω = ½ and ω = ¼, respectively. Because the coefficient matrices $\Pi_1,...,\Pi_4$ reveal information about long-run economic relationships among the data series at each corresponding frequency, the properties of these matrices are discussed. If the matrix Π_k $(k = 1,...,4)$ has a full-rank (in one of my cases $r = 3$), all variables of interest theoretically do not contain unit roots at the corresponding frequency. On the other hand, a cointegration relationship does not exist if the rank of matrix is equal to 0, even though there may exist (seasonal) unit roots in the data series. In the intermediate case, where the rank of the matrix Π_k, r, is 0 < r < 3, there are r stationary cointegrating relationships at the corresponding (seasonal) frequency. In this case, Π_k can be written as a multiplication of two matrices, $\Pi_k = \alpha_k \beta_k^{'}$. The α is called short-run adjustment coefficients and β called long-run parameters in empirical analyses. The ranks of α_k and β_k are determined by the number of cointegrating relationships, r. When $r = 1$, $\alpha_k = (\alpha_{1k}\ \alpha_{2\mathrm{k}}\ \alpha_{3\mathrm{k}})^{'}$ and $\beta_k = (\beta_{1k}\ \beta_{2\mathrm{k}}\ \beta_{3\mathrm{k}})^{'}$; when $r = 2$, $\alpha_k = \begin{pmatrix} \alpha_{11k} & \alpha_{21\mathrm{k}} & \alpha_{31\mathrm{k}} \\ \alpha_{12k} & \alpha_{22\mathrm{k}} & \alpha_{32\mathrm{k}} \end{pmatrix}^{'}$ and $\beta_k = \begin{pmatrix} \beta_{11k} & \beta_{21\mathrm{k}} & \beta_{31\mathrm{k}} \\ \beta_{12k} & \beta_{22\mathrm{k}} & \beta_{32\mathrm{k}} \end{pmatrix}^{'}$. Here $\beta_k^{'} Y_{k,t-1}$ is stationary, defined as the underlying or long-run equilibrium economic relationship even though $Y_{k,t-1}$ itself is non-stationary, and α_k are the adjustment coefficients that result in agents reacting to the disequilibrium error, returning variables to their equilibrium path.

I will impose the annual restriction of contemporaneous cointegration at complex frequencies, i.e., $\Pi_4 = 0$. Lee (1992) has argued that the absence of non-synchronous seasonal cycles should have little effect on the test for seasonal cointegration at frequency ¼, although this restriction is criticized by Johansen and Schaumburg, who state that the test for cointegration rank at complex frequencies is only partially correct. Lof and

Lyhagen (2002) show that the seasonal cointegration model with the annual restriction and unrestricted deterministic seasonal dummies is better than the SECM proposed by Johansen and Schaumburg with restricted seasonal intercepts if one step ahead forecasts are considered. Lee's model, therefore, has strong advantages in terms of the seasonal cointegration test and estimation.

As mentioned above, a full-rank matrix Π_k implies no (seasonal) unit root at the corresponding frequency. If the cointegration rank test shows no seasonal unit roots at all seasonal frequencies, the SECM reduces to the VECM. In other words, if the cointegration test confirms no existence of cointegrating relationships at zero frequency and no seasonal unit roots in SECM, I will try the VECM. First, the VECM with a constant restriction on the error correction term will be tested against without the restriction. In the VECM, a constant is included in the error correction term, which implies that the components are stationary around a constant. Because the introduction of a constant will lead to different null distributions of the likelihood ratio tests about the number of cointegrating vectors, this modification may generate enriched evidence of cointegrating relationships among the relevant variables. Also the constant term entered via the error correction term is also helpful to capture the country-specific effect. If the restriction is rejected, the VECM without a constant will be estimated. The following general VECM version of equation (8) will be applied.

$$\Delta\begin{pmatrix} p_{it} \\ e_{it} \\ cp_t \end{pmatrix} = \Pi(p_{it}, e_{it}, cp_t)' + \sum_{j=1}^{q} \Phi_j^* \Delta\begin{pmatrix} p_{it-j} \\ e_{it-j} \\ cp_{t-j} \end{pmatrix} + \varepsilon_{it} \tag{17}$$

here $\Pi = \alpha\beta'$, $\alpha = (\alpha_1, \alpha_2, \alpha_3)'$, $\beta = (\beta_1, \beta_2, \beta_3, 1)'$, and $\beta'(p_{it}, e_{it}, cp_t, 1) = \beta_1 p_{it} + \beta_2 e_{it} + \beta_3 cp_t + \beta_0$ is stationary and defined as the underlying or long-run equilibrium economic relationship in the VECM with a constant restriction; in the VECM without the restriction, $\beta' = (\beta_1, \beta_2, \beta_3)$ and $\beta'(p_{it}, e_{it}, cp_t) = \beta_1 p_{it} + \beta_2 e_{it} + \beta_3 cp_t$ is the long-run relation. The agents react to the disequilibrium error (the deviation between the actual observation and the long-run relationship) through the adjustment coefficient and α are the adjustment coefficients that have the same explanation as in SECM. If the matrix Π has a full-rank ($r = 3$), the three variables theoretically do not contain unit roots. On the other hand, a cointegration relationship does not exist if the rank of matrix Π is equal to 0. In the intermediate case, where the rank of the matrix Π, r, is less than 3, there are r stationary cointegrating relations. One more comment is that even though based on theoretical concerns, the constant restriction is preferred, but it does not always hold due to the use of producer price indices that makes the level of correlation between the variables arbitrary. Therefore the VECM without a constant is also considered if no cointegration relation can be found in the VECM with a constant.

The following VECM version of equation (18) will be estimated:

$$\Delta\begin{pmatrix} ep_t \\ neer_t \\ \Delta reer_t \\ pd_t \\ cp_t \end{pmatrix} = \Pi(p_t, neer_t, \Delta reer_t, pd_t, cp_t)' + \sum_{j=1}^{q} \Phi_j^* \Delta \begin{pmatrix} ep_{t-j} \\ neer_{t-j} \\ \Delta reer_{t-j} \\ pd_{t-j} \\ cp_{t-j} \end{pmatrix} + \varepsilon_t \qquad (18)$$

here $\Pi = \alpha\beta'$, $\alpha = (\alpha_1, \alpha_2, \alpha_3, \alpha_4, \alpha_5)'$ and $\beta = (\beta_1, \beta_2, \beta_3, \beta_4, \beta_5)'$ For this equation, two versions with and without a constant in the error correction term will be tested again. Here all variables have the same meaning as in equation (14). The interpretations in terms of cointegrating relationships are similar with equation (17). The exception is that the value of the full rank in equation (18) becomes 5, and then the maximum number of possible cointegrating relationships among the five variables can be 4.

CHAPTER 6

RESULTS

6.1 Empirical Evidence

First some empirical evidence of PTM is presented by comparing movements of the US export price specifically to one importing country with the price to all other trading countries (figure 6.1). The specific importing countries include Japan, Canada, Mexico, and South Korea, and the covered time period is from 1995 to 1998. The reason for this choice is that based on the nominal exchange rate, the US dollar kept appreciating with respect to the currency of these four countries over this period. So the starting and ending export prices can capture the overall changing patterns. The export price to all other trading partners for each specific importing country, for example Japan, is calculated as the ratio of two differences, the difference between the US export value to all trading countries and that to Japan and the difference between the US export quantity to all trading counties and that to Japan. The same pricing rule is also applied to Canada, Mexico, and South Korea. Therefore, for each destination country (Japan, Canada, Mexico and South Korea), two prices are constructed, own price and the corresponding price to all other trading partners.

If the US does not engage in any PTM for exports to Japan, movements of the export price to Japan and the price to all other trading partners will be identical (the same reasoning for the other three countries). I assume that opposite directions of changes (positive or negative) in the two prices can be explained as evidence of PTM since they are too significant to be explained by changes in other economic variables. However, it should be remembered that even in the case of the same direction of two prices changes, PTM might also exist because export prices change with varied degrees.

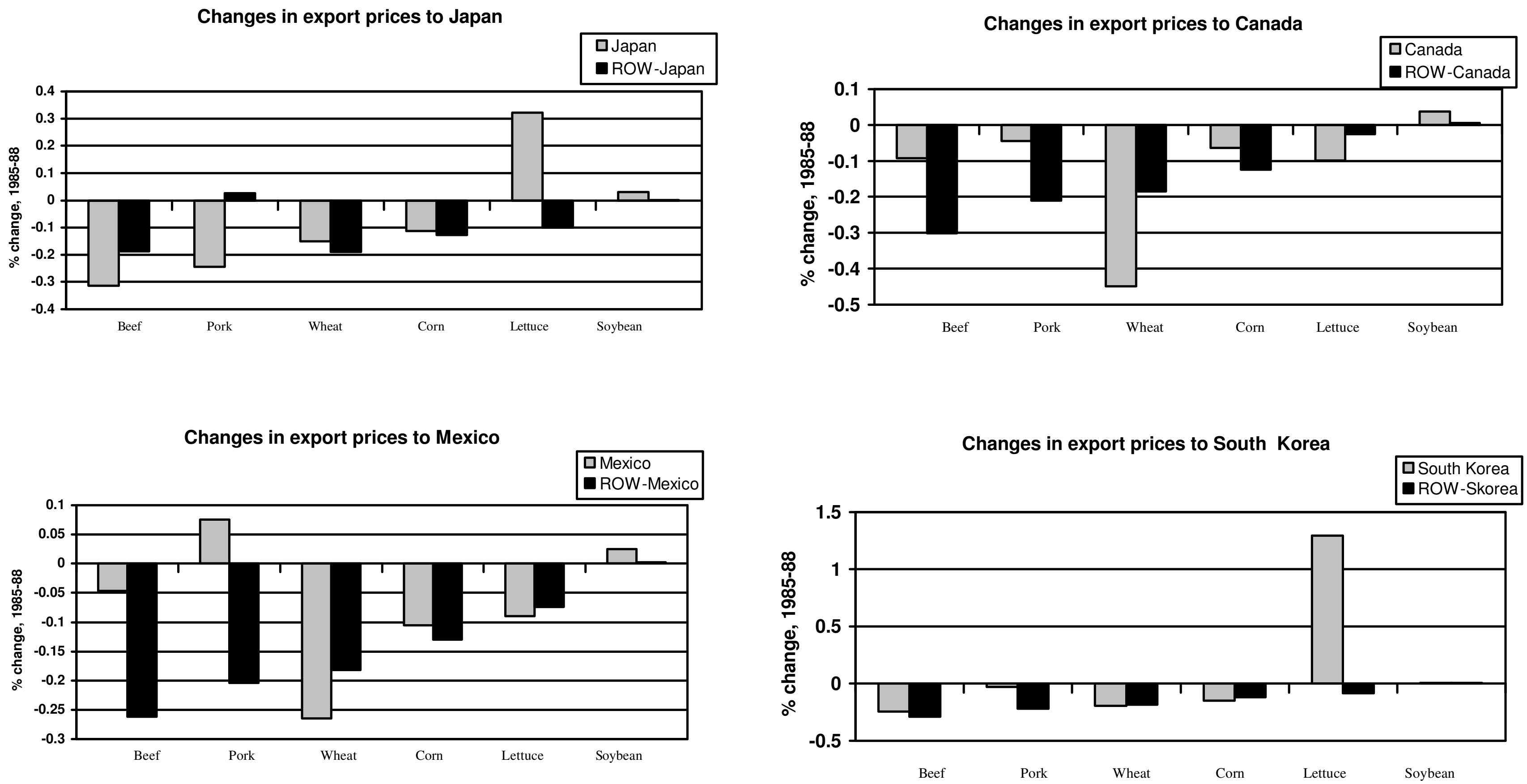
From figure 6.1, it is easy to detect several cases in which opposite movements in export prices occur. The occurrences imply that US exporters apply PTM for exports of pork and lettuce to Japan, exports of pork to Mexico, and exports of lettuce to South Korea, indicating the concentration of PTM in two product categories, pork and lettuce. Other cases deserving attentions are those in which a relatively large gap between movements in export prices happens, even though the changes are in the same direction. These cases include beef, pork and lettuce for Canada, beef and soybean for Mexico, and pork for South Korea, where the smallest divergence between export prices exceeds 225 percent. Therefore, roughly speaking, the evidence of PTM may be present in all four export markets; whereas, PTM is not universal across product categories and destination markets. The evidence seems to limit PTM to pork and lettuce, and perhaps beef and wheat. This sensitivity of the occurrence of PTM is what I am hoping the empirical estimation will confirm.

An interesting product is soybeans whose price changes contrast with the other five products. Given the strong US dollar from 1995 to 1998, US exporters choose to reduce export prices in their own currency in order to stabilize the local currency prices for the other five products. Meanwhile export prices of soybeans increase, albeit by a relatively small amount, which may imply that US exporters amplify the effects of exchange rate changes on their soybean export prices.

6.2 Empirical Results

6.2.1 Results from the monopolistic model

Estimation results from the fixed-effects model given in equation (5) and the SECM and VECM models in equation (16) and (17) will be analyzed. Since all exports are the US, it is necessary to accommodate the existence of contemporaneous correlation of errors across importing countries in estimating equation (5). Consequently, seemingly



ROW-Japan (ROW-Canada, ROW-Mexico, ROW-South Korea) represent rest of the world except Japan (Canada, Mexico, South Korea). All data are annual from FATUS/ERS/USDA

Figure 6.1: Changes in US export prices between 1995 and 1998

unrelated regression (SUR) is applied to the fixed-effects model. Lee's trace method is utilized to do the seasonal cointegration rank test, in which the number of cointegrating vectors is checked at zero frequency as well as at seasonal frequencies. Lee's trace statistics are simplified as partial canonical correlations at each frequency by the annual restriction imposed.

Based on the seasonal cointegration rank test, I only find evidence of seasonal cointegration in wheat export equations. So the SECM method is used for wheat exports. Given that the test results on the data series for US beef, pork, corn, soybean and lettuce exports do not show the seasonal cointegration, the VECM is applied to these products. As emphasized in chapter 5, the VECM with a constant restriction on the error correction term is tested against without the restriction. [48] In my empirical results, however, I do not find a large difference in coefficients between the restricted and unrestricted model in cases that the restriction is rejected. This might suggest that including a constant in the error correction term does not substantially change the basic relationship among the included variables. Both long-run cointegrating parameters (β) and short-run adjustment coefficients (α) in equation (17) are reported. The former describes the underlying economic relationship in the system, and the latter indicates the direction in which economic agents adjust the relevant variables to correct the short-run deviation from the long-run equilibrium level, i.e., the disequilibrium error, in order to restore the system back to the steady state.

Wheat

Table 6.1 summarizes the trace test results of seasonal cointegration for US wheat exports. When the nominal exchange rate is used in estimation, cointegration at zero frequency is confirmed for exports to Egypt, Japan and Mexico. Cointegration at frequency 1/4 is found in China, Philippines, Jamaica and Thailand. In the latter four

[48] Two test statistics proposed by Johansen (1988), the trace test and the maximum eigen-value test, are used to test the cointegration rank and to obtain the number of cointegrating vectors. Greater weight is placed on the trace test results, since first, the trace test is more robust in terms of testing for the possible non-normality of residuals; second, the SAS 9.1 Program performs the restriction test using the trace value. If the trace test fails to reject the constant restriction, the VECM with a constant in the error correction term is treated as the correct model, implying that in the long run the components are stationary around a constant. If the restriction is rejected, the unrestricted model is estimated. The significance of all long-run parameters and short-run coefficients are tested.

Importing countries	Rank	Nominal exchange rate			Real exchange rate		
		$\omega = 0$	$\omega = \frac{1}{2}$	$\omega = \frac{1}{4}$	$\omega = 0$	$\omega = \frac{1}{2}$	$\omega = \frac{1}{4}$
China	r = 0	29.75*	65.2*	41.77*	28.64†	68.1*	47.75*
	r = 1	14.18*	32.34*	19.95*	11.29	32.47*	22.26*
	r = 2	5.9*	12.54*	2.94	2.39	11.89*	5.49*
Egypt	r = 0	29.85*	64.18*	97.67*	28.25†	58.34*	95.81*
	r = 1	9.33	27.53*	44.18*	12.03†	27.77*	45.6*
	r = 2	1.62	10.22*	14.72*	2.89	10.08*	14.89*
Japan	r = 0	56.02*	58.51*	57.18*	52.65*	58.24*	58.37*
	r = 1	19.23*	20.05*	34.87*	14.94*	19.12*	36.31*
	r = 2	3.15	8.98*	14.12*	3.16	8.1*	16.03*
South Korea	r = 0	19.67	64.77*	47.95*	20.2	63.09*	51.4*
	r = 1	9.15	33.28*	24.31*	9.76	31.52*	27.23*
	r = 2	1.52	10.99*	8.6*	2.15	10.72*	10.48*
The Philippines	r = 0	25.54	59.3*	44.2*	24.26	60.89*	50.91*
	r = 1	6.49	24.46*	21.37*	7.26	26.6*	27.3*
	r = 2	0.14	9.04*	4.43	0.44	9.15*	9.78*
Mexico	r = 0	33.86*	74.8*	79.93*	36.45*	74.53*	80.43*
	r = 1	10.96	34.94*	35.77*	11.98	34.09*	39.22*
	r = 2	2.26	12.2*	16.9*	5.53*	12.5*	19.15*
Jamaica	r = 0	45.23*	58.15*	38.14*	39.73*	60.05*	40.75*
	r = 1	24.43*	32.56*	12.93	17.91*	30.93*	14.95*
	r = 2	6.89*	13.04*	1.06	4.02*	12.73*	0.14
Thailand	r = 0	17.26	59.43*	38.68*	17.64	59.84*	39.13*
	r = 1	7.24	31.65*	19.52*	7.54	33.53*	19.71*
	r = 2	0.73	11.86*	3.6	1.0	11.91*	3.82

No constant, deterministic seasonal dummies or a trend are included in the estimation.
No lagged terms are in the model according to the information criterion (AIC, AAIC, BIC).
* and † represent the 5 percent and 10 percent significant levels respectively.
Finite-sample (50) critical values are from Lee (1992).

Table 6.1: Trace test statistics for seasonal cointegration (wheat exports)

cases, two long-run cointegrating vectors are significant. Because the first cointegrating vector is derived by the maximum canonical correlation between the relevant variables, I regard it as the main equilibrium relationship that is my analytical focus (in all cases that more than one cointegrating vectors are found, my analysis is based on the first cointegrating relationship). No cointegration is detected at frequency 1/2. In the case of the real exchange rate cointegration is less likely to be verified. Cointegration at zero frequency is confirmed in exports to China, Egypt and Japan, but only with a ten percent significant level in the first two countries. Two cointegrating vectors at frequency 1/4 are substantiated in wheat exports to Jamaica and Thailand. Again, cointegration at frequency 1/2 is significantly rejected in all cases. [49] The consideration of seasonal cointegration, therefore, provides more evidence for the existence of long-run relationships for wheat exports.

The parameters of the cointegrating vectors for US wheat exports are reported in table 6.2.[50] The positive parameters in Egypt and Philippines are found for both nominal and real exchange rates. The result for the former country is inconsistent, while that for the latter country is consistent with previous studies, e.g., Pick and Park (1991), Pick and Carter (1994), Park and Pick (1996), and Carew and Florkowski (2003). Given that these two countries are among the targeted countries of the US EEP, it is not surprising that US exporters can exacerbate the impact of exchange rate movements, and when the US dollar depreciates, the local currency prices in Egypt and Philippines will be lowered. [51] An intriguing result is the negative effect from China, which is another recipient country of EEP. Indeed this negative result is consistent with previous findings, e.g., Pick and Pack (1991), Pick and Carter (1994), Park and Pick (1996), and Carew and Florkowski (2003). Given that China's nominal exchange rate has been controlled by the Chinese government and over the time period covered in the data, only four periodic readjustments in the nominal exchange rate occurred, the negative effect may be

[49] A lack of cointegrating relationships can be caused by either no unit roots at corresponding frequencies or no long-run relationships even though (seasonal) unit roots exist. The former causes no cointegrating rank at zero frequency for wheat exports to South Korea and Philippines; the latter leads to no cointegration at zero frequency for Mexico in the case of the real exchange rate.

[50] For exports to South Korea, Philippines and Mexico, in which no seasonal cointegration exists, the VECM is applied and one underlying relation among the three variables is derived.

[51] All data and facts used in this chapter are from studies of USDA ERS.

attributed to the rigidity in the nominal exchange rate determination. Another more reasonable explanation can be the US exporters' expectation that the Chinese Yuan will appreciate and even keep appreciating in the future. This expected appreciation will erode future profits in the US dollar so much that US firms will raise their current-period dollar prices by a much larger percentage when facing a temporary depreciation of the US dollar. This perfectly explains the large size of the coefficients of exchange rates for wheat exports to China.

Because of the mixed results for Japan in previous studies, the negative effect of exchange rates in table 6.2 needs careful consideration. The Japanese Food Agency, a parastatal importer, prefers to import wheat from central selling agencies such as the Canadian wheat Board (CWB), since quantity and quality are guaranteed throughout the year (Western Grain Marketing Panel Report 1996). This fact forces US exporters to keep stable local currency prices in Japan to compete with Canadian exporters. Based on that US exporters place second to Canada in South Korea, the negative effect in the case of the nominal exchange rate is in accord with expectation. For the rest three countries, negative parameters in most cases imply that US exporters mitigate the effect of changes in the nominal exchange rate in order to retain its market share. Since only in cases of South Korea and Mexico, the nominal and real exchange rates show different impacts, no big disparity between effects of these two exchange rates can be confirmed in the case of wheat. In all cases, the parameters for the producer price index show consistency with the economic expectation that cost increases will result in an increase in prices, especially for China, Mexico, Jamaica and Thailand where a larger percentage rise in export prices follows an increase in producer prices.

In table 6.3, the relevant coefficients from the fixed-effects model are reported for US wheat exports. Comparing results between the SECM and the fixed-effects model, a slightly different story emerges in terms of US wheat exporters' pricing behavior. The fixed-effects model is more likely to support a positive effect of exchange rates on export prices, especially in the case of the real exchange rate, although not all of the estimated coefficients are significant.

Importing countries	Nominal exchange rate			Real Exchange rate		
	price	ex	ppi	price	ex	ppi
China	1	-5.35	5.83	1	-16.09	4.08
Egypt	1	0.53	0.59	1	1.43	-0.15
Japan	1	-0.08	0.79	1	-0.08	0.77
South Korea	1①	-0.004	0.93	1①	0.01	0.95
The Philippines	1	1.51	0.48	1①	0.01	0.99
Mexico	1	-0.04	1.08	1①	0.15	1.00
Jamaica	1	-0.65	1.55	1	-0.61	1.52
Thailand	1	-0.67	2.73	1	-0.95	2.97

Parameters of the long-run cointegrating relationship are normalized on export price.

Parameters of the second cointegration relationship are 1, 0.73, -0.65 for china, 1, -1.3, 1.7 for Japan, 1, -5.17, 5.97 for the Philippines, 1, 0.43, -0.68 for Jamaica, 1, 0.17, 0.18 for Thailand under the nominal exchange rate; and 1, -0.004, 1.81 for Egypt; 1, 1.69, 2.63 for Japan, 1, 0.38, -0.65 for Jamaica, 1, 0.16, 0.21 for Thailand, under the real exchange rate.

① represents the results from the VECM.

Table 6.2: Long-run parameters in the seasonal error correction model (SECM) for US wheat exports

Importing countries	Nominal exchange rate		Real exchange rate	
	country-specific(λ)	ex(β)	country-specific(λ)	ex(β)
China	2.65	-0.54**	2.03	0.15
Egypt	2.2	-0.11**	2.1	0.02
Japan	2.22	0.006	2.7	-0.23**
South Korea	2.21	-0.003	1.59	0.2**
The Philippines	1.86	0.21**	1.78	0.26**
Mexico	2.15	0.05	2.12	0.07**
Jamaica	2.1	0.05	2.08	0.07**
Thailand①	--	1.47**	--	1.48**

① means intercept term in this equation (country) is dropped to avoid singularity problem in estimation.

** represents 5 percent significant level and * represents 10 percent significant level.

Table 6.3: Coefficients in the fixed-effects model for US wheat exports

Beef

Table 6.4 contains long-run parameters and short-run adjustment coefficients in the VECM for US beef exports. Generally, the hypothesis of perfect competition that US exporters face in overseas markets is rejected in most cases, and negative effects of exchange rate changes on export prices dominate the results, especially in the case of the real exchange rate.

For exports to Japan, the evidence of imperfect competition is found with both nominal and real exchange rates. This result is not surprising given two facts. One, Japan is the biggest export market for US beef, e.g., accounting for more than 36 percent of total US beef exports in 2003. Two, US exporters face strong competition from Australia since over 90 percent of the total Japanese beef imports are from these two countries. In general US exporters try to maintain export sales to this country. However, multiple restrictive measures actually complicate the Japanese market faced by US exporters. From 1989, Japan started to relax beef import quotas, which was gradually replaced by *ad valorem* tariff. Nevertheless, Japan retains the right to reinstate higher rates under 'safeguard provisions'. [52] If US exporters expect that the increased exports esulted from depreciation of the US dollar will induce a higher tariff rate, they may increase their dollar prices in order to offset the future lower sales in Japan. Meanwhile, to expand the Japanese market could be the main objective for pricing strategies, so US exporters will try to offset the effect of exchange rate changes on local currency prices. Therefore, no convincing conclusion can be theoretically derived for exports to this country. Actually, different significant impacts on export prices of the nominal and real exchange rates shown in table 6.4 confirm this ambiguity. Furthermore, previous studies about US beef exports to Japan, e.g., Patterson *et al* (1996), Miljkovic *et al.* (2003), also gave mixed results in terms of the effect of the real exchange rate.

South Korea is the second largest market for US beef, which accounted for 25 percent of US beef exports in 2003. The positive but insignificant effect of the real exchange rate is consistent with previous studies; however, the significantly negative

[52] The 'safeguard provisions' state that Japan is able to increase the tariff rate if current-year imports of frozen or chilled beef exceed previous-year imports by more than 17%. The safeguards were in effect in 1995 and 1996.

Importing countries		Nominal exchange rate				Real exchange rate			
		price	ex	ppi	intercept	price	ex	ppi	intercept
Japan	Long-run parameter (β)	1	2.2**	0.27	-3.37	1	-111.48**	32.17	378.39
	Adjustment coefficient (α)	-0.09**	0.088**	-0.06**	--	0.002**	-0.002**	0.0017**	--
Canada	Long-run parameter (β)	1	1.21**	0.78**	4.9**	1	-1.18**	1.02**	3.65
	Adjustment coefficient (α)	-0.2	-0.16**	0.22	--	0.014	-0.06*	0.25**	--
Mexico	Long-run parameter (β)	1	-0.21**	-0.29	--	1	-0.38**	0.097	8.44**
	Adjustment coefficient (α)	-0.21**	0.04	0.13**	--	-0.64**	-0.65	-0.63**	--
South Korea	Long-run parameter (β)	1	-0.39*	0.37*	9.03**	1	4.52	6.56	--
	Adjustment coefficient (α)	-0.83*	-0.16	-0.19	--	-0.015	0.02	-0.017**	--
Hong Kong	Long-run parameter (β)		No cointegration found			1	-1.66**	3.33**	-3.91
	Adjustment coefficient (α)					-0.12**	-0.03**	-0.006	--
Singapore	Long-run parameter (β)	1	-0.6*	0.66*	6.0**	1	-0.73**	0.98**	4.52**
	Adjustment coefficient (α)	-0.86**	0.02	0.003	--	0.89**	0.03	0.03	--
Switzerland	Long-run parameter (β)	1	0.86	-4.54	30.29	1	-1.13	-8.31	48.58
	Adjustment coefficient (α)	-0.45	-0.05	-0.02	--	-0.07	-0.05*	0.011	--
Philippines	Long-run parameter (β)	1	0.068	0.49	--	1	0.54	0.06	6.45**
	Adjustment coefficient (α)	-0.85**	0.026	0.001	--	-0.97*	0.015	-0.02	--
Indonesia	Long-run parameter (β)	1	0.08	0.11	7.28**	1	0.29*	0.15	5.15*
	Adjustment coefficient (α)	-0.82**	0.04	-0.0004	--	-0.85**	0.05	0.001	--

Parameters of the long-run cointegrating relationship are normalized on export price.

The lag lengths (q in equation) for the nominal and real exchange rates are 7 and 7 for Japan. 5 and 7 for Canada, 8 and 10 for Mexico, 7 and 8 for South Korea, 1 for Hong Kong, 0 and 0 for Singapore, 7 and 7 for Switzerland, 0 and 2 for Philippines, 0 and 0 for Indonesia.

No data for the intercept in the long-run parameter implies no intercept term in the error correction term is included in estimation. There is no adjustment coefficient for the intercept term.

** represents significant at 5 percent level and * represents significant at 10 percent level.

Table 6.4: Coefficients in the vector error correction model (VECM) for US beef exports

parameter of the nominal exchange rate shows that US exporters lower their dollar prices in the face of an appreciation in the US dollar in order to mitigate the adverse effects of exchange rate changes on the local currency prices. This evidence of different effects of the nominal and real exchange rates suggests the consideration of different roles that these two exchange rates play in export pricing decisions. The estimation results for the third largest import country, Mexico, reveal the strong tendency that US beef exporters stabilize the market demand of this country.

Canada is a country among the largest export as well as import markets for US beef. Even though product categories for imports and exports are not exactly the same, maintaining market share in Canada might be expected to be the objective of US exporters' pricing decisions. The significant negative effect of the real exchange rate confirms this proposition, which is consistent with the previous findings of Miljkovic *et al.* (2003). However, the significant positive effect of the nominal exchange rate again requires differentiation between effects of the two exchange rates. For Hong Kong and Singapore, US exporters show a strong intention to stabilize local demand, while for Indonesia, US exporters try to exploit their market power and earn more profits accruing from exaggerating the effect of exchange rate changes. The beef markets in Switzerland and Philippines are perceived by US exporters as perfectly competitive based on insignificant parameters of exchange rates.

The export price is the most active variable to bring the system back to the equilibrium level in the short-run adjustment. Based on the significant short-run adjustment coefficients found for beef exports, export prices are lowered to diminish the deviation of actual variables from the long-run equilibrium in all cases of the nominal exchange rate and most cases of the real one. Both exchange rates play certain roles in the short-run adjustment; however, their effect is less significant than in the determination of the long-run equilibrium. All significant parameters of producer price indices are positive which is consistent with economic proposition, which confirms that this price index at least partially satisfies the criterion for a good proxy for production cost.

In table 6.5, the results from the fixed-effects model indicate a different story about US beef exporters' pricing behavior, except in Canada and Indonesia. For these two countries, the fixed-effects model reveals the similar evidence of a positive effect of exchange rates to the VECM; while for the other seven countries, the fixed-effects model gives different directions of price adjustments to exchange rate changes in most significant cases.

Pork

Table 6.6 reports the estimation results of the VECM for US pork exports. The main conclusions derived from this table are destination-specific effects of exchange rates and contradictive effects of the nominal and real exchange rates. Under the nominal exchange rate, for exports to Japan and South Korea, US exporters tend to amplify the effect of exchange rate fluctuation. One reason could be the strong reliance of Japan and South Korea on US pork imports. US exporters are able to employ strong market power in these two markets to earn extra profits due to exchange rate changes. For Mexico, Canada and Singapore, a negative effect of nominal exchange rate changes is found. For the former two countries, the reason could be bilateral. One, these two countries are the second and third important export markets for the US pork, so US exporters want to maintain their market demand. Two, economic forces, e.g., NAFTA and low transportation costs, accelerate integration in the North American pork industry. Mexico, for example, has imported pork products mainly from the US after the NAFTA is signed. Therefore, it is not surprising that US exporters are willing to keep local currency prices in order to expand these two markets. For Singapore, the reason might be due to the unstable demand of this country for US pork products. US exporters want to increase their market share in this country.

More cases of negative effects are found under the real exchange rate. In Japan and South Korea, unlike beef markets in these two countries, no exporting countries dominate the local market, which results in more competition from other exporting countries facing US exporters. This may to some extent explain the negative effect of the real exchange rate in these two countries. But more importantly this evidence again raises the question of different roles of the nominal and real exchange rates in price determination. Significant and opposite effects of the real exchange rate are found in

Importing countries	Nominal exchange rate		Real exchange rate	
	country-specific(λ)	ex(β)	country-specific(λ)	ex(β)
Japan	4.74	-0.54**	4.11	-0.27**
Canada	3.62	-0.45**	3.49	0.05
Mexico	3.59	-0.12	3.24	0.2**
South Korea	3.87	-0.11	2.88	0.19**
Hong Kong	3.27	0.37**	-1.03	5.13
Singapore	3.81	0.09	3.73	0.14
Switzerland	4.1	-0.69*	4.04	-0.62
The Philippines	2.77	0.65**	2.91	0.54**
Indonesia ①	--	0.97**	--	1.0**

① means intercept term in this equation (country) is dropped to avoid singularity problem in estimation.

** represents 5 percent significant level and * represents 10 percent significant level.

Table 6.5: Coefficients in the fixed-effects model for US beef exports

Mexico and Canada. Miljkovic *et al.* (2003) derived the same effect for these two countries, but the results were not significant in that paper. The opposite results are difficult to explain since I believe they should have the same pattern. No counter-intuitive results in terms of the impact of producer prices on export prices, and all significant results are positive.

Export price is the most effective variable in the short-run adjustment. US pork exporters lower their dollar prices when facing the short-run disequilibrium error irrespective of nominal or real exchange rates, except for exports to Japan. This exception might indicate the extreme reliance of Japanese pork demand on the US. Japan is the biggest importing country for US pork, e.g., accounting for more than 50 percent of total US exports in 2003. The Japanese imports include not only fresh pork precuts, such asloin for retail, but also frozen pork cuts, such as boneless bellies and shoulders for processed pork products. So US exporters have the market power to change export prices in favor of their profits due to exchange rate changes even in the short run. Other cases are consistent with negative adjustment of export prices, implying in the short run, US pork exporters tend to decrease prices in order to return to the equilibrium level.

In table 6.7, the results from the fixed-effects model are presented. More cases of positive effects of exchange rates are reported. Under the real exchange rate, the fixed-effects model shows a positive effect in 5 of 6 cases, while the VECM only shows in 2 cases.

Corn

In table 6.8, long-run parameters and short-run coefficients in the VECM for US corn exports are reported. Significant evidence of imperfect competition is found in 6 of 8 cases with the nominal exchange rate and 5 of 8 cases with the real exchange rate. This result contrasts sharply with significant evidence only found in one (Mexico) of ten cases with the nominal exchange rate and zero case with the real exchange rate in Pick and Park (1991). But, the finding in this study is consistent with the strong market power of the US in the world corn market. The US is the world's largest corn exporter and producer. During the 1990s, US exports only accounted for about 20 percent of domestic corn production, but this relatively small portion averaged 70 percent of world corn exports. So the US is a major determinant of world corn prices.

Importing countries		Nominal exchange rate				Real exchange rate			
		price	ex	ppi	intercept	price	ex	ppi	intercept
Japan	Long-run parameter (β)	1	7.57**	51.89*	--	1	-9.38	53.83**	--
	Adjustment coefficient (α)	0.027**	0.008*	0.012*	--	0.005**	-0.0008	0.01**	--
Mexico	Long-run parameter (β)	1	-0.23*	0.52	--	1	2.7**	3.87**	-17.04**
	Adjustment coefficient (α)	-0.34*	-0.08	0.06	--	-0.09	0.035**	0.042	--
Canada	Long-run parameter (β)	1	-1.52	0.397	6.41	1	-1.19**	0.17	7.34*
	Adjustment coefficient (α)	-0.46*	-0.057*	0.013	--	-0.48**	-0.07**	-0.06	--
Hong Kong	Long-run parameter (β)	No cointegration found				1	0.45	1.31**	0.26**
	Adjustment coefficient (α)					-0.57	-0.012	0.05**	--
South Korea	Long-run parameter (β)	1	0.69**	4.5**	-8.7	1	-1.03*	5.59**	-11.38
	Adjustment coefficient (α)	-0.17	-0.04	0.09**	--	-0.13	-0.04*	0.07**	--
Singapore	Long-run parameter (β)	1	-1.99**	0.65	5.9	1	-1.44**	0.58	5.87
	Adjustment coefficient (α)	-1.65**	-0.002	0.055**	--	-1.04**	0.006	0.05	--

Parameters of the long-run cointegrating relationship are normalized on export price.

The lag lengths (q in equation) for the nominal and real exchange rate are 11 and 5 for Japan. 1 and 6 for Mexico, 2 and 2 for Canada, 0 for Hong Kong, 5 and 5 for South Korea, 2 and 2 for Singapore.

For Mexico with the real exchange rate, two cointegrating vectors are found, and the long-run parameter for the second one is 1, 0.95, -1.29, and 11.36.

No data for the intercept in the long-run parameter implies no intercept term in the error correction term is included in estimation. There is no adjustment coefficient for the intercept term.

** represents significant at 5 percent level and * represents significant at 10 percent level.

Table 6.6: Coefficients of the vector error correction model (VECM) for US pork exports

Importing countries	Nominal exchange rate		Real exchange rate	
	country-specific(λ)	ex(β)	country-specific(λ)	ex(β)
Japan	4.74	-0.58**	5.0	0.7**
Mexico	3.19	0.07	3.17	0.1**
Canada	3.37	-0.22	3.28	0.31
Hong Kong	2.45	0.79**	-9.92	14.68
South Korea①	--	1.1**	--	1.1**
Singapore	3.6	-1.05*	3.87	-2.23**

① means intercept term in this equation (country) is dropped to avoid singularity problem in estimation.

** represents 5 percent significant level and * represents 10 percent significant level

Table 6.7: Coefficients in the fixed-effects model for US pork exports

Importing countries		Nominal exchange rate				Real exchange rate			
		price	ex	ppi	intercept	price	ex	ppi	intercept
Japan	Long-run parameter (β)	1	0.08**	0.75**	0.91**	1	0.04*	077**	1.01**
	Adjustment coefficient (α)	0.69	2.43**	-0.64**	--	-1.13	2.24**	-0.98	--
South Korea	Long-run parameter (β)	1	-0.12**	0.77**	2.01**	1	-0.18**	0.75**	2.53**
	Adjustment coefficient (α)	-1.18**	-0.06**	-2.25	--	-1.18**	-0.11	-0.28	--
Mexico	Long-run parameter (β)	1	0.03**	0.82**	0.896*	1	-1.05**	1.34	1.04
	Adjustment coefficient (α)	0.68	0.36	2.01*	--	0.2	-0.28**	0.4*	--
Egypt	Long-run parameter (β)	1	-0.03**	0.89**	0.64**	1	-0.02	0.9**	0.6**--
	Adjustment coefficient (α)	-0.77**	-0.31	0.38	--	-0.72**	-0.16	0.37	--
Algeria	Long-run parameter (β)	1	0.01**	0.79	0.71	1	-0.05	0.78	1.35**
	Adjustment coefficient (α)	-0.19	0.7**	-0.11	--	-0.42**	-0.21	0.12	--
Dominican	Long-run parameter (β)	1	-1.22**	0.28	6.64	1	0.67**	0.55	0.34
	Adjustment coefficient (α)	0.02	0.06**	0.01	--	-0.79**	0.167*	-0.68	--
Canada	Long-run parameter (β)	1	0.008	0.68**	1.52**	1	0.005	0.69**	1.49**
	Adjustment coefficient (α)	-1.4**	0.3**	-2.2**	--	-1.48**	0.32**	-2.25**	--
Jamaica	Long-run parameter (β)	1	5.11	111.62**	-411.96**	1	-33.4**	101.13**	-218.02**
	Adjustment coefficient (α)	-0.09	-0.000007	0.005**	--	-0.22	-0.003**	0.007**	--

Parameters of the long-run cointegrating relationship are normalized on export price.

The lag lengths (q in equation) for the nominal and real exchange rates are 6 and 6 for Japan. 0 and 0 for South Korea, 5 and 5 for Mexico, 0 and 0 for Egypt, 5 and 0 for Algeria, 7 and 9 for Dominican Republic, 5 and 5 for Canada, 0 and 0 for Jamaica.

No data for the intercept in the long-run parameter implies that no intercept term in the error correction term is included in estimation. There is no adjustment coefficient for the intercept term.

** represents significant at 5 percent level and * represents significant at 10 percent level.

Table 6.8: Coefficients of the vector error correction model (VECM) for US corn exports

The outlier case is Canada. For both nominal and real exchange rates, exports to Canada show no effect of exchange rates on export prices, which implies US exporters face perfect competition in the Canadian corn market. This can be explained by the fact that the Canadian market is almost integrated with the US and the whole corn market is characterized by perfect competition. The interesting point is that even though exchange rates do not play a role in the long-run price determination, they have significant influence in the short-run price adjustment. In order to return the equilibrium relationship in the system, both the nominal and real value of the US dollar tend to build up, which apparently may lead to higher local-currency prices. However the dollar export prices and production costs decrease in the short run. These three short-run conflicting changes in fact offset each other.

Significant positive and negative effects of exchange rates are found for exports to Japan and South Korea respectively. The destination-specific results correspond to the specific demand situation of these two countries. Japan imports the largest amount of corn from the US, e.g., accounting for 33 percent of total US exports in 2003, to fit the need of domestic meat producers. Since there are almost no coarse grains produced in Japan, this large and steady demand for US corn allows US exporters to easily manipulate their market power to make more profit when the dollar value changes. South Korea is very sensitive to price and ready to buy from the cheapest source through switching to feed wheat or other coarse grains. So the US exporters try to stabilize local-currency prices for this destination. For the other selected countries, the effects of the nominal and real exchange rates are opposite based on the significant cases. This result really offers supportive evidence for the different roles that two exchange rates play in export pricing decisions. The parameters for the producer price index are perfectly consistent with the hypothesis that higher production costs lead to higher prices.

The most noticeable result from the fixed-effects model (table 6.9) is the strong evidence of imperfect competition due to significant coefficients of the real exchange rate in all importing countries, with seven cases of a positive coefficient and one case of negative. This result is surprising when compared to the insignificant finding of the fixed-effects model in Pick and Park (1991). The reason could be that there is no overlapping of time span for the dataset between their study, in which the data are from

Importing countries	Nominal exchange rate		Real exchange rate	
	country-specific(λ)	ex(β)	country-specific(λ)	ex(β)
Japan	2.02	0.002	2.29	-0.42**
South Korea	2.54	-0.16**	-0.17	0.52**
Mexico①	--	1.99**	--	1.63**
Egypt	2.04	-0.02	1.23	0.3**
Algeria	2.09	0.03	0.88	0.31**
Dominican Republic	1.98	0.06	0.55	0.74**
Canada	2.01	-0.05	1.14	1.51**
Jamaica	2.33	0.17**	0.96	0.31**

① means intercept term in this equation (country) is dropped to avoid singularity problem in estimation.

** represents 5 percent significant level and * represents 10 percent significant level

Table 6.9: Coefficients in the fixed-effects model for US corn exports

1978 to 1988, and my study that covers data from 1989 to 2003. Another important result in table 6.9 is that more cases of positive effects of exchange rates are confirmed in the fixed-effects model. However, based on the strong argument for positive and negative effects for Japan and South Korea in the VECM, the opposite result in table 6.9 suggests reconsideration about the explanatory power of the fixed-effects model, at least in corn exports.

Soybean

The long-run parameters and short-run adjustment coefficients for US soybean exports from the VECM are presented in table 6.10. According to the parameters of exchange rates in this table, US soybean exports are characterized by imperfect competition in all selected destination countries with the nominal exchange rate and most countries with the real exchange rate. Once again, this significant evidence is in sharp contrast with insignificant evidence of imperfect competition found in most countries in Pick and Park (1991). This might be the result of there no being an overlap in the datasets of these two studies. But my result is justifiable by the strong market power of the US in the world soybean market. The US is the world's largest soybean exporter and producer. In 2003, for example, US soybean production accounted for about 35 percent of world total output, and US exports accounted for 48 percent of world soybean exports volume that was 51 percent of world total export value.

For exports to the Netherlands, Japan and Canada, US exporters are more aggressive in improving dollar export prices in the face of an appreciation of the US dollar. The result for the former country can be interpreted as a result of strong seasonal demands, that is, production shortfalls occur regularly in this country. US exporters can exploit their market power easily in this country according to anticipated seasonal fluctuation in demand, and respond quickly to increased prices. The results for the latter two countries indicate the strong dependence of Japan and Canada on US soybean exports. The result for Canada may require more investigation since this country should be a typical representative market integrated with the US. However, if US exporters believe local consumers and processors have a special preference for US soybeans and their demand will not decrease even when soybean prices in local currencies increase. The positive effect of exchange rates, therefore, is not surprising.

For exports to South Korea, Mexico and Costa Rica, based on the significant results, negative parameters of exchange rates imply that US exporters might be reluctant to jeopardize their market position in response to changes in the value of the US dollar. For South Korea and Costa Rica, these two countries are price-conscious, and ready to change importing sources, and then the aim of US exporters' pricing strategy is price stability in order to keep or increase export sales to these countries. The pricing behavior for exports to Mexico can be interpreted as a result of NAFTA. Since this agreement is in effect, the soybean tariff of Mexico has been reduced immediately to 10 percent, and domestic crop support programs have also been gradually deactivated. As a result, imports have displaced domestic soybean productions, with nearly all imports coming from the United States. So the objective of US exporters for this market is to stabilize and even expand the market demand of this country for US soybeans. An insignificant effect of the real exchange rate may work as proof for perfect integration between the US and Mexico due to decreased trade restrictions and lowered shipping costs by the improvement in Mexico's rail links. This insignificant effect also indicates different roles that the nominal and real exchange rates play in pricing decisions. Generally, the results for US soybean exports suggest that country-specific concerns are important. Based on the significant evidence, producer price indices show an expected positive effect on export prices in all cases.

In the short run, US soybean exporters will lower export prices to return to the equilibrium relation in all significant cases. The adjustment of export prices and exchange rates shows opposite directions in the case of Japan and Canada. This may imply in the short run, exchange rate changes tend to offset changes in dollar export prices for these two countries.

As can be seen in table 11, the fixed-effects model is able to reveal significant evidence for imperfect competition, and more importantly, positive effects of exchange rates are confirmed in all significant cases. The results suggest that the fixed-effects model tends to exaggerate the response of US exporters to exchange rate changes, especially in the direction of improving dollar export prices.

Importing countries		Nominal exchange rate				Real exchange rate			
		price	ex	ppi	intercept	price	ex	ppi	intercept
Netherlands	Long-run parameter (β)	1	0.13**	0.89**	1.11	1	0.14*	0.88**	1.11
	Adjustment coefficient (α)	-0.98**	0.12	0.02	--	-0.99**	0.07	0.02	--
Japan	Long-run parameter (β)	1	0.58**	0.68*	-0.43	1	0.21**	0.81**	0.78*
	Adjustment coefficient (α)	0.03	0.42**	-0.11	--	-0.13	1.48**	-0.51	--
South Korea	Long-run parameter (β)	1	-0.07**	0.86**	1.97**	1	-0.18**	0.79	3.05
	Adjustment coefficient (α)	-0.14	0.62	-2.27**	--	-0.32	0.48	-1.69**	--
Mexico	Long-run parameter (β)	1	-0.01**	0.85**	--	1	0.05	0.87**	1.35**
	Adjustment coefficient (α)	-2.11**	-0.71	-0.77	--	-1.09**	-0.22	-0.08	--
Canada	Long-run parameter (β)	1	0.19*	0.55**	2.87**	1	0.15**	0.54**	2.94**
	Adjustment coefficient (α)	-0.42**	0.18**	0.22	--	-0.43**	0.2**	0.22	--
Costa Rica	Long-run parameter (β)	1	-0.06**	0.95**	--	1	0.28	1.03**	0.86
	Adjustment coefficient (α)	-0.52	-0.07	1.0**	--	-0.59**	-0.05	0.13	--

Parameters of the long-run cointegrating relationship are normalized on export price.

The lag lengths (q in equation) for the nominal and real exchange rates are 2 and 2 for Netherlands, 7 and 7 for Japan, 11 and 11 for South Korea, 6 and 3 for Mexico, 2 and 2 for Canada, 0 and 0 for Costa Rica.

No data for the intercept in the long-run parameter implies that no intercept term in the error correction term is included in estimation. There is no adjustment coefficient for the intercept term.

** represents significant at 5 percent level and * represents significant at 10 percent level.

Table 6.10: Coefficients of the vector error correction model (VECM) for US soybean exports

Importing countries	Nominal exchange rate		Real exchange rate	
	country-specific(λ)	ex(β)	country-specific(λ)	ex(β)
Netherlands	2.4	0.2*	2.29	0.28**
Japan	2.31	0.08*	2.08	0.15
South Korea	2.47	-0.003	1.2	0.39**
Mexico	2.39	0.07**	2.21	0.21**
Canada	2.44	0.19**	2.22	1.18**
Costa Rica①	--	1.0**	--	1.03**

① means intercept term in this equation (country) is dropped to avoid singularity problem in estimation.

** represents 5 percent significant level and * represents 10 percent significant level.

Table 6.11: Coefficients in the fixed-effects model for US soybean exports

Lettuce

Table 6.12 summarizes the results of cointegrating parameters and adjustment coefficients from the VECM for US lettuce exports. Significant parameters of the real exchange rate in all cases and the nominal exchange rate in most cases indicate imperfect competition in US lettuce export markets. This strong market power may be due to the US share of 22 percent of total world lettuce output and 27 percent of total world export value. For exports to Canada and Mexico, strong positive effects of both nominal and real exchange rates are found, which implies that US exporters magnify the impact of exchange rate changes and destabilize local currency prices. This is not surprising given that the US dominates the import market of lettuce in Canada and Mexico. In 1999, for example, the US share of total fresh lettuce imports was 99 percent in Canada and 100 percent in Mexico. For Hong Kong, Japan and Singapore, three Asian countries, only significant negative effects of exchange rates are found. It appears that US exporters tend to absorb fluctuation in exchange rates in order to bolster lettuce sales in these three countries. Again, the producer price indices show positive effect on export prices, which definitely implies that the index is a justifiable proxy for the production cost. Still export prices play an important role in driving the short-run deviation back to the economic long-run relationship. In the short run, the exchange rate also plays a certain role in affecting the system, but the evidence is less significant than in the long run.

The results from the fixed-effects model shown in table 6.13 are quite similar to those derived from the VECM in terms of nominal and real exchange rate effects. For Canada and Mexico, the effects of exchange rates on export unit values are positive, while for Hong Kong, Japan and Singapore, the effects of exchange rates on export unit values are negative.

Importing countries		Nominal exchange rate				Real exchange rate			
		price	ex	ppi	intercept	price	ex	ppi	intercept
Canada	Long-run parameter (β)	1	1.11**	- 0.05	6.1**	1	0.81**	0.007	5.96**
	Adjustment coefficient (α)	-2.08**	- 0.08	- 3.32*	--	-2.01**	-0.09	-3.0*	--
Hong Kong	Long-run parameter (β)		No cointegration			1	-0.26*	0.34**	5.21**
	Adjustment coefficient (α)					-0.23	0.01	2.3**	--
Japan	Long-run parameter (β)	1	- 1.27	1.63**	4.97	1	-0.9*	1.26**	5.06*
	Adjustment coefficient (α)	-0.1	- 0.04*	0.4**	--	-0.32**	-0.06**	0.35**	--
Singapore	Long-run parameter (β)	1	- 0.58*	- 0.15	7.46**	1	-0.5**	0.08	6.29**
	Adjustment coefficient (α)	-1.19**	- 0.002	2.23**	--	-1.37**	0.07*	-0.93	--
Mexico	Long-run parameter (β)	1	0.18**	0.39**	3.62*	1	0.76**	1.25**	-2.0**
	Adjustment coefficient (α)	1.24**	0.84**	4.13**	--	0.65**	0.22**	2.06*	--

Parameters of the long-run cointegrating relationship are normalized on export price.
The lag lengths (q in equation) for the nominal and real exchange rates are 9 and 9 for Canada, 2 for Hong Kong, 4 and 3 for Japan, 4 and 3 for Singapore, 11 and 8 for Mexico.
No data for the intercept in the long-run parameter implies that no intercept term in the error correction term is included in estimation. There is no adjustment coefficient for the intercept term.
** represents significant at 5 percent level and * represents significant at 10 percent level.

Table 6.12: Coefficients of the vector error correction model (VECM) for US lettuce exports

Importing countries	Nominal exchange rate		Real exchange rate	
	country-specific(λ)	ex(β)	country-specific(λ)	ex(β)
Canada	2.73	0.49**	1.41	2.04**
Hong Kong	2.88	-0.05	2.29	-0.6
Japan	4.63	-0.76**	3.95	-0.94**
Singapore	2.99	-0.46**	1.86	-0.22
Mexico ①	--	2.6**	--	1.94**

① means intercept term in this equation (country) is dropped to avoid singularity problem in estimation.
** represents 5 percent significant level and * represents 10 percent significant level

Table 6.13: Coefficients in the fixed-effects model for US lettuce exports

6.2.2 A summary for the monopolistic model

The consideration of seasonal cointegration provides more evidence for the existence of long-run relationships for wheat exports. Positive coefficients for Egypt and the Philippines, two big recipient countries of EEP, imply that US exporters tend to exaggerate the adverse effect of exchange rate changes on local-currency prices for these two countries. This finding implies that the EEP program has improved the competitiveness of US wheat in Egypt and Philippines and provided market power to US wheat exporters. The negative effect of exchange rates for another recipient country of EEP, China, however, may imply that the US exporters' expectation of the future appreciation of Chinese Yuan erode the future dollar profits so much that they will charge higher current-period prices when facing a temporary depreciation of the US dollar. For the rest selected destination markets, the negative effect of the nominal exchange rate implies that US exporters lower dollar export prices if the US dollar appreciates in order to mitigate the adverse effect of exchange rate changes in local currency prices.

Generally, the hypothesis of perfect competition that US exporters face in overseas markets is rejected in most destination countries for US exports of beef, pork, corn, soybean and lettuce. Based on the effect of the nominal exchange rate, for beef and pork, US exporters tend to amplify the effect of exchange rate fluctuation for exports to Japan, which can be caused by the high tariff rate imposed by the Japanese government, or by the strong reliance of Japan on US exports of beef and pork. US exporters are also likely to exploit their market power and earn more profits accruing from exaggerating the effect of exchange rate changes to selected destinations, for example, beef exports to Canada and pork exports to South Korea. In order to maintain and even expand the local markets, US exporters are also willing to stabilize local currency prices when facing appreciations of the US dollar, for example beef exports to South Korea, Mexico, Hong Kong and Singapore, and pork exports to Mexico and Singapore.

For corn and soybean, significant evidence of imperfect competition is consistent with the fact that the US is the world's largest corn and soybean producer and exporter. This finding contrasts with the insignificant effect found in previous analyses, which can be caused by the data limitation, but more importantly, I believe it may result from the application of the cointegration method that accounts for the non-stationary property of the data and long-run economic relations among the relevant variables. US exporters tend to amplify the effect of the nominal exchange rate for corn and soybean exports to Japan probably because of Japan's strong reliance on US exports, and mitigate the effect for exports of these two products to South Korea, probably because South Korea is very sensitive to prices and ready to switch to other cheaper sources. US exporters are aggressive in improving dollar export prices for corn exports to Mexico and soybean exports to Canada, and more likely to lower dollar prices for soybean exports to Mexico. For lettuce, a positive effect of the nominal exchange rate is found for exports to Canada and Mexico, and a negative effect confirmed for Hong Kong, Japan and Singapore.

In most cases, the export price is the most active variable bringing the system back to the equilibrium level through short-run adjustment. Both exchange rates play certain roles in the short-run adjustment; however, the evidence is less significant than in the long run. In some cases, while in the long run the nominal (real) exchange rate has no effect on export prices; its effect does exist in the short-run adjustment. Usually export prices are lowered to diminish the deviation of actual data from the long-run equilibrium, while, the nominal exchange rate plays a significant dampening effect against export price adjustments in most cases.

All significant coefficients of producer price indices are positive, which is consistent with the economic proposition that higher production costs lead to higher prices. This result can be treated as supportive evidence for producer price indices as a good proxy for production cost.

The results from the fixed-effects model often indicate a different story about US exporters' pricing behavior from the VECM. Generally evidence of imperfect competition is found and usually more cases of positive effects of exchange rates are confirmed. Based on destination-specific analyses, I believe the SECM and VECM offer more reasonable results.

6.2.3 Results from the oligopolistic model

The equation (18) is estimated for six US export products (wheat, beef, pork, corn, soybean and lettuce). The long-run cointegrating parameters and short-run adjustment coefficients derived from the VECM are reported in table 6.14. As emphasized in chapter 3, the nominal and real exchange rates play different roles in export price determination.

Exporters compare relative prices changes with their foreign competitors based on the nominal exchange rate; and the effect of the nominal exchange rate on export price measure the degree of PTM. While, the real exchange rate is perceived as a practical measure of product-specific international competitiveness (or productivity advantage) in the international market by US exporters.

Significant effects of the nominal exchange rate are found for US wheat, beef, pork, and corn exports, which imply that overall, US exporters face imperfect competition in the international market for these products. Even though more cases of a negative coefficient for the nominal exchange rate are found in the destination-specific estimation, positive coefficients for Egypt and the Philippines, two big trading countries, boost the effect in the destination-aggregated estimation to be positive. The significant positive parameter suggests that US exporters tend to exaggerate the adverse effect of exchange rate changes on local-currency prices, that is, when the value of the US dollar build up, they will increase their dollar export prices resulting in a larger percentage increase in local-currency prices. This finding implies that the bonus provided by the EEP program successfully offsets the adverse effects of unfair trade practices or subsidies of competing countries and allow US exporters to gain price advantage and extraordinary market power in the international wheat market. US exporters can charge higher prices even during appreciation of the US dollar because of the subsidized lower production costs. For beef, pork and corn, US exporters tend to mitigate the adverse effect of exchange rate changes on export prices. They lower the dollar export prices to maintain local prices stable in destination markets as a result of an appreciation of the US dollar, and may be reluctant to raise their prices for fear of losing their shares in the case of the depreciated US dollar. The purpose of US exporters' pricing strategies is to stabilize and expand exports of these products. For example, since the US pork industry has gradually adopted production practices based on fewer, larger operations since the mid-1980s, maintaining large volume sales to continue to take advantage of economies of scale are critically important to US pork firms.

commodity		price	neer	dreer	pd	cp	intercept
Beef	Long-run parameter (β)	1	-0.44**	7.38**	-0.29	0.44	8.59**
	Adjustment coefficient (α)	0.02	-0.47**	0.06	0.02	-0.04	--
Pork	Long-run parameter (β)	1	-0.77**	45.96**	-4.42**	-3.1	56.65**
	Adjustment coefficient (α)	-0.03**	0.02*	0.003	-0.024**	-0.024**	--
Wheat	Long-run parameter (β)	1	0.06**	1.84	0.086	0.71**	--
	Adjustment coefficient (α)	-0.4**	0.18	0.72*	-0.004	0.13	--
Corn	Long-run parameter (β)	1	-0.04**	3.52**	0.051	0.71**	--
	Adjustment coefficient (α)	-0.16	-0.41	0.98**	1.37**	-0.34	--
Soybean	Long-run parameter (β)	1	0.19	92.6**	-0.59	1.92	0.03
	Adjustment coefficient (α)	0.0003	-0.11**	0.02**	0.025	-0.006	--
lettuce	Long-run parameter (β)	1	-0.11	7.19**	-0.09	1.04**	--
	Adjustment coefficient (α)	0.48**	-0.29**	-0.05*	0.12	1.91**	

Parameters of the long-run cointegrating relationship are normalized on export price.

The lag lengths (q in equation) are13 for beef and pork, 14 for wheat, corn and soybean, and 18 for lettuce.

No data for the intercept in the long-run parameter implies that no intercept term in the error correction term is included in estimation. There is no adjustment coefficient for the intercept term.

The second long-run parameter for beef is 1, -0.53, -2.49, 0.67, -0.64, 6.27, and the corresponding adjustment coefficient is -0.36, 0.05, 0.05, 0.03, -0.004.

** represents significant at 5 percent level and * represents significant at 10 percent level.

Table 6.14: Coefficients of the vector error correction model (VECM) for selected US agricultural exports

For the other two products (soybean and lettuce), no significant parameter of the nominal exchange rate is found. It seems that the international market for these two products is perfectly competitive. This evidence is in sharp contrast with strong imperfect competition found in the destination-specific estimation. This, apparently, suggests that aggregation cancels out destination-specific characteristics. Whereas, this insignificant effect may be complemented by the significant role that the nominal exchange rate plays in the short-run adjustment. The negative adjustment coefficients imply that the nominal exchange rate falls to allow the system to resume the steady state. This adjustment direction is opposite to that of export prices, which suggests these two relevant variables offset each other's effect in the short term.

The nominal exchange rate also plays a significant dampening effect against export price adjustments in the short run for beef and pork exports. So even though in the long run, the nominal exchange rate has no effect on export prices, but this does not rule out the possibility that it will have a considerable influence over restoring the systematic equilibrium if actual variables deviate in the short run from the underlying economic relation.

Since the real exchange rate is hypothesized as a more fundamental factor determined by production technology, I expect to get a positive effect from the empirical estimation, which implies that higher international competitiveness leads to higher export prices. Significant positive parameters of the real exchange rate are found for most selected products except wheat, which strongly support my hypothesis about the role of the real exchange rate in export pricing. Therefore, the real (effective) exchange rate may be a good indicator of the product-specific competitive advantage in the international market. And the effect of the real (effective) exchange rate is successfully differentiated from that of the nominal (effective) exchange rate, which helps answer a puzzling question, that is, which exchange rate should be included in a PTM study. An interesting result is the significant positive effect of the real exchange rate in the short-run adjustment for wheat exports. This may strengthen the hypothesis that the real exchange rate plays a certain role after the effect of the nominal exchange rate has already been taken into account.

The choice of the import-competing price as a representative of the competitors' price is not substantiated by the results in table 6.14. This price has a significant effect on export prices only in one (pork) of six cases. Indeed the negative sign in pork equation is inconsistent with the traditional supposition that increased prices of competitive products have a positive effect on prices of own products. The unreasonable or insignificant effect of the import-competing price can be explained by at least two facts. One, the import quantity may be relatively small compared to the US domestic and export quantity, so US exporters do not include this price in their export pricing decisions. For example, the imports of wheat grain, coming mostly from Canada, are small compared with exports. Two, the product contents of US imports and exports, even under the same category, are heterogeneous. For example, most beef exported from the United States is grain-finished, high-quality choice cuts. Most beef that the US imports is grass-fed beef, destined for processing, primarily as ground beef. So US imports and exports may not compete against each other, while they may be complements to each other. It is, therefore, not unreasonable that the import-competing price has insignificant or positive effect on export prices. The parameters of the producer price index are positive in most cases except pork; especially this index has a positive effect on export prices in all three significant cases. This result can be regarded as the supportive evidence for producer price indices as a good proxy for production cost.

CHAPTER 7

CONCLUSIONS

In this dissertation, the origination of the PTM theorem is first reviewed. Various economic or psychological reasons, either from a static viewpoint or a dynamic perspective, are introduced to understand why PTM might occur and become more and more significant in international trade. In order to carry out more accurate research to capture the difference between the PTM theorem and reality measured by the data series, two types of empirical models are applied to revisit the question of whether US exporters of agricultural commodities price to market. Based on the examination of whether US exporters of agricultural commodities, including wheat, beef, pork, corn, soybean and lettuce, price to market in both a monopolistic and an oligopolistic framework, US exporters' pricing behavior in the world market is revealed by the relationships between US export prices and exchange rates only after other relevant variables are taken into account.

In a static monopolistic framework, an effort has been made to find an appropriate econometric model that can fit the data requirements as well as express the economic theory in terms of the parameters of the model. Considering the seasonality characteristics of prices and costs of agricultural products, a seasonal error correction model (SECM) is estimated. This study is the first one to apply the concepts of seasonal cointegration and seasonal common trends in the study of pricing to market (PTM). In cases where seasonal cointegration is rejected by the hypothesis test, a vector error correction model (VECM) is used to account for the non-stationary property of the data.

Therefore, the hypothesis of the existence of cointegration vectors has been formulated not only at zero frequency but also at seasonal frequencies. The commonly used fixed-effects model of Knetter (1989; 1995) is also estimated to show any discrepancies between the results of the cointegration model and the fixed-effects regression.

Product-specific and destination-specific results from seasonal and vector cointegrations confirm the importance of concerns about product and country particularity. Significant evidence of imperfect competition is found in the cases of selected products. For these exports, the general tendency is more cases of a negative effect of nominal exchange rates in the destination-specific estimation and negative coefficient in the destination-aggregated estimation. These results hint that US exporters for wheat (beef, pork, corn, soybean and lettuce) tend to lower their dollar export prices to maintain stable local currency prices as a result of appreciations of the US dollar, and may be reluctant to raise their prices for fear of losing their shares in the case of a depreciated US dollar. However, the finding from wheat exports to Egypt and Philippines implies that the EEP program has improved the competitiveness of US wheat and provided market power to US wheat exporters in these two markets.

Moreover, the extensive examination reveals strong correlation of price-stabilizing or price-exaggerating behavior with specific destinations, which enriches previous findings of US exporters' pricing behavior. [53] According to results from selected products, US exporters are more likely to magnify the impact of exchange rate changes for exports to Japan, Canada, and Philippines, while trying to absorb fluctuations in exchange rates in order to stabilize local currency prices for exports to South Korea, Mexico, Singapore, Thailand and Hong Kong. Different price responses imply that under depreciations of the US dollar, exports to the former group of countries will increase but have a smaller effect on improving the US trade balance than in the case of perfect competition, while exports to the latter group of countries will increase by a relatively small percentage, which results in an ambiguous impact on the US trade balance.

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[53] These studies include (Knetter 1989, 1995), Pick and Park (1991), Pick and Carter (1994), Patterson *et al.* (1996), Park and Pick (1996), Carew and Florkowski (2003), and Miljkovic *et al.* (2003).

Second, in an oligopolistic framework, in order to differentiate impacts of relevant economic elements on exporters' pricing behaviors, I propose a practical method to tackle the most controversial issue in the PTM study, that is, whether the nominal or real exchange rate is more significant in influencing pricing decisions. Based on the hypothesis of different roles of nominal and real (effective) exchange rates in export pricing strategies, this study successfully distinguishes different roles of the two exchange rates in export pricing strategies by introducing the level of the nominal exchange rate and the first difference of the real exchange rate in the estimation equation. The effect of the nominal (effective) exchange rate on export prices measures the degree of PTM. The change in the real (effective) exchange rate indicates the export product's international competitive advantage. A positive (negative) change in REER means productivity growth (decline) or competitiveness increase (decrease), which makes exporters charge a higher (lower) export price.

Based on detailed analyses of destination-aggregated data of US agricultural exports, PTM behavior is confirmed by this application, and imperfect competition is found in US wheat, beef, pork, and corn export markets. For beef, pork, and corn exports, the objective of US exporters is to keep local currency prices stable, which to some extent mitigates the export-enhancing effect of depreciations of the US dollar. The exceptional case is US wheat exports, in which a large increase in exports results from depreciations of the US dollar. Taking into account the huge export subsidies that US wheat exporters receive from the US Export Enhancement Program (EEP), US agricultural exporters tend to keep price-stabilizing strategies unless strong financial support from the government is available. Therefore, the depreciation of the US dollar is not sufficient for improving the US agricultural trade balance without governmental export supports.

For the other two products (soybean and lettuce), an insignificant coefficient of the nominal exchange rate is found, which may suggest that the international market for these two products is perfect competitive. But since in the destination-specific estimation, strong evidence of imperfect competition is found in almost all selected importing countries for soybean and lettuce exports, this may imply that different effects across destinations contradict with each other and therefore in aggregation, a negligible effect may be derived. Even though from the long run perspective, the nominal exchange rate has no effect on export prices of soybeans and lettuce, but a significantly price-mitigating effect of the nominal exchange rate exists with respect to short run adjustment.

The real exchange rate exhibits a strong price-enhancing effect on export prices in most selected products except wheat, after the effect of the nominal exchange rate is taken into account. This result strongly supports my hypothesis that the real exchange rate works as an indicator of the export product's international competitiveness in determining export prices. The choice of the import-competing price as representative of competitors' price is not supported by my study.

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