Exchange Rate Pass-Through and Market Structure in a Multi-Country World*

Kanda Naknoi[†]

University of Connecticut

September 2015

Abstract

In a multi-country world, currencies do not move in isolation, and competitors' exchange rate movements may help or hurt an exporting firm. Motivated by this fact, I construct a multi-country model to examine how export prices are affected by movements in own-currency and cross-currency exchange rates. Own-currency appreciations move firms along the demand curve while cross-currency appreciations shift the position of the demand curve. Both affect the price elasticity of demand and therefore the degree to which exchange rate movements affect prices. When own- and cross-currency appreciations are correlated, the exporter changes price in response to both. In the empirical section, I employ monthly data and provide estimates of own and cross exchange rate pass-through to the price of exports from Canada to the U.S. The cross exchange rate pass-through is found to exist in about one-tenth of sample sectors.

JEL Classifications: F31; F41

Key words: Exchange rate pass-through; Pricing to market; Exchange rate shocks

*I thank Raphael Auer, Scott Davis, David Hummels, Mohitosh Kejriwal, Stephen Martin, Raphael Schoenle and the participants in Purdue Brownbag, the seminar at the University of Tokyo, the 2009 Midwest Macro Meeting, the 2009 FESAMES Meeting and the 2013 BIS-CEPR-Dallas FED-Swiss National Bank Conference on International Dynamics in a Post-Crisis Globalized Economy for comments and suggestions. I thank Kwan-Yong Lee and Anouk Govil for excellent research assistance. All remaining errors are my own.

[†]Department of Economics, University of Connecticut, 365 Fairfield Way, Unit 1063, Storrs, CT 06269-1063, USA; E-mail: kanda.naknoi@uconn.edu.

1 Introduction

The recent literature on pricing to market (PTM) and exchange rate pass-through (ERPT) extensively investigates the role of strategic interactions among heterogeneous firms in a two-country setting. For instance, Atkeson and Burstein (2008) illustrate that cost dispersion among firms, and trade costs, are essential for exporters to practice PTM such that the exporter's markup increases in market share. Auer and Chaney (2009) find that the ERPT to the import prices of low-quality products is higher than to that of high-quality products. However, these studies overlook the fact that international trade involves competition between exporters from multiple countries.

Attempts to incorporate the multi-country aspect of trade into studies of ERPT have been made by Bacchetta and van Wincoop (2005), Bergin and Feenstra (2009) and Auer and Schoenle (2013). Specifically, Bacchetta and van Wincoop (2005) examine conditions that cause multiple countries to form a monetary union and set their export price in the union's currency. Bergin and Feenstra (2009) provide theory and evidence that an increase in the share of imports from countries whose currency is pegged to the dollar increases the ERPT from the effective exchange rate to the U.S. import price index. Contrary to the aggregate approach in Bergin and Feenstra (2009), Auer and Schoenle (2013) employ U.S. firm-level data and show that the rate at which the firm-level import price responds to the competitors' average price is hump-shaped in the competitors' market share.

The present study examines ERPT in a multi-country framework and provides empirical estimates of ERPT from own- and competitors' currency appreciations to export prices. My model relies on quadratic preferences similar to those in Ottaviano, Tabuchi and Thisse

(2002). Quadratic preferences provide two key advantages. First, they yield quasi-linear demand curves with a variable price elasticity of demand. Second, they enable me to examine the effect of competitors' pricing behavior on the position of the demand curve facing a firm. The literature contains many examples in which a monopolist faces a variable elasticity demand curve, or in which constant-elasticity-of-substitution (CES) preferences and monopolistic competition allow the pricing of rival firms to affect the position of the demand curve. Quadratic preferences allow me to incorporate both, and to aggregate the correlated shocks to the demand. Providing a theoretically grounded aggregation of correlated shocks is important because a single bilateral exchange rate does not move in isolation.

To highlight the multi-country aspect of trade, I shut down firm heterogeneity within a country and assume that products are differentiated by the country of production. Thus, the number of traded varieties is given by the number of source countries. These multiple countries sell to the same destination market, and therefore an exporter adjusts pricing in response to the appreciation of all currencies against the destination's currency. The gist is that appreciations of an exporter's own currency move her along the demand curve, whereas appreciations of competitors' currencies shift her demand curve. Henceforth, I refer to export price elasticity with respect to an exporter's own currency appreciation as own-ERPT elasticity, and export price elasticity with respect to competitors' currency appreciation as cross-ERPT elasticity.

Next, I show analytically that own-ERPT elasticity varies within the range (-1,-0.5). In other words, when the exporter's currency appreciates, the exporter absorbs exchange rate shocks in the form of lower export prices in the seller's currency, and even more so when demand is close to being inelastic. However, cross-ERPT elasticity has no specific range and is positive. Intuitively, an exporter raises prices when competitors' currencies appreciate and demand is elastic, because such appreciations raise competitors' prices in the buyer's currency. Moreover, the value of cross-ERPT elasticity is predicted to increase in the competitors' market share.

Finally, I estimate own-ERPT elasticity and cross-ERPT elasticity using monthly data on the unit values of exports in the 4-digit harmonized system (HS) from Canada to the U.S. from January 1992 to December 2009, taking into account all competing countries selling to the U.S. In the sample of 18 sectors, there is evidence for cross-ERPT elasticity in two sectors. Based on the average of Canada's observed share in U.S. imports relative to other source countries in these sectors, cross-ERPT elasticity varies from 0.42 to 22.31. These scales of cross-ERPT elasticity are sizable. Own-ERPT elasticity is statistically significant in 11 sectors, and its significant estimate varies from -1.39 to -0.79. Overall, the estimated ranges of own- and cross-ERPT elasticities are in line with the model prediction.

My reexamination of ERPT provides insights into international pricing and has macro implications. At the aggregate level, the extent of ERPT determines the degree to which exchange rate movements affect the domestic prices of imported goods and the consumer price index (CPI). This in turn has important implications for monetary policy in open economies (Devereux and Engel, 2002; 2003). The macro literature has focused on cross-country differences in ERPT elasticity, linking them to the volatility and persistence of exchange rate depreciation, the level of CPI inflation, monetary stability, and the industry composition of trade (Baldwin, 1988; Froot and Klemperer, 1989; Taylor, 2000; Devereux, Engel and Storgaard, 2004; Campa and Goldberg, 2005, and Bacchetta and van Wincoop, 2005).

In contrast, I highlight the point that we cannot understand ERPT unless we take into account the pricing decisions of all exporters. I provide an implication for exchange rate regimes by showing that the estimating equation must include all competing exporters' exchange rates when they are floated against the U.S. dollar. The coefficient of this additional term measures the cross-price effect, which has important implications for trade but has not been extensively studied in the empirical literature. Theoretically, Feenstra, Gagnon and Knetter (1996) and Atkeson and Burstein (2008) generate variable markups with nested CES preferences by assuming a small number of competitors or small competitors so that an exporter internalizes the effect of own-price changes on the aggregate price index. My model generates variable markups with a large number of competitors and so is more broadly applicable.

My work also has implications for the long-run instability of ERPT estimates found in Taylor (2000) and Campa and Goldberg (2005). Taylor (2000) argues that ERPT increases in CPI inflation, hence structural changes in inflation can explain the instability of ERPT estimates. However, my theory suggests that the instability of ERPT can arise from changes in the number of competitors faced in a given market and the co-movements between own- and cross-currency exchange rates.

I discuss the model in the next section. Section 3 presents the empirical results and Section 4 concludes my study.

2 Model

I construct a flexible price model in which exchange rate fluctuations are exogenous. Specifically, I assume that a monopolistically competitive exporter costlessly adjusts the seller's currency price after observing exchange rate movements; therefore, the model abstracts from uncertainty. Although prices are assumed to be flexible *ex ante*, whether they are flexible *ex post* depends on the exporter's decision. Also, because of the flexible price assumption it does not matter whether the exporter is assumed to set prices in the seller's or the buyer's currency. For the sake of exposition, I assume that prices are set in the seller's currency, as I am interested in the degree of ERPT to the seller's currency price.

The assumptions concerning goods trade are the following. First, the world economy consists of a large number of countries and each country produces a differentiated product for exporting and for domestic consumption. Since products are differentiated by the location of production, the trade pattern is given and exchange rate movements influence only the equilibrium price and quantity without changing the composition of trade. Since a monopolist exporter takes the demand curve as given when setting prices, I discuss the consumers' problem before the firms' problem in the next subsection.

2.1 Consumers

The representative consumer in country d chooses the quantity of imports from country i, where $i = 1, 2, ..., N$ and $d \neq i$. Hence, i indicates both distinct countries and distinct varieties. Let Q_{id} be the demand for imports from each exporter to destination country d, and Q_{0d} be the demand for the homogeneous numeraire non-traded good in country d. Traded goods are differentiated by the location of production and aggregated into final consumption by the following quadratic utility, similar to Ottaviano, Tabuchi and Thisse (2002).

$$u(Q_{0d}; Q_{id}) = Q_{0d} + \alpha \sum_{i} Q_{id} - \frac{\beta}{2} \sum_{i} (Q_{id})^2 - \gamma \sum_{j \neq i} \sum_{i} Q_{id} Q_{jd},$$

where $\alpha > 0$ and $\beta > \gamma > 0$. γ measures the degree of substitutability across varieties. My departure from the specification in Ottaviano, Tabuchi and Thisse (2002) is that I assume only one variety per country, whereas they assume multiple varieties. My assumption of one variety per country is motivated by my data set, in which firm-level heterogeneity is not observed.

The key advantage of this utility function is that it features a variable price elasticity of demand and demand can be tractably aggregated over distinct varieties. Although the nested CES preferences, as in Feenstra, Gagnon and Knetter (1996) and Atkeson and Burstein (2008), can also generate a variable price elasticity of demand, the nested CES preference requires that a small number of producers engage in strategic interactions. However, the quadratic preferences specification does not require an assumption of a small size of producers.

Let P_{id}^{d} denote the price charged by exporter i for the product shipped to country d in country d's currency. The subscript denotes the pair of source and destination countries, and the superscript denotes the currency of denomination. The representative consumer faces the following budget constraint:

$$\sum_{i} P_{id}^{d} Q_{id} + Q_{od} = W_d L_d + Y_d,$$

where W_d, L_d, and Y_d are wage, labor supply and endowment of the numeraire in Country

d, respectively.

Consumers maximize the utility by taking as given the number of varieties, wage and labor demand. The first order condition is the following.

$$\alpha - \beta Q_{id} - \gamma \sum_{j \neq i} Q_{jd} = P_{id}^{d}, \tag{1}$$

Define Q_d as the industry demand, $Q_d = \sum_i Q_{id}$. Thus,

$$\alpha - (\beta - \gamma) Q_{id} - \gamma Q_d = P_{id}^{d}. \tag{2}$$

Equation (2) implies the following relationship between any pair of imports. For all $j \neq i$,

$$Q_{id} - Q_{jd} = \frac{1}{\beta - \gamma}[P_{jd}^{d} - P_{id}^{d}]. \tag{3}$$

Substituting (3) into (1) gives the variety demand function:

$$Q_{id} = \frac{\alpha(\beta - \gamma) + \gamma \sum_{j \neq i} P_{jd}^{d}}{(\beta - \gamma)(\beta + \gamma(N-1))} - \frac{\beta - \gamma + \gamma(N-1)}{(\beta - \gamma)(\beta + \gamma(N-1))} P_{id}^{d} \tag{4}$$

According to the residual demand in (4), a rise in own price implies a downward move along the demand curve. The own-price elasticity of demand is:

$$\theta_{id} = -\frac{\partial Q_{id}}{\partial P_{id}^{d}} \frac{P_{id}^{d}}{Q_{id}} = \left[\frac{\beta + \gamma(N-2)}{(\beta - \gamma)(\beta + \gamma(N-1))} \right] \frac{P_{id}^{d}}{Q_{id}}. \tag{5}$$

In the limit case in which country i is the only exporter to country d, $N = 1$ and as a result the own-price elasticity becomes $P_{id}^{d}/(\beta Q_{id})$. In contrast, when there is an extremely large number of exporters, $N - 1$ is close to N, thus the own price elasticity is approximated by $P_{id}^{d}/((\beta - \gamma) Q_{id})$. Intuitively, the own-price elasticity of demand is low when there is a large number of exporters, as in this case the market share of country i is large.

The demand in (4) also indicates the importance of the prices of imports from competing exporters. To be precise, a rise in the prices of imports from competing exporters acts as a demand shock shifting the demand curve outward through the intercept term in (4). The cross-price elasticity of demand with respect to competing exporters in country j is:

$$\theta_{ijd} = \frac{\partial Q_{id}}{\partial P^d_{jd}} \frac{P^d_{jd}}{Q_{id}} = \frac{\gamma P^d_{jd}}{(\beta - \gamma)(\beta + \gamma(N-1))Q_{id}}. \tag{6}$$

Intuitively, an increase in competing exporters' prices causes consumers to decrease demand for the competing product and thus increase demand for exports from country i.

In the limit case in which there is only one competitor, $N = 2$ and as a result the cross-price elasticity becomes $\gamma P^d_{jd}/((\beta^2 - \gamma^2)Q_{jd})$. In contrast, when there is an extremely large number of competitors, the cross-price elasticity is close to zero. Intuitively, the cross-price elasticity of demand is low when there is a large number of exporters, as in this case the market share of country i is extremely small.

2.2 Exporters' Price Setting

Assume a linear production function with constant marginal cost. Let C_i be marginal cost denominated in the exporter's currency. P^i_{id} denotes the price of exports from Country i to Country d in the seller's currency. Then, I can write the profit function as:

$$\pi_i = Q_{id}[P^i_{id} - C_i].$$

The representative exporter from country i has monopoly power in country j, because I assume that products are differentiated by the location of production. The exporter takes the residual demand in (4) and exchange rates as given. Exchange rate E_{id} is defined as units of currency d per unit of currency i. Assume no trade frictions to simplify the model, so the buyer's currency price becomes:

$$P_{id}^{d} = E_{id} P_{id}^{i}. \tag{7}$$

Hence, the monopolist exporter sets the seller's currency price P_{id}^{i} to maximize profits taking as given the residual demand in (4) and the buyer's currency price in 7. The first-order condition gives the optimal price setting rule:

$$P_{id}^{i} = \frac{\theta_{id}}{\theta_{id} - 1} C_i, \tag{8}$$

where θ_{id} is given by (5).

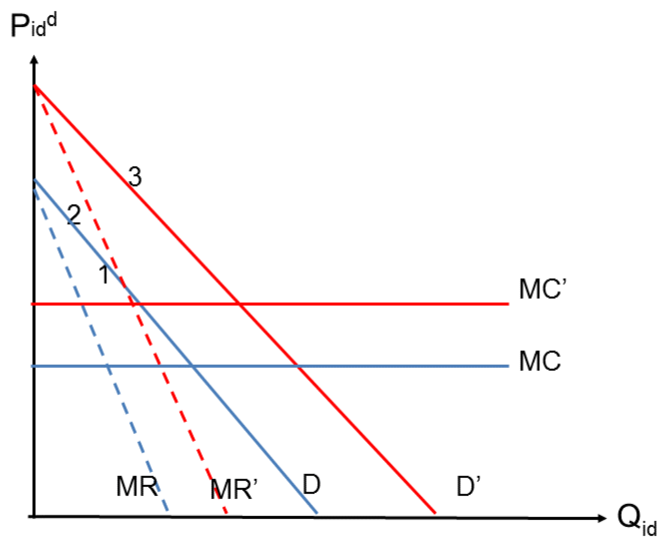
2.3 Exchange Rate Pass-through Elasticity

First, I consider the effect of an exogenous depreciation of currency d relative to currency i on the pricing set by exporters in country i. Let lowercase letters denote natural logarithms. Then, the price setting rule in (8) and the buyer's currency price in (7) imply that a depreciation of currency d acts as an adverse cost shock:

$$dp_{id}^{d} = d\left(\frac{\theta_{id}}{\theta_{id} - 1}\right) + dc_i + de_{id} \tag{9}$$

Figure 1 illustrates this effect as the upward shift of the cost curve from MC to MC'. Thus the price moves upward along the residual demand curve D, depending on where the marginal revenue schedule (MR) intersects with MC'. Hence, an appreciation of currency i moves the equilibrium from point 1 to point 2. In the existing literature with only two countries, this is the full effect. But I have $N > 2$ countries, therefore currency d may

Figure 1: Effects of cross-currency appreciation and own-currency appreciation on the buyer's currency price

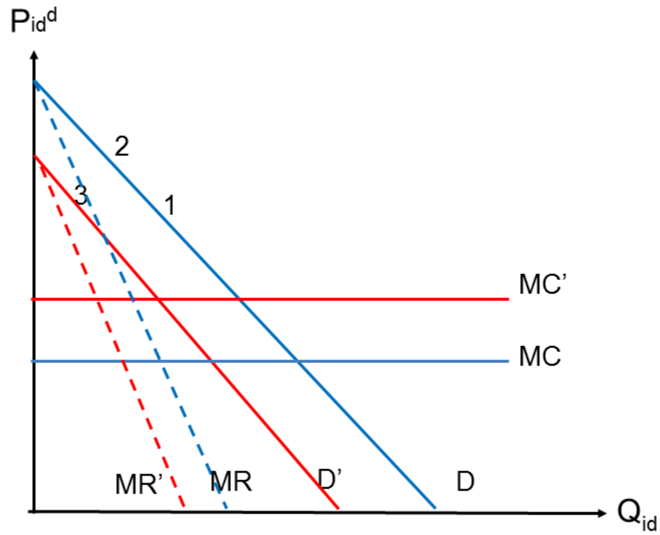


fall against both currency i and other currencies. For example, suppose currency d also depreciates against currency j, or $de_{jd} > 0$ for all $j \neq i$. Similar to (9), a depreciation of currency d acts as an adverse cost shock for exporter j:

$$dp_{jd}^{d} = d\left(\frac{\theta_{jd}}{\theta_{jd} - 1}\right) + dc_j + de_{jd} \tag{10}$$

From the perspective of exporters in country i, (10) implies that the cost of a substitute product has risen. This shifts the intercept term in the residual demand for product i through the cross-price elasticity of demand in (6). This cross-price effect corresponds to the upward shift of the demand curve in Figure 1 from D to D'. Thus, the depreciation of currency d simultaneously shocks the marginal cost curve for i and its residual demand. Consequently,

Figure 2: Effects of cross-currency depreciation and own-currency appreciation on the buyer's currency price



the equilibrium following the appreciation of both currency i and currency j is now point 3. When I compare the consumer price at each point, $P_{id}^{d}(1) < P_{id}^{d}(2) < P_{id}^{d}(3)$. This ranking suggests that an appreciation of currency j causes the exporter i to increase the markup.

Of course, currency d might depreciate against currency i and appreciate against currency j at the same time. In this case, the cost of a substitute for product i has fallen, shifting the demand curve to the left, as in Figure 2. In this case, $P_{id}^{d}(1) < P_{id}^{d}(3) < P_{id}^{d}(2)$. The ranking implies that exporter i reduces the markup even further following an appreciation of currency j. In an extreme case, exporter i could even lower its markup to the point where the new buyer's price is below the initial buyer's price.

Next, I formulate this logic in an N country world in which currencies do not move in isolation and exchange rates are correlated. I express cross-currency movements as follows:

$$de_{jd} = \eta_{ji} de_{id},$$

where $\eta_{ji} \neq 0$. The parameter η_{ji} measures the elasticity of changes in currency j's exchange rate with respect to currency i's exchange rate. Assume for simplicity that exchange rate movements are the only type of exogenous shocks. The total derivative of the exporter's price depends on the movement of all exchange rates:

$$\begin{aligned} dp^i_{id} &= \frac{\partial p^i_{id}}{\partial e_{id}} de_{id} + \sum_{j \neq i} \frac{\partial p^i_{id}}{\partial e_{jd}} de_{jd} \\ &= \left[\frac{\partial p^i_{id}}{\partial e_{id}} + \sum_{j \neq i} \eta_{ji} \frac{\partial p^i_{id}}{\partial e_{jd}} \right] de_{id}. \end{aligned} \tag{11}$$

As a result,

$$\frac{dp^i_{id}}{de_{id}} = \frac{\partial p^i_{id}}{\partial e_{id}} + \sum_{j \neq i} \eta_{ji} \frac{\partial p^i_{id}}{\partial e_{jd}}. \tag{12}$$

In other words, I can decompose ERPT to the export price, which is denoted by ϵ_i, into the pass-through from shocks on exporter i's exchange rate or ϵ_{ii}, and the pass-through from shocks on the exchange rate of competing exporters or ϵ_{ij} as follows:

$$\epsilon_i = \epsilon_{ii} + \sum_{j \neq i} \epsilon_{ij} \eta_{ji}, \tag{13}$$

where $\epsilon_{ii} = \frac{\partial p^i_{id}}{\partial e_{id}}$ and $\epsilon_{ij} = \frac{\partial p^i_{id}}{\partial e_{jd}}$. Henceforth, I refer to ϵ_{ii} and ϵ_{ji} as the own ERPT and the cross ERPT, respectively.

The quadratic utility model allows me to calculate the theoretical values of η_{ii} and η_{ij}. Given the price setting rule in (8) and the effects of exchange rate shocks in (9) and (10), I can show that the own ERPT and the cross ERPT depends on the own-price and the cross-price elasticities as follows.

$$\epsilon_{ii} = -0.5 - \frac{0.5}{\theta_{id}}, \quad (14)$$

$$\epsilon_{ij} = 0.5\frac{\theta_{ijd}}{\theta_{id}}\left(\frac{\theta_{jd}-1}{\theta_{jd}}\right) \quad (15)$$

Proposition 1 *If* $1 < \theta_{id} < \infty$*, then* $\epsilon_{ii} \in (-1, -0.5)$*.*

Proof. $d\epsilon_{ii}/d\theta_{id} > 0$, so ϵ_{ii} is monotonically increasing in θ_{id}. When $\theta_{id} = 1$, $\epsilon_{ii} = -1$. Also, $\lim_{\theta_{id}\to\infty} \epsilon_{ii} = -0.5$. ■ The negative range of own-ERPT elasticity indicates that the exporter practices PTM by reducing the own-currency price to absorb currency appreciation. When $\theta_{id} = 1$, consumers maintain the fixed expenditure share of each variety, so the exporter absorbs all exchange rate shocks and the own ERPT becomes -1.

Proposition 2 *Suppose* $1 < \theta_{id} < \infty$*. Then* $d\epsilon_{ii}/d\theta_{id} > 0$*.*

Proof. From (14), $d\epsilon_{ii}/d\theta_{id} = 0.5/(\theta_{id})^2 > 0$ ■ This proposition suggests that low demand elasticity generates low ERPT to export price. This is because low demand elasticity means high market power and results in high markups, so in this case the exporter can sharply reduce prices to absorb currency appreciation. This prediction is in line with that in Bacchetta and van Wincoop (2005).

Proposition 3 $d\epsilon_{ii}/dN > 0$*.*

Proof. $d\epsilon_{ii}/dN = (d\epsilon_{ii}/d\theta_{id})\, d\theta_{id}/dN$. From (5), $d\theta_{id}/dN > 0$. From Proposition 2, $d\epsilon_{ii}/d\theta_{id} > 0$. ■ The effect of the number of exporters works through its effect on the own-price elasticity of demand. A large number of exporters raises the own-price elasticity, since it shrinks each exporter's share in the destination market. Therefore, a large number of exporters results in low market power and high ERPT to export price.

Proposition 4 *If* $\theta_{jd} > 1$*, then* $\epsilon_{ij} > 0$*.*

Proof. When $\theta_{jd} > 1$, $\theta_{jd} - 1 > 0$. ■ Intuitively, an appreciation of competitors' currency reduces demand for the competitors. Hence, an appreciation of competing exporters' currencies allows exporters from country i to raise prices. This is the reason why cross-ERPT elasticity takes positive values when demand is elastic.

Finally, the overall ERPT elasticity is also influenced by cross-currency co-movement.

Proposition 5 *Suppose* $\theta_{jd} > 1$*. Then* $d\epsilon_i/d\eta_{ji} > 0$*.*

Proof. From Equation (13), $d\epsilon_i/d\eta_{ji} = \sum_{j\neq i}\epsilon_{ij}$, and from Proposition 4 $\epsilon_{ij} > 0$. ■ The overall ERPT to export price increases in the elasticity of j's exchange rate with respect to currency i's exchange rate. This is because high exchange rate elasticity implies a large appreciation of currency j following an appreciation of currency i. Alternatively, the higher the exchange rate elasticity, the larger the demand shocks in Figure 1.

2.4 Estimating Equation

Let Δ denote the first difference, and let t denote the period. The model-based ERPT in (13) implies the following estimating equation.

$$\Delta p^i_{id,t} = \beta_0 + \epsilon_{ii}\Delta e_{id,t} + \sum_{j\neq i}\epsilon_{ij}\Delta e_{jd,t} + v_{i,t}$$

Substituting (15), (5) and (6) into the cross ERPT ϵ_{ij} in the expression above yields the following:

$$\Delta p^i_{id,t} = \beta_0 + \beta_1^{id}\Delta e_{id,t} + \beta_2^{id}\sum_{j\neq i}\frac{C_{j,t}E_{jd,t}}{C_{i,t}E_{id,t}}\Delta e_{jd,t} + v_{i,t}, \tag{16}$$

where $\beta_1^{id} = \epsilon_{ii}$ or own-ERPT elasticity, and $\epsilon_{ij} = \beta_2^{id} C_{j,t} E_{jd,t} / (C_{i,t} E_{id,t})$. The coefficient β_2^{id} is the common coefficient of the weighted appreciation of currency j, where the weight is the exporter j's cost relative to the exporter i's cost. Although β_2^{id} alone is not exactly cross-ERPT elasticity, β_2^{id} captures a component of cross-ERPT elasticity that is common for all competitors. Moreover, $\beta_2^{id} > 0$ when cross-ERPT elasticity is positive. Hence, a statistically significant and positive value of β_2^{id} would be evidence for a positive cross ERPT elasticity.

In the next section, I discuss the empirical strategy, the description of data, and the empirical results.

3 The Evidence

3.1 Empirical Strategy

The estimating equation in Equation (16) contains unobserved relative cost adjusted by exchange rate. If all exporters have the same own-price elasticity before exchange rate shocks are realized, this relative cost term determines relative demand as well as market share. For this reason, I weight each competing exporter j with their market share relative to exporter i.

In practice, there may be shocks on costs in local currency and it is critical to control for cost shocks. I use the producer price index (PPI) in the exporting country as a proxy for unobserved cost shocks, although some of its variation could come from adjustments in the domestic markup. The advantage of using the PPI instead of the prices of input such as unit labor cost, as in Campa and Goldberg (2005), is that the PPI varies across both products and time, whereas unit labor cost does not vary across products.

I estimate the following equation by exploiting time series variation within each product, one by one.

$$\Delta p^i_{id,t} = \beta_0 + \beta^{id}_1 \Delta e_{id,t} + \beta^{id}_2 \sum_{j \neq i} \frac{s_{j,t-1}}{s_{i,t-1}} \Delta e_{jd,t} + \beta_3 \Delta ppi_{i,t} + v_{i,t}, \quad (17)$$

From the regression in Equation (17), the own ERPT for each sector is $\hat{\beta}^{id}_1$ and cross-ERPT elasticity from currency j is $\hat{\beta}^{id}_2 s_{j,t-1}/s_{i,t-1}$, where $s_{j,t-1}$ and $s_{i,t-1}$ denote the market share of exporters j and i in period $t-1$. The variable $ppi_{i,t}$ denotes the log of PPI. I use lagged market shares to avoid the endogeneity problem, as market shares in period t are influenced by prices chosen by all exporters, including exporter i. Before estimating Equation (17), the Dickey-Fuller tests on the dependent variable and the independent variables are performed as well.

Although my model does not incorporate endogenous entries and exits, entries and exits are observed in my data set and have the following implications on the weighted average of competing exporters' currency appreciation in Equation (17). When country j is an exporter in period $t-1$ but does not export in period t, the appreciation of currency j in period t carries a positive weight. In contrast, when country j does not export in period $t-1$ but begins exporting in period t, the appreciation of currency j carries a zero weight. These implications are intuitive, since in practice exporter i is aware that exporter j is a competitor only when exports from j are observed.

From Proposition 4, cross-ERPT elasticity may be positive or negative, depending on the value of the own-price elasticity of the competitors. In Equation (17), the cross-ERPT elasticity from currency j to the seller's currency price is $\hat{\beta}^{id}_2 s_{j,t-1}/s_{i,t-1}$. Hence, the absolute value of cross-ERPT elasticity is predicted to increase in the competing countries' market share.

3.2 Data

Country i in my data set is Canada, and destination d is the U.S. These choices of countries are driven by the availability of unit value series of all countries exporting to the U.S. and Canada's PPI series. I employ monthly data from three databases. First, time series of the unit value of U.S. imports are constructed from data of imported values and quantities from the *U.S. Census Bureau Trade Database*. This database covers more than 10,000 HS-10 categories of products and more than 100 source countries. Second, I obtain monthly PPI series from *Statistics Canada*'s Table 329-0077. This database provides PPI data for 20 sectors in the 6-digit North American Industry Classification System (NAICS). Finally, the Canada-U.S. end-of-month exchange rate series are from the International Monetary Fund's *International Financial Statistics.*

I merge data from the first two databases in the following steps. First, I aggregate the port-specific value and quantity of U.S. imports over all ports of entry, and the district-specific value of exports over all districts. To create consistent time series, I exclude the HS-10 categories that are created or dropped by the *U.S. Census Bureau* using the methodology in Pierce and Schott (2012). Their methodology identifies the set of new and obsolete categories, conditioning on the initial set of categories in April 1990. Dropping the new and the obsolete categories allows changes in unit values to reflect actual changes in exporters' decisions. This algorithm requires information about the new and obsolete categories, and such information available in public domain ends in 2009. For this reason, my sample period ends in December 2009.

Next, after obtaining consistent time series of U.S. imported values and quantities, I apply the concordance between NAICS-6 and HS-10 categories. This step assigns a common PPI category to multiple HS-10 categories, since NAICS-6 categories are more aggregate than HS-10 categories. After that I aggregate values and quantities into HS-4 categories, to increase the number of products being exported by Canada and the number of competing exporters. To illustrate the point, consider Japan and Mexico as examples of competing exporters. Canada, Japan and Mexico may export a common HS-4 product, which is classified as three different HS-10 products. Consider also a common HS-4 product exported by Canada every month. However, this HS-4 category may be classified as two or more HS-10 products that are exported less frequently than every month. This step results in 1,256 HS-4 categories being exported from Canada to the U.S.

Third, the data on values and quantities are merged with the data on Canada's PPI, using NAICS-6 as a bridge. Canada's PPI data begin from January 1992, whereas the data on values and quantities begin from January 1990. Thus, the beginning of my sample period is constrained by Canada's PPI data, and my data set covers 216 months from January 1990 to December 2009. This step reduces the number of HS-4 categories being exported from Canada to the U.S. from 1,258 to 56, due to the small number of NAICS-6 sectors in the PPI series.

Finally, I restrict my data set to the products being exported by Canada every month from January 1990 to December 2009. This step results in dropping 38 HS-4 sectors and keeping 18 HS-4 sectors, as displayed in Table 1. Then, I calculate the unit value as the ratio of export values and quantities for Canada and other exporters to the U.S. The market share for each exporter is calculated as its export values relative to the sum over all exporters for each HS-4 product in each month.

Table 1: Sample sectors being exported every month from Canada to the U.S. from January 1990 to December 2009.

HS code	Sector description
0203	Meat of swine, fresh, chilled or frozen
0206	Edible offal of domestic animals
0208	Meat, edible meat offal, not elsewhere specified (NES), fresh, chilled or frozen
0504	Guts, bladders and stomachs of animals except fish
1601	Sausages, similar products of meat, meat offal or blood
4418	Builders joinery and carpentry, of wood
4801	Newsprint
4803	Paper, household, sanitary, width $> 36cm$.
4804	Uncoated kraft paper and paperboard
4805	Uncoated paper and paperboard, NES
4806	Glazed transparent, translucent papers
4808	Paper, board, corrugated, creped, embossed, perforated, NES
4811	Paper, board, etc. coated, impregnated, colored, NES
4813	Cigarette paper
8501	Electric motors and generators, except generating set
8502	Electric generating sets and rotary converters
8504	Electric transformers, static converters and rectifiers
8903	Yachts, pleasure, sport vessels, rolling boats, canoe

Table 2 provides summary statistics of Canada's market share in the U.S. market and the number of competing source countries for each sector. There is wide variation in Canada's market share across sectors and across time. The average market share and the median market share ranges from 3% to 98%. The variability of market share over time ranges from 1% to 13%. The median number of competing countries ranges from 5 to 131. Even in the sector in which Canada's median market share is 98%, the median number of competing exporters is still as high as 6. There is also substantial variation in the number of competing countries over time, and in our model we take changes in the number of competing countries as given.

Table 2: Summary statistics of Canada's market share and the number of competing countries

	Canada's market share				Number of competing countries			
HS code	Range	Average	Std. dev	Median	Range	Average	Std. dev	Median
0203	[0.64, 0.91]	0.76	0.05	0.76	[2, 10]	6.18	1.71	6
0206	[0.16, 0.84]	0.62	0.11	0.63	[3, 10]	6.00	1.47	6
0208	[0.09, 0.44]	0.23	0.07	0.22	[2, 9]	4.72	1.36	5
0504	[0.01, 0.21]	0.07	0.04	0.07	[8, 22]	14.07	3.05	14
1601	[0.28, 0.86]	0.55	0.10	0.54	[2, 9]	5.69	1.49	6
4418	[0.14, 0.29]	0.20	0.02	0.20	[35, 112]	68.50	14.84	68
4801	[0.92, 0.99]	0.98	0.01	0.98	[2, 16]	6.79	2.59	6
4803	[0.39, 0.98]	0.64	0.13	0.60	[4, 23]	12.68	3.82	13
4804	[0.35, 0.92]	0.77	0.12	0.79	[12, 40]	20.37	4.99	20
4805	[0.04, 0.55]	0.33	0.12	0.38	[9, 36]	17.50	3.55	17
4806	[0.001, 0.23]	0.08	0.04	0.08	[5, 17]	11.37	1.95	12
4808	[0.10, 0.49]	0.33	0.10	0.33	[5, 25]	14.84	4.01	15
4811	[0.01, 0.21]	0.10	0.06	0.13	[14, 62]	37.20	6.76	37
4813	[0.001, 0.20]	0.07	0.05	0.07	[4, 26]	12.73	4.79	12
8501	[0.02, 0.08]	0.04	0.01	0.04	[41, 75]	54.57	7.15	54
8502	[0.0001, 0.12]	0.03	0.03	0.03	[11, 43]	23.72	6.59	23
8504	[0.01, 0.07]	0.03	0.01	0.03	[53, 202]	133.41	25.40	131
8903	[0.03, 0.58]	0.23	0.11	0.23	[21, 52]	32.81	5.66	33

The summary statistics of competitors' share-adjusted currency appreciation and sector-level inflation are tabulated in Table 3. Although the average and median of competitors' share-adjusted currency appreciations are zero for a large number of sectors, their range and standard deviation indicate that the variation over time is substantial. There are periods of double-digit appreciation as well as periods of double-digit depreciation of competitors' currencies in most sectors. Such time series variation is critical for my estimation. The sector-level inflation displays a moderate level of variability, as the magnitude is single digit in most sectors and most periods.

Table 3: Summary statistics of competitors' share-adjusted currency appreciation and Canada's sector-specific inflation

	$\sum_j (s_{j,t-1}/s_{i,t-1})\Delta e_{jd,t}$				Canada's PPI inflation			
HS code	Range	Average	Std. dev	Median	Range	Average	Std. dev	Median
0203	[-0.04, 0.02]	0.00	0.01	0.00	[-0.10, 0.07]	0.00	0.03	0.00
0206	[-0.10, 0.25]	0.00	0.02	0.00	[-0.10, 0.07]	0.00	0.03	0.00
0208	[-0.33, 0.63]	0.01	0.08	0.01	[-0.04, 0.03]	0.00	0.01	0.00
0504	[-2.23, 2.16]	-0.06	0.42	0.00	[-0.10, 0.07]	0.00	0.03	0.00
1601	[-0.10, 0.07]	0.00	0.02	0.00	[-0.10, 0.07]	0.00	0.03	0.00
4418	[-0.23, 0.10]	0.00	0.03	0.00	[-0.02, 0.05]	0.00	0.01	0.00
4801	[-0.00, 0.00]	0.00	0.00	0.00	[-0.07, 0.09]	0.00	0.02	0.00
4803	[-0.11, 0.04]	0.00	0.02	0.00	[-0.06, 0.07]	0.00	0.02	0.00
4804	[-0.05, 0.04]	0.00	0.01	0.00	[-0.06, 0.07]	0.00	0.02	0.00
4805	[-0.73, 1.02]	0.00	0.12	0.00	[-0.06, 0.07]	0.00	0.02	0.00
4806	[-3.18, 9.67]	0.04	0.83	0.01	[-0.06, 0.07]	0.00	0.02	0.00
4808	[-0.35, 0.24]	0.00	0.05	0.00	[-0.06, 0.07]	0.00	0.02	0.00
4811	[-2.87, 3.00]	0.03	0.53	-0.01	[-0.06, 0.07]	0.00	0.02	0.00
4813	[-43.7, 8.68]	-0.25	3.23	0.02	[-0.06, 0.07]	0.00	0.02	0.00
8501	[-2.29, 1.51]	-0.04	0.42	-0.01	[-0.03, 0.04]	0.00	0.01	0.00
8502	[-184, 42.54]	-0.31	14.47	0.02	[-0.03, 0.04]	0.00	0.01	0.00
8504	[-6.57, 2.83]	-0.12	0.86	-0.05	[-0.05, 0.08]	0.00	0.02	0.00
8903	[-0.74, 0.82]	0.00	0.12	0.00	[-0.04, 0.08]	0.00	0.02	0.00

3.3 Benchmark Estimation Results

Before estimating ERPT elasticities, I perform Dickey-Fuller tests on the dependent variable and all independent variables with one lagged difference. The null hypothesis of the unit root is rejected at 1% significance level for all variables and all sectors.

Table 4 summarizes the estimation results without reporting the constant term. The estimates of $\hat{\beta}_1$ or own-ERPT elasticity are statistically significant in 11 out of 18 sectors. The significant estimates are all negative and range from -1.39 to -0.79. Half of the estimates are lower than -1. Recall Proposition 1, which proposes that own-ERPT elasticity does not fall below than -1 if the own-price elasticity is above 1. This suggests that my model explain about half of the significant estimates. Own-ERPT elasticity may also fall below -1 due to alternative mechanisms, as previously suggested in the literature. For instance, Froot and Klemperer (1989) show that firms may anticipate the currency appreciation to be persistent and reduce price even more than the observed rate of appreciation.

The estimated coefficient $\hat{\beta}_2$ is found to be statistically significant in five sectors. The statistically significant estimates of $\hat{\beta}_2$ are -0.01, -0.02, -0.06, 0.74 and 2.21, and their sign indicates the sign of cross-ERPT elasticity. From Proposition 4, cross-ERPT elasticity will be positive if the own-price elasticity of demand for competing exporters is greater than 1. This is the case for two sectors. For the other three sectors, the estimated coefficient $\hat{\beta}_2$ is statistically significant and negative, but their values are virtually zero. The estimated coefficient of the PPI is significantly positive in five sectors. The positive estimates are consistent with the theory.

Quantitatively, the estimate of $\hat{\beta}_2$ implies the following scale of price adjustments in

Table 4: Benchmark estimation results

HS code	β_1	β_2	β_3	Adjusted R^2	Sample size
0203	-1.27***	0.56	0.82***	0.48	215
	(0.27)	(0.85)	(0.10)		
0206	-0.95***	2.21***	1.10***	0.11	215
	(0.40)	(0.47)	(0.42)		
0208	-1.39***	0.08	-0.49	0.10	215
	(0.29)	(0.10)	(0.81)		
0504	-0.77	0.08	-1.27	0.00	215
	(0.96)	(0.07)	(0.98)		
1601	-0.34	-0.64	0.15	0.02	215
	(0.46)	(0.59)	(0.33)		
4418	-1.17***	-0.10	0.36	0.07	215
	(0.35)	(0.36)	(1.38)		
4801	-1.06***	1.08	0.56***	0.71	215
	(0.06)	(1.71)	(0.07)		
4803	-0.79***	-0.14	0.24	0.23	215
	(0.11)	(0.20)	(0.19)		
4804	-1.12***	0.30	0.34***	0.44	215
	(0.12)	(0.41)	(0.16)		
4805	-1.04***	0.06	0.98***	0.19	215
	(0.19)	(0.05)	(0.28)		
4806	-0.44	-0.06***	-0.43	0.12	215
	(0.40)	(0.01)	(0.61)		
4808	-0.80**	-0.10	0.03	0.02	215
	(0.43)	(0.25)	(0.64)		
4811	-1.22**	0.01	0.51	0.01	215
	(0.63)	(0.03)	(0.87)		
4813	-1.01	-0.02***	-0.84	0.06	215
	(0.64)	(0.01)	(1.09)		
8501	-0.93*	0.03	0.42	0.00	215
	(0.54)	(0.04)	(1.84)		
8502	0.66	-0.01**	-2.11	0.00	215
	(3.67)	(0.01)	(13.86)		
8504	1.80	0.03	-1.40	0.00	215
	(1.75)	(0.06)	(2.85)		
8903	0.02	0.74*	2.41	0.02	215
	(1.59)	(0.39)	(2.41)		

Notes: Standard errors are in the bracket. ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

response to competitors' currency appreciation. If Canada's market share is fraction k of the competitors' market share, a 1% appreciation of all competitors' currency will cause the exporter to increase price by $\hat{\beta}_2/k\%$ or the cross-ERPT elasticity is $\hat{\beta}_2/k$. Then, the cross-ERPT elasticity could be sizable even when $\hat{\beta}_2$ is close to zero, so long as k is sufficiently low.

Table 5 provides the summary statistics of the implied cross-ERPT elasticity from the benchmark estimation using Canada's observed market share relative to all competitors' market share in the sectors in which $\hat{\beta}_2$ is positive and statistically significant. The sign of the implied cross-ERPT in Table 5 is determined by the sign of $\hat{\beta}_2$ in Table 4. The implied cross-ERPT elasticity ranges from 0.42 to 22.31. The average implied cross-ERPT for these sectors are 1.53 and 3.61. These scales of cross-ERPT elasticity are quite large.

Table 5: Summary statistics of implied cross-ERPT elasticity from the benchmark estimation

HS code	Min	Max	Average	Std. dev
0206	0.42	11.32	1.53	1.29
8903	0.53	22.31	3.61	3.07

Note: The implied cross-ERPT elasticity in period t is $\hat{\beta}_2(1 - s_{i,t-1})/s_{i,t-1}$.

3.4 Sensitivity Analysis

It is empirically possible that exporters adjust pricing with some lags. For this reason, I augment Equation (17) with a lag structure in the sensitivity analysis. First, I consider lags of currency appreciation up to the six-month lag, as in Bergin and Feenstra (2009). I denote the coefficient of the s-month lag of own currency appreciation with $\hat{\beta}_{1,s}$, and the coefficient of the s-month lag of sum of all competitors' currency depreciation with $\hat{\beta}_{2,s}$, where $s = 1, ..., 6$.

Table 6: Results of estimation with lagged currency appreciations

HS code	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_1 + \sum_{s=1}^{6} \hat{\beta}_{1,s}$	$\hat{\beta}_2 + \sum_{s=1}^{6} \hat{\beta}_{2,s}$	β_3	Adjusted R^2	Sample size
0203	-1.27***	0.48	-0.01	-1.86	0.83***	0.50	209
	(0.28)	(0.88)	(0.63)	(1.89)	(0.11)		
0206	-0.82***	2.22***	-1.33	0.68	0.97***	0.17	209
	(0.42)	(0.50)	(1.09)	(1.50)	(0.43)		
0208	-1.53***	0.13	-1.25	0.08	-0.55	0.09	209
	(0.31)	(0.11)	(0.85)	(0.29)	(0.83)		
0504	-0.24	0.12***	0.10	-0.05	-1.15	0.03	209
	(0.97)	(0.07)	(2.30)	(0.15)	(0.99)		
1601	-0.36	-0.63	0.11	-0.38	0.24	-0.01	209
	(0.48)	(0.63)	(1.47)	(1.91)	(0.35)		
4418	-1.39***	-0.18	-1.28	0.11	-0.61	0.12	209
	(0.37)	(0.40)	(0.94)	(0.87)	(1.41)		
4801	-1.05***	0.83	-0.74***	-6.50	0.56***	0.70	209
	(0.06)	(1.82)	(0.15)	(5.07)	(0.07)		
4803	-0.75***	-0.08	-0.62***	0.05	0.27	0.21	209
	(0.11)	(0.20)	(0.26)	(0.47)	(0.20)		
4804	-1.10***	0.26	-0.96***	1.44	0.38***	0.47	209
	(0.12)	(0.41)	(0.32)	(1.10)	(0.16)		
4805	-0.99***	0.01	-1.11***	0.07	1.05***	0.23	209
	(0.20)	(0.05)	(0.48)	(0.14)	(0.31)		
4806	-0.37	-0.05***	-0.12***	-0.06***	0.08	0.49	209
	(0.32)	(0.01)	(0.82)	(0.02)	(0.49)		
4808	-0.72	-0.08	-0.72	-0.10	0.00	0.02	209
	(0.46)	(0.27)	(1.08)	(0.65)	(0.71)		
4811	-0.84	0.00	0.50	-0.04	0.48	0.07	209
	(0.65)	(0.04)	(1.66)	(0.09)	(0.89)		
4813	-1.12**	-0.02***	-0.65	-0.02	-1.14	0.20	209
	(0.61)	(0.01)	(1.45)	(0.02)	(1.04)		
8501	-1.12**	0.02	-0.40	-0.05	-0.32	0.04	209
	(0.56)	(0.04)	(1.30)	(0.09)	(1.96)		
8502	0.72	-0.01	2.14	0.02	-2.96	0.13	209
	(3.37)	(0.01)	(8.22)	(0.02)	(12.48)		
8504	0.86	0.03	-0.40	-0.13	-2.40	0.08	209
	(1.75)	(0.06)	(4.23)	(0.14)	(2.88)		
8903	0.28	0.80**	0.39	0.59	1.74	0.01	209
	(1.69)	(0.41)	(4.19)	(0.93)	(2.61)		

Notes: Standard errors are in the bracket. ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

Table 6 reports the estimated coefficients from the estimation including lags of own and competitors' currency appreciation. In Columns 1 and 2, the contemporaneous coefficients $\hat{\beta}_1$ and $\hat{\beta}_2$ are statistically significant for ten and five sectors, respectively. The number of significant coefficients and the scale of estimates are close that in the benchmark result in Table 4.

Columns 3 and 4 in Table 6 report the sum of the contemporaneous coefficient and the coefficients of lagged currency appreciation. The sum represents the long-run elasticity, whereas the contemporaneous coefficient represents the short-run elasticity. The long-run own-ERPT elasticity is statistically significant in six sectors, and its estimates are all negative, as in the benchmark estimates. In five of these six sectors, the long-run own-ERPT elasticity is higher than the short-run own-ERPT elasticity, indicating that there is overshooting in the response of export prices to own-currency appreciation. However, the sum of the contemporaneous coefficient of competitors' appreciation and the coefficients of its lags is significant in only one sector. In that sector, the scale of the long-run own-ERPT elasticity is only slightly different from the short-run estimate.

The last column in Table 6 reports the coefficient of the sector-specific PPI. It is statistically significant in the same five sectors in the benchmark results, and its scale is close to that in Table 4.

In the other sensitivity analysis, I augment the benchmark estimating equation with the lagged dependent variable and let $\hat{\beta}_p$ denote its estimated coefficient. In Table 7, $\hat{\beta}_p$ is statistically significant in almost all cases. The negative sign of $\hat{\beta}_p$ implies that the long-run ERPT elasticities are higher than the short-run ones and therefore there is overshooting in

Table 7: Results of estimation with the lagged dependent variable

HS4 code	$\hat{\beta}_1$	$\hat{\beta}_2$	$\hat{\beta}_3$	$\hat{\beta}_p$	Adjusted R^2	Sample size
0203	-1.30***	0.62	0.84***	-0.07	0.48	214
	(0.27)	(0.85)	(0.11)	(0.05)		
0206	-1.00***	2.33***	1.19***	-0.08	0.11	214
	(0.41)	(0.48)	(0.43)	(0.07)		
0208	-1.40***	0.08	-0.35	-0.48***	0.33	214
	(0.25)	(0.09)	(0.70)	(0.06)		
0504	-1.25	0.03	-0.67	-0.53***	0.27	214
	(0.83)	(0.06)	(0.84)	(0.06)		
1601	-0.36	-0.64	0.02	-0.37***	0.15	214
	(0.43)	(0.55)	(0.31)	(0.07)		
4418	-1.14***	-0.18	0.44	-0.32***	0.16	214
	(0.33)	(0.35)	(1.31)	(0.06)		
4801	-1.05***	1.11	0.52***	0.06	0.71	214
	(0.06)	(1.71)	(0.07)	(0.04)		
4803	-0.78***	-0.16	0.27	-0.15***	0.25	214
	(0.11)	(0.20)	(0.19)	(0.06)		
4804	-1.10***	0.10	0.43***	-0.24***	0.49	214
	(0.11)	(0.39)	(0.15)	(0.05)		
4805	-1.02***	0.05	1.10***	-0.20***	0.23	214
	(0.18)	(0.04)	(0.28)	(0.06)		
4806	-0.39	-0.05***	-0.12	-0.44***	0.30	214
	(0.36)	(0.01)	(0.55)	(0.06)		
4808	-0.78**	-0.13	0.15	-0.15***	0.04	214
	(0.43)	(0.25)	(0.64)	(0.07)		
4811	-1.30**	0.01	0.09	-0.30***	0.10	214
	(0.61)	(0.03)	(0.83)	(0.07)		
4813	-0.94	-0.02***	-0.47	-0.43***	0.24	214
	(0.57)	(0.01)	(0.98)	(0.06)		
8501	-0.94*	0.02	0.81	-0.33***	0.10	214
	(0.52)	(0.04)	(1.75)	(0.07)		
8502	0.64	-0.01**	2.22	-0.44***	0.19	214
	(3.31)	(0.01)	(12.50)	(0.06)		
8504	1.57	0.04	-0.37	-0.46***	0.20	214
	(1.56)	(0.05)	(2.55)	(0.06)		
8903	-0.14	0.63*	1.53	-0.32***	0.11	214
	(1.52)	(0.38)	(2.31)	(0.07)		

Notes: Standard errors are in the bracket. ***, ** and * denote statistical significance at 1%, 5% and 10% levels, respectively.

the response of export prices.

The estimated coefficients $\hat{\beta}_1$, $\hat{\beta}_2$ and $\hat{\beta}_3$ in Table 7 are statistically significant in the same sectors as those in the benchmark results in Table 4. Furthermore, their scale is quite close to that in Table 4.

4 Concluding Remarks

I examine the micro and macro determinants of ERPT using a model with quadratic preferences, and provide empirical evidence in line with the model. The empirical results indicate that competitors' exchange rate movements matter to exporter's price setting in roughly one-tenth of sample sectors. This finding highlights the importance of the multi-country aspect of trade, which has not been extensively studied in the macro literature. The cross-ERPT elasticity found in my study has important implications as follows.

First, changes in exchange rate policy could explain structural changes in ERPT. Taylor (2000) argues that the structural decline in ERPT elasticity in the U.S. case is caused by low inflation as a result of successful monetary policy. Campa and Goldberg (2005) show that a structural change in the U.S. trade pattern, and heterogeneity in ERPT elasticity across sectors help explain the structural decline in ERPT elasticity. However, my model suggests that one cause could be a shift in the exchange rate policy of a large number of trading partners away from the dollar peg system. If their exchange rate appreciations have negative co-movements, then the cross-currency ERPT will bring down the overall ERPT. However, a direct test of structural decline in ERPT is not feasible in this study, as my data set covers less than two decades.

Second, there could be ERPT to exporters in countries fixing exchange rates, because the currencies of competing exporters fluctuate over time. In other words, fixing exchange rates does not remove exporters from currency risk exposure, as exporters still adjust prices in response to other exchange rates. Based on my model, this effect is predicted to be large in the sector in which exporters in the fixed-exchange rate country occupies a small share. Estimating cross-ERPT elasticity for exporters in a country fixing exchange rates is a natural extension of this study.

Finally, my finding suggests the importance of a three-country general equilibrium model. In this study, exchange rates are taken as given, as the model is constructed for an estimation using data on sector-level prices. However, the gist of the model is that exchange rate movements of competing countries influence external demand. In general equilibrium models, co-movements of multiple exchange rates could be driven by monetary policy or some other shocks. Incorporating the third country into a general equilibrium model will be useful for our understanding of inflation dynamics in open economies.

References

Atkeson, A. and A. Burstein (2008). Pricing-to-market, trade costs, and international relative prices. *American Economic Review 98*(5), 1998–2031.

Auer, R. and T. Chaney (2009). Exchange rate pass-through in a competitive model of pricing-to-market. *Journal of Money, Credit and Banking 41*(1), 151–175.

Auer, R. and R. Schoenle (2013). Market structure and exchange rate pass-through. *Working Paper*.

Bacchetta, P. and E. van Wincoop (2005). A theory of the currency denomination of international trade. *Journal of International Economics 67*(2), 295–319.

Baldwin, R. (1988). Hysteresis in import prices: The beachhead effect. *American Economic Review 78*(4), 773–785.

Bergin, P. R. and R. C. Feenstra (2009). Pass-through of exchange rates and competition between floaters and fixers. *Journal of Money, Credit and Banking 41*(s1), 35–70.

Campa, J. M. and L. Goldberg (2005). Exchange rate pass-through into import prices. *Review of Economics and Statistics 87*(4), 679–90.

Devereux, M. B. and C. Engel (2002). Exchange rate pass-through, exchange rate volatility and exchange rate disconnect. *Journal of Monetary Economics 49*, 913–940.

Devereux, M. B. and C. Engel (2003). Monetary policy in the open economy revisited: Price setting and exchange-rate flexibility. *Review of Economic Studies 70*(4), 765–783.

Devereux, M. B., C. Engel, and P. E. Storgaard (2004). Endogenous exchange rate pass-through when nominal prices are set in advance. *Journal of International Economics 63*(2), 263–91.

Feenstra, R. C., J. E. Gagnon, and M. M. Knetter (1996). Market share and exchange rate pass-through in world automobile trade. *Journal of International Economics 40*(1-2), 187–207.

Froot, K. A. and P. D. Klemperer (1989). Exchange rate pass-through when market share matters. *American Economic Review 79*(4), 637–54.

Ottaviano, G. I. P., T. Tabuchi, and J.-F. Thisse (2002). Agglomeration and trade revisited. *International Economic Review 43*(2), 409–35.

Pierce, J. R. and P. K. Schott (2012). Concording U.S. harmonized system codes over time. *Journal of Official Statistics 28*(1), 53–68.

Taylor, J. B. (2000). Low inflation, pass-through, and the pricing power of firms. *European Economic Review 44*(7), 1389–1408.