ESSAYS ON THE RELATIONSHIP BETWEEN EXCHANGE RATES AND PRICES

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A dissertation submitted to the faculty of the University of North Carolina at Chapel Hill in partial fulfillment of the requirements for the degree of Doctor of Philosophy in the Department of Economics.

Chapel Hill

2007

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ABSTRACT

Mark David Witte: Essays on the Relationship between Exchange Rates and Prices
(Under the direction of Stanley W. Black)

The border effect is created when violations of the law of one price are greater between cities in different countries than cities in the same country. In Chapter 1, I introduce a method that leads to more accurate estimates of the proportion of the border effect attributable to 'sticky' prices and a more volatile exchange rate. Employing this method on price index data, I find that this proportion varies depending on the good; from 8% to 91% and averaging 53%. For non-indexed annual commodity prices, the proportion is estimated as 11% to 58% depending on the good and averaging 36%. These results are predicated on first stage estimates that are statistically questionable.

Exchange rate pass-through is defined as the percentage change in the relative prices between different countries for a given change in the exchange rate. In Chapter 2, I test different possible determinants for the pass-through rate including, uniquely, the exporting country's macroeconomic information using a new dataset of U.S. imports of 96,739 unit value observations from 57 countries of 253 goods. There is a significant, positive relationship between the country specific pass-through rate and the exporter's long term monetary volatility or the exporter's long term average inflation. Short term price volatility in the exporting country significantly decreases the pass-through rate. This is empirical evidence for the theoretically predicted effects of short term and long term inflation introduced by Taylor (2000).

Firms engaging in international trade must choose what currency in which to denominate their price and how often to change their price. In Chapter 3, I model the optimal currency of denomination for traded goods in the presence of an endogenous frequency of price adjustment: enabling a more detailed analysis than in previous theoretical studies regarding "herding" and exchange rate volatility. By "herding" a firm chooses a currency of denomination in order to maintain a stable unit of account with its competitors. The dynamic model suggests that exporting firms will "herd" with the local currency, producer's currency or a vehicle currency. Greater exchange rate volatility amplifies the representative firm's desire to "herd" relative to all other considerations.

ACKNOWLEDGEMENTS

I am blessed with many supporters, so I can not be brief nor can I mention everyone; for these things I apologize.

I'm very grateful to my advisor Dr. Stanley W. Black. Under all circumstances, he has been both my sage guide as well as a supportive friend. I will always be indebted. I'm also very grateful to Dr. Patrick Conway. Without his advice and aid this document would never have met its full potential. I have no doubts that he has made me a better researcher.

And to my fellow graduate students, I can't thank you enough for your moral support *and* academic support. In particular, if it were not for Sean Zhang, this document would never have been written.

I'm also very thankful to my family. I'm grateful for my parents, Jim and Nancy Patton, who raised me to take risks, accept challenges without flinching and to persist in spite of all circumstances. Carl Witte, Dawn Witte, Bryan Witte, Diskin Clay and Sara Clay have also been consistent sources of strength when needed.

And to my wife, Hilary, you've been an inspiration for all of my exams, assignments and drafts. Your love and support can not possibly be summarized here. Meeting you has been the greatest stroke of luck I've ever encountered and marrying you is the best decision I've ever made. R:SLY.

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ABBREVIATIONS

BIC	Bayesian information criterion
CPI	Consumer price index
DWH	Durbin-Wu-Hausman
EU	European Union
GDP	Gross domestic product
IIT	Intra-industry trade
LCP	Local currency pricing
LHS	Left hand side
LOOP	Law of one price
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary least squares
PCP	Producer currency pricing
RHS	Right hand side
SIC	Standard industrial classification
SITC	Standard international trade classification
USITC	United States International Trade Commission
VAR	Vector auto-regression
VCP	Vehicle currency pricing
WLS	Weighted least squares

CHAPTER 1

STICKY PRICES, A VOLATILE EXCHANGE RATE AND THE BORDER

1.1 Introduction

The border effect on relative prices is caused by greater Law of One Price (LOOP) failure across countries relative to LOOP failure within countries. In this paper, I introduce a method that leads to more accurate estimates of the proportion of the border effect attributable to incomplete pass-through of the exchange rate. Using monthly price index data from Engel and Rogers (1996), I estimate that the proportion of the border effect due to incomplete pass-through of the exchange rate varies depending on the good; from 8% to 91% and averaging 53% for all goods. I also analyze non-indexed, annual commodity price data from the Economist Intelligence Unit. In this dataset the proportion of the border effect attributable to incomplete pass-through of the exchange rate is estimated between 11% and 58% depending on the good and averaging 36% for all goods. This portion of the border effect is not necessarily suboptimal; it is the result of firms acting optimally by not changing their price and paying menu costs simply to reflect volatile exchange rate movements. These results are predicated on first stage estimates that are statistically questionable.

Engel and Rogers (2001) highlight four reasons for the failure of the Law of One Price.

1. There are formal and informal barriers to trade such as tariffs, quotas, language barriers etc...
2. The presence of a non-traded component makes up some proportion of the final price of any traded good.
3. Consumers in different places may have different preferences.

4. Nominal prices tend to be sticky while the nominal exchange rate is more volatile.

The fourth reason for LOOP failure is the focus of this paper. As stated in "How Wide is the Border?" by Engel and Rogers (1996, 1114) this fourth reason is as follows:

"…the price of a consumer good might be sticky in terms of the currency of the country in which the good is sold. Goods sold in the United States might have sticky prices in U.S. dollar terms, and goods sold in Canada might have sticky prices in Canadian dollar terms. The nominal exchange rate is, in fact, highly variable. In this case, the cross border prices would fluctuate along with the exchange rate, but the within-country prices would be fairly stable."

Firms may choose to keep their prices 'sticky' to minimize menu costs or for strategic considerations. As exchange rates are more volatile, it may not be in the best interests for firms to change their prices simply to reflect movements in the exchange rate. Thus, the portion of the border effect due to 'sticky' prices does not imply suboptimal international integration; it is the result of firms acting optimally.

This paper has three aims. One, I show a methodology where the proportion of the border effect directly attributable to the fourth reason for LOOP failure (the nominal price/nominal exchange rate relationship) can be estimated. Other attempts to estimate this proportion include Engel and Rogers (1996) as well as Gorodnichenko and Tesar (2005) These authors *change* the standard LHS variable and compare the new results with those using the standard LHS variable. This is discussed in section 1.3.2. Cheung and Lai (2006) overestimate the proportion of the border effect caused by the fourth reason for LOOP failure as shown in the Appendix. Only by fully understanding exchange rate pass-through can the border effect be understood. Exchange rate pass-through is defined as the percentage change in relative prices given a change in the exchange rate. The Law of One Price requires that exchange rate pass-through be perfect (equal to 1); however, this is rarely the case. As shown in section 1.3.1, some proportion of the failure in the LOOP is simply caused by imperfect exchange rate pass-through.

Two, for each of the 14 goods in the monthly or bi-monthly price index dataset from Engel and Rogers (1996), I calculate the percentage of the border effect due to the nominal price/nominal exchange rate relationship. Depending on the good, 8% to 91% of the measured border effect on price volatility is due to incomplete pass-through of a volatile exchange rate; the average proportion for all goods is 53%. And for at least one good, there is evidence that the nominal price/nominal exchange rate relationship is responsible for the entirety of the border effect.

Three, using annual commodity prices from the Economist Intelligence Unit, I calculate a smaller percentage of the border effect due to the nominal price/nominal exchange rate relationship than in the price index data; averaging only 36% for all goods. The proportion of the border effect caused by incomplete pass-through of the exchange rate varies from 11% to 58% among the goods studied with reason to suspect that the nominal price/nominal exchange rate relationship is responsible for the entirety of the border effect for at least one good.

The organization of this paper is as follows. Section 1.2 contains a review of previous empirical work and highlights the multicollinearity troubles inherent to particular regression techniques. Section 1.3 of this paper will illustrate a methodology in which the relationship of the nominal prices and nominal exchange rate can be explored. Also in section 1.3, I examine other attempts to control for the fourth reason for LOOP failure. Section 1.4 reports the results and section 1.5 concludes.

1.2 Empirical Background

In this section, I will discuss the main method of estimating the border effect on the Law of One Price. In a dataset of only two countries, it is difficult to account for the effect of the nominal price/nominal exchange rate relationship because all cross-border observations necessarily contain both the border and a volatile exchange rate.

When the relative Law of One Price is tested, a baseline regression formulation is as follows (used in Engel and Rogers (1996), Parsley and Wei (2001)):

$$
\begin{aligned}
&Std\ \ Dev\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)= \\
&\qquad \beta_0+\beta_{dist}\ln(dist_{ij})+\beta_{bord}\mathrm{I}_{bord,ij}+\sum_{q=1}^{\bar{c}-1}\beta_q\mathrm{I}_q+\varepsilon_{ij}
\end{aligned}
\tag{1.1}
$$

$p_{i,t}$ represents the price of a particular good in city *i* at time *t*. Similarly, $p_{j,t}$ is the price of the same good in city *j* at time *t*. e_t represents the exchange rate between the two countries in which city *i* and city *j* are located. $\mathrm{I}_{bord,ij}$ represents a dummy variable, which equals 1 when there is a border between cities *i* and *j*. $dist_{ij}$ is the distance from city *i* to city *j*. I_q is a dummy variable equal to 1 if either $q = i$ or $q = j$[1].

One extension to the RHS formulation given in Eq. 1.1 is the addition of exchange rate volatility.

$$
\begin{aligned}
&Std\ \ Dev\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)= \\
&\qquad \beta_0+\beta_{dist}\ln(dist_{ij})+\beta_{bord}\mathrm{I}_{bord,ij}+\beta_{ex}Std\ \ Dev(e_t)+\sum_{q=1}^{\bar{c}-1}\beta_q\mathrm{I}_q+\varepsilon_{ij}
\end{aligned}
\tag{1.2}
$$

[1] It should be noted that some papers exclude the constant term and include every city's dummy variable instead.

The inclusion of the explanatory variable, $Std\ \ Dev(e_t)$, represents one component of the LHS variable. Thus, it is not surprising that the coefficient β_{ex} is often significant. $Std\ \ Dev(e_t)$ is only included in an observation if the two cities are using different currencies; these cross border city pairs will also have $\mathrm{I}_{bord,ij} = 1$. As a result, a certain level of multicollinearity is introduced. For a two-country model, if $Std\ \ Dev(e_t)$ is the same for all cross border city pairs then *perfect* multicollinearity is present in the estimating equation[2].

In section 1.3, I offer a more appropriate RHS formulation for estimating the proportion of the border effect that is attributable to the nominal price/nominal exchange rate relationship. The LHS variable from Eq. 1.1 may explicitly or implicitly include the volatility in the exchange rate; thus, any coefficient on the volatility of the exchange rate will likely be significant. Section 1.3 will also include an analysis of other attempts to estimate the effect of the nominal price/nominal exchange rate relationship.

1.3 Empirical Methods

Section 1.3 is separated into two parts. In section 1.3.1, I illustrate the impact of the exchange rate on the border effect and develop a three stage method designed to estimate that impact. In section 1.3.2, I examine previous methods used to estimate the impact of the nominal price/nominal exchange rate relationship on the border effect.

1.3.1 The role of the exchange rate

In order to understand how the volatility of the exchange rate influences the border effect it is necessary to review previous work on the relationship of prices and the exchange rate: namely, the rate of exchange rate pass-through. Recall, there may be a border effect

[2] One suggestion is to use an instrumental variable for the exchange rate to reduce this multicollinearity.

simply because sticky prices don't necessarily reflect changes in exchange rates. So long as exchange rate pass-through is incomplete, the fourth reason for LOOP failure remains: sticky cross-border prices do not fully reflect the continual changes in the exchange rate. Thus, it is necessary to understand the pass-through rate within the context of the LOOP.

The following regression equation used to estimate the pass-through rate γ, generalized in Goldberg and Knetter (1997), is as follows:

$$\ln(p_{i,t}) = \delta \ln(p_{j,t}) + \gamma \ln(e_t) + \psi Z_{ij,t} + u_t \tag{1.3}$$

Where $Z_{ij,t}$ represents additional, non-collinear control variables with a variance of Ω_Z. One form of Eq. 1.3, in first differencing is as follows:

$$\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) = \delta \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) + \gamma \ln\left(\frac{e_t}{e_{t-1}}\right) + \psi Z_{ij,t} + v_t \tag{1.4}$$

Eq. 1.4, or some version thereof, was used recently in Frankel, Parsley and Wei (2004) and Pollard and Coughlin (2004). For Eq. 1.4, the relative LOOP holds so long as δ = 1 and γ = 1. And when there is a perfect fit of δ = 1 and γ = 1 the LHS variable described in Eq. 1.1 is zero and the relative LOOP holds. However, all that is needed for complete exchange rate pass-through is γ = 1.

In order to test the relative LOOP, I will retain the condition that δ = 1, just as the LHS variable in Eq. 1.1 demands, but I will allow for the pass-through rate, γ, to be estimated. Eq. 1.4 then becomes the following regression equation.

$$\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) = \gamma \ln\left(\frac{e_t}{e_{t-1}}\right) + \psi Z_{ij,t} + \mu_t \qquad \mu_t \to (0, \Omega_\mu) \tag{1.5}$$

So long as ψ and γ are estimated consistently the LHS variable in Eq. 1.1 can be decomposed as follows:

$$Std\ \ Dev\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)=$$

$$=\left[V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)+V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)\right]^{1/2}$$

$$=\left[V\left(\gamma\ln\left(\frac{e_t}{e_{t-1}}\right)+\psi Z_{ij,t}+\mu_t\right)+V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\gamma\ln\left(\frac{e_t}{e_{t-1}}\right)+\psi Z_{ij,t}+\mu_t\right)\right]^{1/2}$$

$$=\left[\Omega_\mu+\psi^2\Omega_Z+\gamma^2V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)+V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2\gamma V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)\right]^{1/2}$$

$$=\left[\Omega_\mu+\psi^2\Omega_Z+(1-\gamma)^2V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)\right]^{1/2}$$

(1.6)

The deviation from the relative LOOP has been separated into an exchange rate component and a non-exchange rate component. Specifically, any movements in the nominal relative price that are *not* described by movements in the exchange rate are captured in $Z_{ij,t}$ and μ_t[3]. As shown in Eq. 1.6, $(1-\gamma)^2V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ contains the entirety of the fourth reason for LOOP failure: the nominal price/nominal exchange rate relationship. For all cross border pairs $(1-\gamma)^2V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ is part of the LHS variable. However, for city pairs with the same currency $V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)=0$; only Ω_μ and Ω_Z remain.

[3] Because there many reasons why prices may move, Ω_μ should not be considered mere white noise. This is in many ways synonymous with residuals from GDP growth regressions. The residuals for GDP growth regressions, sometimes taken as technology changes, also contain much useful information.

Now, I use Eq. 1.5 and $(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ so that I can estimate the proportion of the border effect created by the fourth reason for LOOP failure (This procedure is applied in section 1.4.). Using Eq. 1.5 it is possible to estimate γ and construct $(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ for all cross border city pairs and all goods[4]. Estimating the pass-through rate is the first step to take in finding the proportion of the border effect due to the nominal price/nominal exchange rate relationship.

The second step is to calculate the LHS variable $V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ for all city pairs. When city *i* and city *j* are in the same country $\ln\left(\frac{e_t}{e_{t-1}}\right)=0$ and city pairs with the same currency have $V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)$ as their LHS variable.

The third step is to place the exchange rate volatility effect, $(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$, into the following regression equation to be estimated once for each good:

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)= \beta_0+\beta_{dist}\ln(dist_{ij})+\beta_{bp}I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)+\sum_{q=1}^{\bar{c}-1}\beta_q \mathrm{I}_q+\varepsilon_{ij} \quad (1.7)$$

[4] This is a potential 126 x 14 = 1764 pass-through estimates for the data in Engel and Rogers (1996) and 12,371 pass-through estimates for the annual commodity price data.

The dummy variable for the border is replaced with $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$.

Also, the LHS variable is now the variance of $\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_{it}}{e_{t-1}}\right)$ and not the standard deviation. As shown in Eq. 1.6, $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ will affect the LHS variable in a simple linear manner. Thus, if β_{bp} = 1 then the entirety of the border effect is due to the fourth reason for LOOP failure: incomplete pass-through of the exchange rate. However, if $\beta_{bp} > 1$ then the proportion of the border effect that is due to the nominal price/nominal exchange rate relationship is $1/\beta_{bp}$. In the Appendix, I derive the relationship between the LHS variable in Eq. 1.7 and $(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ to show how β_{bp} is formed. Recall that Eq. 1.2 exhibits perfect multicollinearity when only two countries are considered. The estimation procedure described in this paper can be used regardless of how many countries are included.

In section 1.3.2, I examine other empirical methods used to measure the proportion of the border effect generated by the nominal price/nominal exchange rate relationship. Section 1.4 will include a review of the methodology introduced here in Section 1.3.1 and apply that method to the price index data from Engel and Rogers (1996) and the annual commodity price data from the Economist Intelligence Unit.

1.3.2 Other Empirical Methods

As stated in the introduction, even if the nominal exchange rate is removed from the LHS variable, the LHS variable may still *inadvertently imply* the nominal exchange rate. Exchange rates may not be affected by movements in the prices of goods, especially disaggregated goods. However, it is very likely that movements in prices of goods are affected to some degree by the exchange rate; any measure of price must then contain some degree of information regarding the exchange rate.

Engel and Rogers (1996) use a LHS variable, with no exchange rate included, in an attempt to estimate a border effect that is independent of the fourth reason for LOOP failure. The authors compare the nominal price/nominal exchange rate "independent" estimate with the baseline estimates to see how much the nominal price/nominal exchange rate "independent" border effect declines relative to the total border effect. Unfortunately, the LHS variable designed by Engel and Rogers to exclude the nominal exchange rate implicitly may still reflect the nominal exchange rate. Engel and Rogers use the standard deviation of the forecast error U_t as shown in the regression equation below:

$$\ln\left(\frac{p_{i,t}/P_{i,t}}{p_{j,t}/P_{j,t}}\right) = a + b\ln\left(\frac{p_{i,t-1}/P_{i,t-1}}{p_{j,t-1}/P_{j,t-1}}\right) + U_t \qquad (1.8)$$

Where $P_{j,t}$ represents the overall price index for all goods in city *j* at time *t*. Thus, Engel and Rogers use the following LHS variable as "independent" of the nominal exchange rate.

$$Std\ Dev[U_t] = Std\ Dev\left[\ln\left(\frac{p_{i,t}/P_{i,t}}{p_{j,t}/P_{j,t}}\right) - a - b\ln\left(\frac{p_{i,t-1}/P_{i,t-1}}{p_{j,t-1}/P_{j,t-1}}\right)\right] \qquad (1.9)$$

Suppose Eq. 1.5 is applied to Eq. 1.9. Then the nominal price/nominal exchange rate "independent" LHS variable can be shown to implicitly include the volatility of the nominal exchange rate.

$$Std\ Dev[U_t] = Std\ Dev\left[\ln\left(\frac{p_{i,t}/P_{i,t}}{p_{j,t}/P_{j,t}}\right) - a - b\ln\left(\frac{p_{i,t-1}/P_{i,t-1}}{p_{j,t-1}/P_{j,t-1}}\right)\right] =$$

$$= \left[V\left(\ln\left(p_{i,t}/p_{j,t}\right) - \ln\left(P_{i,t}/P_{j,t}\right) - a - b\ln\left(\frac{p_{i,t-1}/P_{i,t-1}}{p_{j,t-1}/P_{j,t-1}}\right)\right)\right]^{1/2}$$

$$= \left[V\left(\gamma\ln\left(e_t/e_{t-1}\right) + \psi Z_t + \mu_t - \gamma_O\ln\left(e_t/e_{t-1}\right) - \psi Z_{Ot} - \mu_{Ot} + (1-b)\ln\left(\frac{p_{i,t-1}/P_{i,t-1}}{p_{j,t-1}/P_{j,t-1}}\right)\right)\right]^{1/2}$$

$$= \left[V\left((\gamma-\gamma_O)\ln\left(e_t/e_{t-1}\right) + \psi Z_t - \psi Z_{Ot} + \mu_t - \mu_{Ot} + (1-b)\ln\left(\frac{p_{i,t-1}/P_{i,t-1}}{p_{j,t-1}/P_{j,t-1}}\right)\right)\right]^{1/2}$$

(1.10)

As long as the pass-through rate for the overall price index, γ_O, does not equal the pass-through rate of the particular good in question, γ, the volatility of the exchange rate is part of the LHS variable. Engel and Rogers use Eq. 1.9 to find the border effect assuming that they've completely controlled for the volatility of the exchange rate. Yet as shown in

Eq. 1.10, the authors may not control for the variance of the nominal exchange rate as long as $\gamma_O \neq \gamma$.

In Table 1.1, for all 126 cross border city pairs and for each of the 14 goods studied in "How Wide is the Border?", the percentage of cross border city pairs for which $\gamma_O \neq \gamma$ at the 90% confidence interval is shown. For Goods 1, 3, 5, 7, 8, 9, 11, 12 and 13 a large proportion of the cross border city pairs state that $\gamma_O \neq \gamma$ at the 90% confidence interval. For these goods the estimation procedure outlined in section 1.3 is a statistical improvement over the method used by Engel and Rogers. For Goods 2, 4, 6, 10 and 14 the improvement made by the procedure in section 1.3 over Engel and Rogers's method is less statistically conclusive.

Gorodnichenko and Tesar (2005) attempt to create a LHS variable that eliminates the volatility of the exchange rate. They use the volatility of forecast errors, ω_t, from the regression in Eq. 1.11 which is taken for each city pair and each good (3371 in total).

For cross border city pairs:

$$\ln\left(\frac{p_{i,t}}{p_{j,t}}\right) = \sum_{m=1}^{6} \psi_m \ln\left(\frac{p_{i,t-m}}{p_{j,t-m}}\right) + \sum_{m=0}^{6} \varphi_m \ln(e_{t-m}) + \omega_t \qquad (1.11a)$$

For same country city pairs:

$$\ln\left(\frac{p_{i,t}}{p_{j,t}}\right) = \sum_{m=1}^{6} \psi_m \ln\left(\frac{p_{i,t-m}}{p_{j,t-m}}\right) + \omega_t \qquad (1.11b)$$

Thus, Gorodnichenko and Tesar's LHS variable is as follows:

$$Std\ \ Dev[\omega_t] \qquad (1.12)$$

Eq. 1.11 is in many ways an extension of Eq. 1.4. Recall that in order for the LOOP to be true both $\delta = 1$ and $\gamma = 1$. For Eq. 1.11a, ψ_m is directly related to δ while φ_m is directly related to γ. Because both φ_m and ψ_m are estimated, Eq. 1.11a allows the LOOP to fail on multiple dimensions. The LOOP demands that $\delta = 1$ and $\gamma = 1$; however, only γ relates to the fourth reason for LOOP failure. The series of φ_m alone controls for the effect of the nominal exchange rate. However, because Eq. 1.11 does not enforce $\sum_{m=1}^{6} \psi_m = 1$, Gorodnichenko and Tesar's method controls for more than just the fourth reason for LOOP failure. Consequently, it is unlikely that Gorodnichenko and Tesar (2005) can control for *only* the volatility of the nominal exchange rate.

In both Engel and Rogers (1996) and Gorodnichenko and Tesar (2005) the authors control for the exchange rate by *changing* the LHS variable being tested. They then compare the results to the original LHS variable given in Eq. 1.1. In contrast, section 1.3.1 notes that the effect of the volatility of the exchange rate on the border can be estimated and the proportion of the border effect directly attributable to the exchange rate can be found and tested for significance *without changing the LHS variable*. In section 1.4, this paper will apply the methodology of section 1.3.1 to find the proportion of the border effect that is attributable to the nominal price/nominal exchange rate relationship.

1.4 Results

In this section, I will use the three stage method, outlined in section 1.3, to find the proportion of the border effect attributable to incomplete pass-through of the exchange rate.

First, I will study the price index data in Engel and Rogers (1996) and then I will analyze the commodity price data from the Economist Intelligence Unit.

The first stage to finding the proportion of the border effect attributable to the fourth reason for LOOP failure is to find the pass-through rate for each of the 126 cross border city pairs and for each of the 14 goods (126 x 14 = 1,764 regressions in Engel and Rogers (1996) dataset). To estimate the pass-through rate I use the following regression equation:

$$\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)=\alpha+\gamma\ln\left(\frac{e_t}{e_{t-1}}\right)+\sum_{p=t}^{T-1}\beta_p I_p+\mu_t \qquad (1.13)$$

I_t is a yearly dummy meant to capture any dynamic movements in any of the other three reasons for LOOP failure. Because the city pair has a constant distance, distance is captured by α (as is any static parameter for the good and city pair). Any dynamic effect is controlled with the yearly dummies. The 1,764 pass-through estimates are reported in Table 1.2[5]. The pass-through estimates, γ, are retained so long as the estimate is non-negative. If γ is estimated to be less than zero then γ is set to zero. $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ is calculated for each city pair. Figure 1.1 plots $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ for all 14 goods. For all same country city pairs $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ = 0. For all cross border city pairs $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) > 0$.

[5] Implicit in the formulation of Eq. 1.6 is the assumption that the exchange rate is uncorrelated with the error term when estimating the pass-through rate. In order to assess this, I use the Durbin-Wu-Hausman test. For Eq. 1.13, 6.6% of the 1,764 estimates fail the DWH test at a 95% confidence interval. This is sufficiently close to the 5% failure rate so as to not be of great concern. Results are given in Table A.4.

As shown in Table 1.2 and Figure 1.2 there are a large number of pass-through coefficients that are insignificant or negative. Theoretically, all pass-through coefficients should range between 0 and 1. In this paper, when γ is estimated to be below 0, the term $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ instead sets γ to 0 because the estimate is not theoretically feasible. This necessarily will increase any estimate of β_{bp} and decrease the resulting estimate of the proportion of the border effect due to nominal price/nominal exchange rate relationship. As such these first stage estimates are statistically questionable.

Why is it that so many pass-through estimates are not significant or below 0?

First, because the pass-through rates are using city-level data, and not regional or country-level data, we should not necessarily expect to see the prices in smaller geographical areas to be as susceptible to the influence of macroeconomic characteristics inherent in the exchange rate.

Second, the LOOP statistic of the LHS variable of Eq. 1.14 demands *immediate* pass-through of the monthly or bi-monthly exchange rate change to the prices in cities. As shown in Campa and Goldberg (2002) as well as Coughlin and Pollard (2004), pass-through estimates tend to be larger for long-run (annual) changes in the exchange rate than for short-run (quarterly) changes in the exchange rate. For example, in the United States, Campa and Goldberg (2002) estimate a long-run pass-through rate of .41 and a short-run pass-through rate of .26. It is likely then that immediate pass-through estimates are even lower or may tend to zero as city level price setters may not change prices on a monthly or bi-monthly basis to reflect the exchange rate change.

Third, there may be a non-linear relationship between the city-level prices and the change in the exchange rate. In fact, when $\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)^2$ is added to the RHS of Eq. 1.13, the squared exchange rate term is significant at the 95% confidence interval in over 8% of the 1,764 cross border city pairs. This is all the more remarkable when considering that only 48% of the pass-through estimates in Eq. 1.13 are significant.

In the second stage, I calculate $V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$. Obviously, same country city pairs have $\ln\left(\frac{e_t}{e_{t-1}}\right)=0$.

For the third stage I apply the regression stated in Eq. 1.7, which is reproduced below:

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)= \beta_0+\beta_{dist}\ln(dist_{ij})+\beta_{bp}I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)+\sum_{q=1}^{\bar{c}-1}\beta_q \mathrm{I}_q+\varepsilon_{ij} \tag{1.14}$$

Again, the proportion of the border effect directly attributable to the fourth reason for LOOP failure, the nominal price/nominal exchange rate relationship, is equal to ${}^{1}\!/_{\beta_{bp}}$.

The results are given in Table 1.3. The calculated proportion of the border effect attributable to the fourth reason for LOOP failure varies widely from good to good. Three goods, Fuel and other Utilities (Good 5), Women's and Girl's Apparel (8) and Public Transportation (11), have a comparatively small proportion of their border effect that is accountable to the fourth reason for LOOP failure. Thus, the proportion of the border effect that is due to the first three reasons for LOOP failure (barriers to trade, the non-traded component in the final price and different preferences) is relatively large for these goods[6].

The average proportion (among the 14 goods) of the border effect attributable to the fourth reason for LOOP failure is approximately 53%. While one good, Footwear (9), appears to have the entirety of its border effect motivated by the nominal price/nominal exchange rate relationship. That is, for Good 9, β_{bp} is not significantly different from 1. Thus, it appears that $(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ may be the entirety of Footwear's border effect[7].

Another way to understand the methodology in this paper is to subtract $\ln\left(\frac{e_t}{e_{t-1}}\right)$ from both side of Eq. 1.5. This leaves us with the following equation.

$$\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)=-(1-\gamma)\ln\left(\frac{e_t}{e_{t-1}}\right)+\psi Z_{ij,t}+\mu_t \qquad (1.15)$$

Then by taking the variance of Eq. 1.5 and we get an equation that's very similar to the regression equations in Eq. 1.7 and Eq. 1.14.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)=(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)+\psi^2 V\left(Z_{ij,t}\right)+V\left(\mu_t\right)$$

(1.16)

This necessarily means that the first stage regression exemplified by Eq. 1.5 is a regression on *levels* of LOOP failure while the final stage regression, exemplified by Eq. 1.7,

[6] In an alternative formulation, I add a lagged relative price variable to the RHS of Eq. 1.13 as a first stage regression. The final results are very similar to the results in Table 1.3. The estimated proportion of the border effect for goods 1-14 are, respectively, 64%, 66%, 51%, 73%, 21%, 77%, 31%, 11%, 85%, 46%, 8%, 50%, 67% and 76%. For this estimation procedure, the DWH test fails in 4.5% of estimates at the 95% confidence interval. Results for the DWH test are given in Table A.4.

[7] Further estimation is contained in the appendix that controls for the country heterogeneity problem highlighted by Gorodnichenko and Tesar (2005) and Cheung and Lai (2006).

is a regression on the *volatility* of LOOP failure. Again, we see that the degree of LOOP failure caused by the nominal price/nominal exchange rate relationship is built into the final stage regression. Because the two equations are so similar, we can use a strategy, employed by Cheung and Lai (2006), which directly calculates the portion of the border effect caused by the nominal price/nominal exchange rate relationship without regression analysis. Instead of using Eq. 1.5 to find the pass-through rate γ and placing the estimated pass-through rate into $(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ we will calculate the additional volatility of the nominal price/nominal exchange rate relationship as follows[8].

$$VPEx = V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) - 2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right) + \frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)} \quad (1.17)$$

Then we can place *VPEx* into the following regression equation.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) - \ln\left(\frac{e_t}{e_{t-1}}\right)\right) = \beta_0 + \beta_{dist}\ln(dist_{ij}) + \beta_{bp}VPEx + \sum_{q=1}^{\bar{c}-1}\beta_q \mathrm{I}_q + \varepsilon_{ij} \quad (1.18)$$

The results for Eq. 1.18 are given in Table 1.4. Note that the estimated proportion of the border effect is greater than that given by the results using Eq. 1.14. This is because of the possibility that $\frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}$ is less than zero. For Eq. 1.14 all pass-through rates that are estimates to be below 0 are set to 0 because negative pass-through

[8] This relationship is derived in Appendix A.

estimates are considered theoretically impossible. For Eq. 1.18,

$$\frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}$$ is placed directly in the regression equation regardless

of its value.

Another alternative *regression* framework to that given in Eq. 1.14 is to place the coefficient measuring the volatility of the nominal price/nominal exchange rate relationship, $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$, from the RHS of the equation and build it instead into the LHS variable. $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ is then replaced by a standard border dummy, $I_{bord,ij}$ as shown in the following regression equation.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) - \ln\left(\frac{e_t}{e_{t-1}}\right)\right) - I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) = \beta_0 + \beta_{dist}\ln(dist_{ij}) + \beta_{bord} I_{bord,ij} + \sum_{q=1}^{\bar{c}-1}\beta_q \mathrm{I}_q + \varepsilon_{ij} \quad (1.19)$$

Results from testing Eq. 1.19 are given in Table 1.5. Also in Table 1.5 are the regression results using the methodology of Engel and Rogers (1996) as shown in the equation below.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) - \ln\left(\frac{e_t}{e_{t-1}}\right)\right) = \beta_0 + \beta_{dist}\ln(dist_{ij}) + \beta_{bord} I_{bord,ij} + \sum_{q=1}^{\bar{c}-1}\beta_q \mathrm{I}_q + \varepsilon_{ij} \quad (1.20)$$

The proportion of the border effect due to incomplete pass-through is calculated in Table 1.5 as β_{bord} of Eq. 1.19 divided by β_{bord} of Eq. 1.20; the results are similar to the estimates in Eq. 1.14.

As shown in Eq. 1.16, $\psi^2 V\left(Z_{ij,t}\right)$ is part of the variance of the LHS variable that is used to test for LOOP failure. Table 1.6 has results for the following equation which includes $\psi^2 V\left(Z_{ij,t}\right)$ as part of the LHS variable.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)= \\ \beta_0+\beta_{dist}\ln(dist_{ij})+\beta_{bord}I_{bord,ij}+\beta_Z\psi^2 V\left(Z_{ij,t}\right)+\sum_{q=1}^{\bar{c}-1}\beta_q I_q+\varepsilon_{ij} \tag{1.21}$$

Also in Table 1.6 are the results for the regression equation below where there is no control for the nominal price/nominal exchange rate relationship.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)= \\ \beta_0+\beta_{dist}\ln(dist_{ij})+\beta_{bord}I_{bord,ij}+\beta_Z\psi^2 V\left(Z_{ij,t}\right)+\sum_{q=1}^{\bar{c}-1}\beta_q I_q+\varepsilon_{ij} \tag{1.22}$$

The proportion of the border effect due to incomplete pass-through is calculated in Table 1.6 as β_{bord} of Eq. 1.21 divided by β_{bord} of Eq. 1.22.

One worry with data of this nature is the possibility of unreliable tests of significance due to heteroskedasticity. The data used in Eq. 1.14, Eq. 1.18 and Eq. 1.19 can be heteroskedastic because of the multi-city nature of the observations and/or because the time series for some observations is either monthly or bi-monthly. To combat this, I use heteroskedastic robust standard errors just as is done in Engel and Rogers (1996).

There are two ways to calculate $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$. The first method uses regression analysis via Eq. 1.5 while the second method simply uses *VPEx*. Figure 1.2 plots the 1,764 potential pass-through estimates from Eq. 1.13 (126 cross border city pairs x 14 goods), separated into significant and insignificant coefficients. Table 1.7 contains summary statistics for both significant and insignificant coefficients.

As shown in Figure 1.2 many of the estimated pass-through rates hover around 0 or are negative. This result suggests that price setters in individual cities react slowly to any change in the exchange rate between countries or that they ignore the change in the exchange rate altogether. Surmised from Taylor (2000), if the city-level price makers see changes in the exchange rate as temporary then there would be little reason to expect prices to change much. If the Canadian/U.S. exchange rate is considered as fairly stable, with little persistence in movements, compared to other currency pairs then the resulting low city-level pass-through estimates are not necessarily surprising.

Of the regressions that create the pass-through rate, 83.4% have a homoskedastic, normal distribution at a 5% confidence interval. Because this is well below the expected 95% proportion the significance of the pass-through estimates is less reliable. However, the significance of the pass-through estimates does not impact the method in which they contribute to Eq. 1.14 or Eq. 1.18.

Now I will analyze the annual commodity prices as provided by the Economist Intelligence Unit. The goods are listed in Table 1.8. The prices are collected annually from 1990-2004 in 223 narrowly defined goods. The data is collected in the following cities; Atlanta, Boston, Chicago, Cleveland, Detroit, Honolulu, Houston, Los Angeles, Miami, New York, Pittsburgh, San Francisco, Seattle, Washington D.C., Calgary, Montreal, Toronto and Vancouver[9]. Because the time series contains only 15 observations I group the individual commodities into 7 broader categories: Food, Alcohol, Household Supplies, Recreation, Personal Care, Tobacco and Clothing.

[9] Data from Honolulu is collected only from 1992-2004.

First, I calculate the pass-through rate according to the following regression equation undertaken once for each of the 223 goods and each of the 56 cross border city pairs (of the 223 x 56 = 12,488 potential regressions only 12,371 of the instances have sufficient data)[10].

$$\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) = \alpha + \gamma \ln\left(\frac{e_t}{e_{t-1}}\right) + \mu_t \qquad (1.23)$$

The 12,371 estimated pass-through rates are placed into $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$.

If the estimated pass-through rate is negative then γ is set to zero. For the second stage, I calculate $V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right) - \ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ for each of the 33,751 observations (223 goods x 153 city pairs = 34,119 of which only 33,751 have sufficient data). In the third stage, I place $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$ into the following regression undertaken for each of the 7 broadly defined categories with each individual good denominated by *k*.

$$V\left(\ln\left(\frac{p_{ik,t}}{p_{ik,t-1}}\right) - \ln\left(\frac{p_{jk,t}}{p_{jk,t-1}}\right) - \ln\left(\frac{e_t}{e_{t-1}}\right)\right) =$$
$$\beta_{dist}\ln(dist_{ij}) + \beta_{bp} I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) + \sum_{q=1}^{\bar{c}-1}\beta_q \mathrm{I}_q + \sum_{r=1}^{\bar{k}-1}\beta_{r+\bar{c}-1}\mathrm{I}_r + \varepsilon_{ij}$$

(1.24)

Unlike Eq. 1.14, Eq. 1.24 includes both city dummy variables *and* good dummy variables. Results from Eq. 1.24 are reported in Table 1.9. The average proportion of the border effect attributable to incomplete pass-through of the exchange rate is 36%; while individual goods have estimates ranging from 11% to 58%. However, Personal Care's β_{bp} is

[10] The program used to estimate the 12,371 pass-through rates is available at www.unc.edu/~witte.

not significantly different from 1; intimating the possibility that the entirety of Personal Care's border effect is caused by incomplete pass-through of the exchange rate.

On the whole, the proportion of the border effect attributable to incomplete pass-through of the exchange rate is comparably smaller in the annual commodity priced dataset as opposed to the monthly, or bimonthly, price index data from Engel and Rogers (1996). This is not unexpected as the commodity price data is less processed than the comparable price index data.

1.5 Conclusion

The border effect on relative prices is caused by greater Law of One Price (LOOP) failure across countries relative to LOOP failure within countries. A proportion of the border effect is caused by incomplete pass-through of a volatile exchange rate. I introduce a method that can lead to more accurate estimates of that proportion. With price index data from Engel and Rogers (1996), I estimate that the proportion of the border effect due to incomplete pass-through of the exchange rate varies from 8% to 91% depending on the good and averaging 53% for all goods. For non-indexed, annual commodity prices, the proportion is estimated as 11% to 58% depending on the good and averaging 36% for all goods. These results are predicated on first stage estimates that are statistically questionable.

Table 1.1 Inability of E&R (1996) to estimate the effect of the exchange rate

Good	Proportion of cross-border pass-through estimates for which $\gamma \neq \gamma_0$ at 90% confidence level
Good 1 US: Food at Home Can: Food Purchased from stores	42.9%
Good 2 US: Food away from home Can: Food purchased-restaurants	21.4%
Good 3 US: Alcoholic Beverages Can: Alcoholic Beverages	59.5%
Good 4 US: Shelter Can: Shelter - .2135(Good 5)	31.0%
Good 5 US: Fuel and other utilities Can: Water, fuel and electricity	70.6%
Good 6 US: Household Furn. and Operations Can: Housing excluding Shelter	20.6%
Good 7 US: Men's and Boy's Apparel Can: .8058(Men's)+.1942(Boy's)	79.4%
Good 8 US: Women's and Girl's Apparel Can: .8355(Women's)+.1645(Girl's)	77.8%
Good 9 US: Footwear Can: Footwear	77.0%
Good 10 US: Private Transportation Can: Private Transportation	20.6%
Good 11 US: Public Transportation Can: Public Transportation	57.9%
Good 12 US: Medical Care Can: Medical Care	46.8%
Good 13 US: Personal Care Can: Personal Care	42.1%
Good 14 US: Entertainment Can: .8567(Rec.)+.1433(reading material)	19.0%

Table 1.2a City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Balt. Calg.	Balt. Edm.	Balt. Mont.	Balt. Otwa.	Balt. Qubc.	Balt. Reg.	Balt. Tor.	Balt. Van.	Balt. Win.
Good 1									
Pass-through rate	.145	.181	.082	-.238	.015	.009	.000	-.098	.069
std err	.129	.138	.105	.109	.109	.113	.094	.099	.112
Good 2									
Pass-through rate	-.154	-.026	-.140	-.006	-.019	-.155	.021	-.233	-.083
std err	.113	.106	.092	.121	.104	.134	.118	.107	.108
Good 3									
Pass-through rate	.209	.097	-.168	-.149	-.224	-.112	-.149	-.158	-.120
std err	.163	.160	.143	.140	.151	.120	.135	.140	.152
Good 4									
Pass-through rate	.062	.022	.048	.084	-.013	.056	.124	.119	.051
std err	.135	.127	.126	.133	.127	.138	.142	.137	.132
Good 5									
Pass-through rate	.601	.451	.228	.207	.256	.247	.290	.129	.230
std err	.509	.481	.396	.399	.404	.399	.415	.435	.403
Good 6									
Pass-through rate	-.073	-.168	-.192	-.207	-.177	-.214	-.177	-.128	-.195
std err	.137	.137	.135	.135	.123	.144	.120	.137	.128
Good 7									
Pass-through rate	.103	.199	.262	.183	.185	.114	.167	.301	.139
std err	.365	.379	.377	.384	.386	.393	.391	.352	.387
Good 8									
Pass-through rate	-1.027	-.932	-.769	-.739	-1.048	-.894	-.706	-.791	-.985
std err	.892	.915	.879	.892	.872	.909	.897	.861	.899
Good 9									
Pass-through rate	-.086	-.025	.139	-.066	.129	-.003	-.148	-.162	-.086
std err	.464	.462	.467	.462	.458	.468	.433	.468	.454
Good 10									
Pass-through rate	.092	.086	-.098	.038	-.028	.170	.056	-.135	-.041
std err	.143	.140	.139	.165	.142	.184	.196	.137	.183
Good 11									
Pass-through rate	-.409	-.336	-.232	-.372	-.215	-.449	-.301	-.462	-.343
std err	.576	.538	.408	.442	.380	.562	.468	.559	.553
Good 12									
Pass-through rate	.020	-.048	-.119	-.018	-.088	-.084	-.091	-.086	-.024
std err	.148	.156	.129	.145	.119	.327	.136	.142	.123
Good 13									
Pass-through rate	-.007	.096	.000	.039	.079	-.036	.057	.076	.028
std err	.239	.224	.215	.219	.228	.219	.232	.207	.234
Good 14									
Pass-through rate	.145	.155	.219	.185	.226	.182	.238	.105	.128
std err	.134	.133	.146	.155	.155	.150	.146	.136	.141
Good 0 (All goods)									
Pass-through rate	.059	.057	-.017	-.042	-.022	.004	.028	-.028	-.005
std err	.074	.077	.076	.072	.073	.076	.072	.063	.072

Table 1.2b City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Bost. Calg.	Bost. Edm.	Bost. Mont.	Bost. Otwa.	Bost. Qubc.	Bost. Reg.	Bost. Tor.	Bost. Van.	Bost. Win.
Good 1									
Pass-through rate	.068	.103	.004	-.316	-.063	-.068	-.078	-.176	-.009
std err	.137	.141	.113	.113	.116	.120	.100	.110	.118
Good 2									
Pass-through rate	.055	.183	.069	.202	.190	.054	.230	-.024	.126
std err	.121	.122	.121	.128	.119	.144	.127	.117	.113
Good 3									
Pass-through rate	.151	.040	-.225	-.206	-.281	-.169	-.206	-.215	-.177
std err	.177	.179	.173	.160	.172	.160	.157	.168	.179
Good 4									
Pass-through rate	.033	-.007	.019	.055	-.041	.027	.095	.090	.023
std err	.166	.164	.143	.156	.145	.162	.161	.175	.153
Good 5									
Pass-through rate	.258	.107	-.116	-.136	-.087	-.096	-.053	-.214	-.113
std err	.364	.382	.341	.337	.358	.399	.334	.341	.352
Good 6									
Pass-through rate	.348	.253	.229	.214	.244	.207	.244	.293	.226
std err	.151	.135	.150	.141	.149	.143	.144	.158	.155
Good 7									
Pass-through rate	.139	.236	.298	.220	.221	.150	.204	.338	.176
std err	.323	.315	.341	.322	.340	.337	.320	.306	.336
Good 8									
Pass-through rate	1.189	1.284	1.447	1.477	1.168	1.321	1.510	1.425	1.230
std err	1.017	1.040	1.026	1.020	1.021	1.047	1.032	.994	1.027
Good 9									
Pass-through rate	-.083	-.024	.201	-.060	.144	-.029	-.096	-.153	-.075
std err	.317	.307	.339	.295	.366	.333	.308	.304	.318
Good 10									
Pass-through rate	.044	.038	-.146	-.010	-.076	.122	.008	-.184	-.090
std err	.159	.156	.147	.168	.153	.186	.202	.152	.187
Good 11									
Pass-through rate	-.194	-.121	-.017	-.157	.000	-.234	-.086	-.247	-.128
std err	.554	.535	.383	.441	.383	.536	.454	.539	.529
Good 12									
Pass-through rate	-.102	-.170	-.241	-.141	-.211	-.207	-.214	-.209	-.146
std err	.164	.181	.148	.180	.135	.338	.164	.165	.140
Good 13									
Pass-through rate	.102	.208	.131	.161	.204	.100	.176	.198	.151
std err	.199	.186	.170	.185	.172	.191	.173	.174	.177
Good 14									
Pass-through rate	.017	.027	.091	.057	.098	.054	.111	-.023	.001
std err	.126	.130	.155	.164	.158	.131	.154	.137	.130
Good 0 (All goods)									
Pass-through rate	.113	.110	.036	.011	.031	.057	.081	.025	.048
std err	.091	.092	.082	.079	.082	.091	.081	.073	.082

Table 1.2c City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Chi. Calg.	Chi. Edm.	Chi. Mont.	Chi. Otwa.	Chi. Qubc.	Chi. Reg.	Chi. Tor.	Chi. Van.	Chi. Win.
Good 1									
Pass-through rate	.123	.158	.060	-.260	-.007	-.013	-.022	-.120	.047
std err	.131	.139	.110	.110	.108	.112	.094	.097	.112
Good 2									
Pass-through rate	-.056	-.042	-.037	.086	-.009	-.111	.024	-.079	-.047
std err	.076	.069	.071	.078	.073	.089	.072	.078	.075
Good 3									
Pass-through rate	.136	.075	-.097	.026	-.149	-.073	.030	-.104	-.025
std err	.108	.110	.106	.108	.106	.101	.108	.101	.113
Good 4									
Pass-through rate	-.005	-.012	-.007	.020	-.030	.005	.026	.079	-.006
std err	.101	.104	.105	.100	.112	.101	.101	.106	.102
Good 5									
Pass-through rate	-.305	-.329	-.394	-.462	-.391	-.457	-.372	-.500	-.387
std err	.454	.437	.415	.415	.421	.438	.420	.415	.422
Good 6									
Pass-through rate	-.017	-.059	-.070	-.066	-.014	-.060	-.037	-.005	-.103
std err	.099	.097	.096	.096	.092	.098	.097	.095	.095
Good 7									
Pass-through rate	.307	.359	.327	.334	.388	.292	.408	.541	.344
std err	.259	.255	.287	.257	.291	.265	.265	.259	.273
Good 8									
Pass-through rate	-.206	-.144	-.198	-.059	-.136	-.083	-.032	-.004	-.256
std err	.395	.401	.410	.399	.416	.403	.398	.390	.401
Good 9									
Pass-through rate	.127	.197	.208	.185	.289	.116	.205	.136	.154
std err	.297	.301	.283	.281	.294	.295	.283	.302	.280
Good 10									
Pass-through rate	-.079	-.009	-.170	-.022	-.048	.112	-.019	-.264	-.094
std err	.119	.124	.110	.119	.119	.139	.133	.126	.151
Good 11									
Pass-through rate	-.124	-.148	-.278	-.203	-.179	-.151	-.184	-.202	.049
std err	.380	.355	.288	.293	.262	.370	.314	.367	.368
Good 12									
Pass-through rate	-.122	-.051	-.137	-.051	-.070	-.129	-.120	.019	-.022
std err	.097	.108	.083	.097	.081	.219	.090	.094	.077
Good 13									
Pass-through rate	-.047	.014	-.006	.074	.038	-.044	.019	.051	.055
std err	.140	.111	.124	.124	.124	.134	.123	.119	.128
Good 14									
Pass-through rate	.057	.080	.124	.146	.135	.074	.159	.050	.129
std err	.083	.084	.095	.097	.099	.090	.099	.085	.091
Good 0 (All goods)									
Pass-through rate	-.010	.005	-.054	-.041	-.045	-.017	-.006	-.067	-.017
std err	.052	.052	.057	.052	.058	.059	.052	.052	.054

Table 1.2d City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Dal. Calg.	Dal. Edm.	Dal. Mont.	Dal. Otwa.	Dal. Qubc.	Dal. Reg.	Dal. Tor.	Dal. Van.	Dal. Win.
Good 1									
Pass-through rate	.214	.249	.151	-.169	.084	.078	.069	-.029	.138
std err	.133	.143	.120	.122	.123	.116	.111	.105	.122
Good 2									
Pass-through rate	-.009	-.005	.001	.071	.046	-.105	.083	-.004	-.010
std err	.091	.098	.079	.101	.092	.111	.092	.105	.088
Good 3									
Pass-through rate	.163	.101	-.141	.138	-.154	-.123	.127	-.131	-.040
std err	.185	.178	.169	.177	.172	.156	.179	.176	.180
Good 4									
Pass-through rate	-.081	-.092	-.105	-.042	-.172	-.083	-.026	.043	-.078
std err	.107	.106	.116	.109	.116	.111	.112	.120	.110
Good 5									
Pass-through rate	.332	.263	.262	.182	.289	.128	.198	.251	.182
std err	.528	.521	.458	.461	.440	.472	.471	.474	.461
Good 6									
Pass-through rate	.106	.060	.025	.076	.055	.135	.112	.114	.011
std err	.158	.156	.156	.153	.159	.161	.150	.150	.156
Good 7									
Pass-through rate	.126	.195	.009	.097	.110	.052	.216	.255	.160
std err	.373	.378	.364	.361	.362	.379	.365	.362	.383
Good 8									
Pass-through rate	-.414	-.312	-.344	-.265	-.341	-.347	-.304	-.180	-.349
std err	.570	.577	.556	.562	.551	.555	.567	.549	.567
Good 9									
Pass-through rate	-.019	.081	-.111	.030	-.168	-.185	.087	.128	.024
std err	.264	.253	.295	.266	.286	.294	.277	.275	.267
Good 10									
Pass-through rate	-.073	.050	-.096	.012	.023	.003	-.039	-.217	.065
std err	.156	.160	.149	.146	.164	.176	.159	.150	.183
Good 11									
Pass-through rate	-.165	-.078	-.330	-.123	-.168	-.180	-.222	-.124	.029
std err	.603	.575	.479	.506	.466	.584	.518	.584	.581
Good 12									
Pass-through rate	-.263	-.159	-.281	-.164	-.172	-.199	-.201	-.031	-.135
std err	.136	.147	.107	.125	.105	.287	.116	.117	.102
Good 13									
Pass-through rate	-.273	-.190	-.330	-.204	-.193	-.359	-.303	-.229	-.263
std err	.182	.174	.171	.169	.153	.172	.166	.178	.165
Good 14									
Pass-through rate	-.032	.004	-.059	-.018	-.056	-.021	-.025	-.019	.019
std err	.098	.099	.096	.102	.104	.109	.102	.098	.109
Good 0 (All goods)									
Pass-through rate	.017	.029	-.005	-.007	.003	-.018	.037	-.026	.038
std err	.068	.065	.071	.066	.068	.074	.063	.063	.071

Table 1.2e City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Det. Calg.	Det. Edm.	Det. Mont.	Det. Otwa.	Det. Qubc.	Det. Reg.	Det. Tor.	Det. Van.	Det. Win.
Good 1									
Pass-through rate	.172	.207	.109	-.211	.042	.036	.027	-.071	.096
std err	.127	.135	.103	.109	.105	.111	.094	.094	.109
Good 2									
Pass-through rate	-.072	-.006	-.020	.056	.025	-.116	.035	-.054	-.014
std err	.083	.074	.073	.082	.083	.095	.081	.085	.073
Good 3									
Pass-through rate	.111	.045	-.100	.049	-.129	-.047	.061	-.114	-.025
std err	.109	.106	.111	.109	.110	.099	.107	.100	.120
Good 4									
Pass-through rate	-.003	.011	.011	.059	-.015	.018	.079	.146	.025
std err	.126	.126	.126	.123	.126	.128	.125	.133	.128
Good 5									
Pass-through rate	.098	-.013	-.001	-.105	-.010	-.198	-.056	-.130	-.065
std err	.326	.309	.278	.275	.278	.316	.280	.290	.304
Good 6									
Pass-through rate	.016	-.036	-.027	.013	.009	.016	.050	.019	-.065
std err	.112	.101	.099	.113	.099	.100	.097	.106	.105
Good 7									
Pass-through rate	.045	.103	.013	.051	.082	-.031	.153	.156	.090
std err	.262	.266	.259	.250	.264	.280	.255	.256	.270
Good 8									
Pass-through rate	.414	.482	.527	.600	.586	.492	.557	.614	.464
std err	.451	.462	.430	.439	.446	.454	.444	.440	.449
Good 9									
Pass-through rate	-.396	-.338	-.419	-.374	-.340	-.504	-.310	-.376	-.394
std err	.312	.311	.322	.299	.329	.321	.304	.317	.302
Good 10									
Pass-through rate	-.186	-.079	-.222	-.087	-.081	-.021	-.105	-.349	-.200
std err	.126	.128	.121	.137	.137	.150	.146	.130	.172
Good 11									
Pass-through rate	-.066	-.151	-.303	-.131	-.148	-.107	-.165	-.158	.025
std err	.404	.380	.297	.316	.271	.391	.336	.391	.386
Good 12									
Pass-through rate	-.184	-.128	-.203	-.140	-.153	-.097	-.172	-.065	-.100
std err	.107	.121	.096	.112	.095	.233	.102	.110	.089
Good 13									
Pass-through rate	-.128	-.105	-.159	-.103	-.013	-.186	-.154	-.137	-.030
std err	.142	.112	.122	.107	.107	.120	.113	.117	.114
Good 14									
Pass-through rate	-.189	-.161	-.166	-.143	-.146	-.172	-.118	-.186	-.110
std err	.098	.099	.096	.098	.102	.095	.100	.092	.101
Good 0 (All goods)									
Pass-through rate	-.012	.010	-.004	-.016	.013	-.021	.020	-.058	-.004
std err	.062	.062	.064	.059	.061	.068	.060	.058	.067

Table 1.2f City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Hous. Calg.	Hous. Edm.	Hous. Mont.	Hous. Otwa.	Hous. Qubc.	Hous. Reg.	Hous. Tor.	Hous. Van.	Hous. Win.
Good 1									
Pass-through rate	.217	.253	.154	-.166	.087	.082	.072	-.026	.141
std err	.142	.148	.125	.124	.127	.129	.110	.107	.134
Good 2									
Pass-through rate	-.019	-.015	-.009	.061	.036	-.115	.073	-.014	-.020
std err	.088	.096	.079	.095	.098	.110	.078	.108	.091
Good 3									
Pass-through rate	-.088	-.149	-.391	-.112	-.404	-.373	-.123	-.381	-.290
std err	.164	.161	.147	.161	.153	.144	.165	.147	.155
Good 4									
Pass-through rate	-.056	-.068	-.081	-.017	-.148	-.058	-.002	.068	-.054
std err	.112	.113	.118	.114	.117	.119	.117	.124	.119
Good 5									
Pass-through rate	.219	.151	.149	.069	.177	.015	.086	.139	.070
std err	.498	.482	.388	.422	.382	.437	.433	.416	.411
Good 6									
Pass-through rate	-.005	-.050	-.086	-.035	-.055	.024	.001	.004	-.100
std err	.175	.163	.155	.177	.150	.163	.163	.156	.165
Good 7									
Pass-through rate	.202	.271	.085	.173	.186	.128	.292	.330	.236
std err	.288	.291	.309	.291	.311	.312	.302	.279	.322
Good 8									
Pass-through rate	.530	.631	.600	.679	.602	.596	.640	.764	.594
std err	.611	.613	.579	.591	.585	.620	.598	.612	.608
Good 9									
Pass-through rate	.436	.519	.347	.476	.267	.265	.546	.550	.456
std err	.333	.328	.327	.327	.325	.362	.319	.349	.339
Good 10									
Pass-through rate	.028	.152	.005	.113	.124	.104	.062	-.116	.167
std err	.156	.161	.152	.149	.167	.186	.163	.150	.186
Good 11									
Pass-through rate	.165	.252	.000	.208	.162	.150	.109	.206	.359
std err	.460	.433	.325	.352	.305	.440	.369	.442	.438
Good 12									
Pass-through rate	-.050	.054	-.069	.049	.041	.013	.012	.182	.078
std err	.128	.144	.111	.127	.098	.278	.112	.122	.104
Good 13									
Pass-through rate	.185	.268	.128	.254	.265	.099	.155	.228	.194
std err	.205	.155	.165	.167	.152	.163	.163	.177	.170
Good 14									
Pass-through rate	.103	.138	.075	.116	.079	.113	.110	.115	.153
std err	.148	.145	.149	.145	.151	.155	.148	.148	.161
Good 0 (All goods)									
Pass-through rate	.041	.053	.020	.017	.028	.006	.061	-.002	.062
std err	.071	.068	.070	.064	.070	.074	.058	.061	.072

Table 1.2g City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	L.A. Calg.	L.A. Edm.	L.A. Mont.	L.A. Otwa.	L.A. Qubc.	L.A. Reg.	L.A. Tor.	L.A. Van.	L.A. Win.
Good 1									
Pass-through rate	.159	.194	.096	-.224	.029	.023	.014	-.084	.083
std err	.133	.141	.115	.111	.115	.113	.105	.098	.116
Good 2									
Pass-through rate	-.028	-.015	-.010	.113	.018	-.084	.051	-.052	-.020
std err	.067	.063	.058	.070	.065	.079	.068	.073	.068
Good 3									
Pass-through rate	.054	-.008	-.180	-.057	-.232	-.156	-.053	-.187	-.107
std err	.114	.113	.118	.117	.114	.112	.119	.116	.121
Good 4									
Pass-through rate	-.036	-.044	-.038	-.012	-.061	-.026	-.005	.048	-.038
std err	.074	.076	.078	.074	.081	.078	.078	.081	.076
Good 5									
Pass-through rate	.216	.192	.127	.060	.130	.065	.149	.022	.134
std err	.307	.289	.240	.250	.240	.261	.254	.254	.263
Good 6									
Pass-through rate	.016	-.025	-.036	-.032	.020	-.026	-.004	.028	-.069
std err	.108	.101	.105	.108	.106	.107	.105	.106	.115
Good 7									
Pass-through rate	.066	.117	.086	.093	.146	.051	.166	.299	.102
std err	.214	.211	.223	.210	.227	.219	.217	.203	.222
Good 8									
Pass-through rate	-.062	-.001	-.054	.084	.008	.061	.111	.140	-.112
std err	.291	.299	.303	.293	.326	.303	.292	.300	.292
Good 9									
Pass-through rate	.349	.419	.430	.407	.511	.338	.427	.358	.376
std err	.176	.174	.196	.178	.199	.197	.179	.192	.179
Good 10									
Pass-through rate	.023	.093	-.068	.080	.054	.213	.083	-.162	.007
std err	.120	.128	.113	.120	.120	.141	.134	.126	.155
Good 11									
Pass-through rate	.001	-.022	-.153	-.077	-.053	-.026	-.058	-.077	.174
std err	.402	.381	.308	.330	.292	.395	.346	.389	.392
Good 12									
Pass-through rate	-.134	-.063	-.149	-.063	-.082	-.141	-.132	.007	-.034
std err	.102	.113	.088	.103	.084	.225	.094	.098	.085
Good 13									
Pass-through rate	-.038	.023	.002	.083	.046	-.035	.028	.060	.064
std err	.137	.119	.128	.122	.123	.121	.125	.124	.130
Good 14									
Pass-through rate	.002	.025	.069	.091	.080	.019	.104	-.006	.074
std err	.081	.082	.085	.091	.089	.087	.090	.082	.083
Good 0 (All goods)									
Pass-through rate	.032	.047	-.012	.001	-.003	.025	.036	-.025	.025
std err	.043	.044	.047	.041	.046	.049	.042	.040	.047

Table 1.2h

City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Miami Calg.	Miami Edm.	Miami Mont.	Miami Otwa.	Miami Qubc.	Miami Reg.	Miami Tor.	Miami Van.	Miami Win.
Good 1									
Pass-through rate	.103	.138	.039	-.280	-.027	-.033	-.042	-.141	.026
std err	.143	.149	.127	.123	.131	.134	.119	.115	.130
Good 2									
Pass-through rate	-.002	.126	.012	.146	.134	-.003	.174	-.080	.070
std err	.175	.180	.171	.181	.168	.193	.174	.195	.174
Good 3									
Pass-through rate	.244	.133	-.132	-.114	-.188	-.077	-.113	-.122	-.084
std err	.204	.199	.192	.177	.181	.189	.177	.199	.207
Good 4									
Pass-through rate	.236	.195	.222	.258	.161	.230	.297	.292	.225
std err	.132	.131	.135	.134	.135	.140	.134	.144	.139
Good 5									
Pass-through rate	.318	.168	-.056	-.076	-.027	-.036	.007	-.154	-.053
std err	.341	.319	.256	.257	.269	.281	.271	.268	.242
Good 6									
Pass-through rate	.118	.024	-.001	-.016	.015	-.022	.015	.064	-.003
std err	.136	.156	.158	.143	.144	.141	.142	.142	.142
Good 7									
Pass-through rate	-.228	-.132	-.069	-.148	-.146	-.217	-.164	-.030	-.192
std err	.382	.374	.410	.387	.426	.384	.386	.365	.381
Good 8									
Pass-through rate	-1.169	-1.074	-.911	-.880	-1.190	-1.036	-.848	-.933	-1.127
std err	.600	.602	.603	.587	.646	.615	.586	.577	.596
Good 9									
Pass-through rate	-.191	-.117	.088	-.171	.070	-.127	-.216	-.226	-.162
std err	.405	.404	.435	.426	.463	.442	.440	.415	.426
Good 10									
Pass-through rate	.145	.140	-.045	.091	.026	.224	.109	-.082	.012
std err	.162	.152	.142	.170	.146	.192	.205	.145	.185
Good 11									
Pass-through rate	-.725	-.653	-.548	-.688	-.531	-.765	-.617	-.778	-.659
std err	.604	.569	.443	.472	.427	.586	.493	.581	.576
Good 12									
Pass-through rate	.086	.018	-.053	.048	-.023	-.018	-.025	-.020	.042
std err	.156	.162	.129	.149	.115	.309	.140	.133	.122
Good 13									
Pass-through rate	.108	.211	.115	.154	.194	.079	.172	.190	.142
std err	.191	.159	.169	.177	.162	.169	.179	.168	.184
Good 14									
Pass-through rate	.003	.013	.077	.043	.084	.040	.096	-.037	-.014
std err	.123	.130	.155	.155	.159	.137	.152	.127	.126
Good 0 (All goods)									
Pass-through rate	.102	.100	.026	.001	.020	.047	.070	.015	.038
std err	.080	.081	.075	.071	.075	.080	.073	.064	.075

Table 1.2i

City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	N.Y. Calg.	N.Y. Edm.	N.Y. Mont.	N.Y. Otwa.	N.Y. Qubc.	N.Y. Reg.	N.Y. Tor.	N.Y. Van.	N.Y. Win.
Good 1									
Pass-through rate	.141	.176	.077	-.242	.011	.005	-.004	-.103	.064
std err	.120	.131	.102	.105	.103	.105	.087	.091	.105
Good 2									
Pass-through rate	-.058	-.045	-.040	.083	-.012	-.114	.021	-.082	-.050
std err	.067	.063	.059	.073	.063	.080	.066	.072	.066
Good 3									
Pass-through rate	.113	.052	-.120	.003	-.172	-.096	.007	-.127	-.048
std err	.097	.095	.096	.089	.091	.083	.089	.085	.100
Good 4									
Pass-through rate	-.053	-.061	-.055	-.029	-.078	-.043	-.022	.031	-.055
std err	.076	.076	.075	.075	.077	.076	.077	.082	.074
Good 5									
Pass-through rate	.053	.029	-.036	-.104	-.033	-.099	-.014	-.141	-.029
std err	.226	.196	.145	.152	.158	.192	.156	.158	.161
Good 6									
Pass-through rate	-.008	-.049	-.061	-.056	-.005	-.051	-.028	.004	-.093
std err	.085	.080	.080	.084	.082	.085	.084	.085	.081
Good 7									
Pass-through rate	-.009	.043	.011	.018	.071	-.024	.091	.225	.028
std err	.198	.191	.208	.183	.207	.200	.205	.179	.206
Good 8									
Pass-through rate	-.224	-.162	-.216	-.078	-.154	-.101	-.051	-.022	-.274
std err	.399	.411	.394	.389	.399	.421	.391	.388	.403
Good 9									
Pass-through rate	.080	.151	.162	.138	.242	.070	.159	.090	.107
std err	.181	.176	.180	.169	.196	.187	.171	.180	.183
Good 10									
Pass-through rate	-.063	.006	-.155	-.007	-.032	.127	-.003	-.249	-.079
std err	.113	.119	.102	.112	.111	.128	.122	.116	.148
Good 11									
Pass-through rate	-.161	-.184	-.314	-.239	-.215	-.187	-.220	-.239	.013
std err	.356	.331	.235	.261	.209	.339	.283	.343	.340
Good 12									
Pass-through rate	-.125	-.054	-.140	-.054	-.074	-.133	-.124	.016	-.025
std err	.093	.099	.077	.089	.073	.221	.082	.087	.068
Good 13									
Pass-through rate	-.024	.037	.016	.097	.060	-.021	.042	.074	.078
std err	.135	.095	.109	.092	.106	.111	.102	.103	.105
Good 14									
Pass-through rate	-.040	-.017	.027	.049	.038	-.023	.062	-.047	.032
std err	.070	.071	.085	.088	.089	.071	.089	.072	.076
Good 0 (All goods)									
Pass-through rate	.000	.016	-.043	-.031	-.035	-.006	.005	-.056	-.007
std err	.041	.042	.044	.040	.044	.048	.041	.037	.044

Table 1.2j

City-pair specific and good specific pass-through rates

US City / Can. City / Eq. 1.13	Phil. Calg.	Phil. Edm.	Phil. Mont.	Phil. Otwa.	Phil. Qubc.	Phil. Reg.	Phil. Tor.	Phil. Van.	Phil. Win.
Good 1									
Pass-through rate	.238	.273	.174	-.145	.108	.102	.093	-.006	.161
std err	.130	.140	.107	.111	.106	.112	.098	.098	.112
Good 2									
Pass-through rate	.023	.037	.042	.165	.070	-.032	.103	-.001	.031
std err	.074	.070	.070	.076	.072	.090	.074	.081	.071
Good 3									
Pass-through rate	.180	.119	-.053	.069	-.105	-.029	.074	-.060	.019
std err	.098	.101	.104	.100	.104	.094	.099	.099	.111
Good 4									
Pass-through rate	-.060	-.068	-.062	-.036	-.085	-.050	-.029	.024	-.061
std err	.088	.088	.089	.086	.094	.090	.088	.089	.090
Good 5									
Pass-through rate	.017	-.006	-.072	-.139	-.069	-.134	-.050	-.177	-.065
std err	.263	.242	.207	.214	.215	.245	.219	.223	.224
Good 6									
Pass-through rate	-.048	-.089	-.100	-.096	-.044	-.091	-.068	-.036	-.133
Std err	.110	.111	.107	.101	.111	.106	.102	.104	.103
Good 7									
Pass-through rate	.305	.357	.326	.332	.386	.290	.406	.539	.342
Std err	.315	.315	.316	.312	.322	.315	.316	.312	.331
Good 8									
Pass-through rate	.114	.176	.122	.261	.184	.237	.288	.316	.064
Std err	.498	.502	.507	.498	.503	.510	.497	.491	.494
Good 9									
Pass-through rate	.080	.150	.161	.138	.242	.069	.158	.089	.107
Std err	.281	.288	.292	.281	.300	.288	.296	.292	.283
Good 10									
Pass-through rate	-.008	.061	-.100	.049	.023	.182	.052	-.194	-.024
Std err	.113	.117	.099	.111	.108	.123	.123	.115	.150
Good 11									
Pass-through rate	.123	.099	-.031	.044	.069	.096	.063	.045	.296
Std err	.376	.357	.292	.303	.264	.366	.318	.367	.363
Good 12									
Pass-through rate	-.072	-.001	-.087	-.001	-.020	-.079	-.071	.069	.028
Std err	.102	.119	.092	.105	.086	.221	.098	.103	.090
Good 13									
Pass-through rate	-.053	.008	-.012	.068	.032	-.050	.013	.045	.050
Std err	.177	.139	.143	.148	.148	.151	.149	.146	.146
Good 14									
Pass-through rate	-.041	-.019	.025	.047	.036	-.024	.060	-.049	.030
Std err	.117	.115	.117	.120	.119	.116	.122	.117	.116
Good 0 (All goods)									
Pass-through rate	.024	.040	-.020	-.007	-.011	.017	.028	-.033	.017
Std err	.043	.045	.045	.042	.045	.048	.040	.041	.045

Table 1.2k City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	Pitt. Calg.	Pitt. Edm.	Pitt. Mont.	Pitt. Otwa.	Pitt. Qubc.	Pitt. Reg.	Pitt. Tor.	Pitt. Van.	Pitt. Win.
Good 1									
Pass-through rate	.007	.042	-.057	-.377	-.124	-.129	-.139	-.237	-.070
Std err	.140	.138	.117	.125	.119	.118	.109	.107	.124
Good 2									
Pass-through rate	-.062	-.058	-.052	.018	-.007	-.158	.030	-.057	-.063
std err	.084	.092	.083	.084	.092	.108	.082	.103	.088
Good 3									
Pass-through rate	.076	.015	-.227	.051	-.241	-.210	.040	-.218	-.127
std err	.135	.129	.134	.138	.130	.119	.141	.104	.148
Good 4									
Pass-through rate	.049	.038	.025	.088	-.042	.047	.104	.173	.052
std err	.166	.167	.154	.162	.152	.163	.163	.179	.160
Good 5									
Pass-through rate	.384	.316	.314	.234	.342	.180	.251	.304	.235
std err	.251	.232	.176	.189	.188	.227	.186	.173	.180
Good 6									
Pass-through rate	.002	-.044	-.079	-.028	-.049	.031	.008	.011	-.093
std err	.114	.108	.113	.100	.114	.127	.107	.106	.119
Good 7									
Pass-through rate	.298	.367	.181	.269	.282	.224	.388	.427	.332
std err	.313	.300	.316	.309	.305	.334	.334	.300	.337
Good 8									
Pass-through rate	.097	.198	.167	.246	.169	.163	.207	.331	.162
std err	.575	.578	.574	.574	.575	.574	.576	.560	.573
Good 9									
Pass-through rate	-.385	-.302	-.474	-.345	-.554	-.556	-.275	-.271	-.365
std err	.229	.231	.245	.228	.223	.250	.232	.252	.234
Good 10									
Pass-through rate	.003	.127	-.020	.088	.099	.080	.037	-.140	.142
std err	.152	.159	.154	.150	.170	.174	.151	.152	.195
Good 11									
Pass-through rate	.030	.117	-.136	.072	.027	.015	-.027	.071	.223
std err	.570	.543	.455	.469	.427	.555	.488	.559	.549
Good 12									
Pass-through rate	-.085	.019	-.103	.014	.006	-.022	-.023	.147	.043
std err	.124	.147	.102	.123	.102	.285	.111	.119	.103
Good 13									
Pass-through rate	.132	.215	.075	.201	.212	.046	.102	.175	.141
std err	.172	.158	.185	.176	.177	.181	.169	.174	.170
Good 14									
Pass-through rate	.068	.103	.040	.082	.044	.079	.075	.080	.119
std err	.126	.122	.115	.114	.125	.123	.121	.126	.129
Good 0 (All goods)									
Pass-through rate	.056	.069	.035	.033	.043	.021	.077	.014	.077
std err	.068	.066	.067	.065	.066	.068	.069	.065	.069

Table 1.2l

City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	S.F. Calg.	S.F. Edm.	S.F. Mont.	S.F. Otwa.	S.F. Qubc.	S.F. Reg.	S.F. Tor.	S.F. Van.	S.F. Win.
Good 1									
Pass-through rate	.225	.260	.161	-.158	.095	.089	.080	-.019	.148
std err	.135	.143	.117	.116	.119	.120	.107	.101	.116
Good 2									
Pass-through rate	-.046	-.095	-.069	.043	-.040	-.156	.020	-.081	-.098
std err	.076	.072	.066	.085	.078	.094	.077	.082	.072
Good 3									
Pass-through rate	.026	-.031	-.305	-.041	-.338	-.316	-.061	-.287	-.205
std err	.124	.121	.131	.132	.135	.118	.133	.118	.130
Good 4									
Pass-through rate	-.056	-.089	-.098	-.054	-.164	-.069	-.051	.007	-.082
std err	.118	.122	.123	.124	.131	.124	.124	.118	.125
Good 5									
Pass-through rate	.606	.621	.548	.504	.589	.543	.555	.568	.533
std err	.368	.358	.288	.297	.285	.303	.305	.300	.316
Good 6									
Pass-through rate	.060	.025	-.033	-.014	.016	.052	.014	.077	-.040
std err	.111	.110	.109	.117	.114	.112	.106	.104	.105
Good 7									
Pass-through rate	-.144	-.080	-.219	-.156	-.124	-.162	-.063	.098	-.119
std err	.260	.264	.273	.258	.268	.274	.264	.257	.282
Good 8									
Pass-through rate	-.236	-.138	-.266	-.126	-.265	-.129	-.100	.002	-.263
std err	.428	.434	.430	.432	.439	.444	.430	.421	.433
Good 9									
Pass-through rate	-.052	.054	-.041	.037	-.085	-.078	.041	.067	.007
std err	.223	.233	.231	.218	.231	.252	.231	.242	.236
Good 10									
Pass-through rate	.033	.123	-.041	.078	.060	.126	.044	-.130	.181
std err	.132	.143	.120	.111	.129	.158	.126	.138	.151
Good 11									
Pass-through rate	-.026	.131	-.108	.013	.003	-.025	-.042	.038	.252
std err	.410	.381	.288	.310	.263	.392	.330	.390	.391
Good 12									
Pass-through rate	-.128	-.007	-.143	.000	-.014	-.154	-.073	.131	.018
std err	.102	.110	.085	.101	.081	.240	.089	.093	.079
Good 13									
Pass-through rate	-.002	.120	.005	.158	.046	-.034	.052	.144	.005
std err	.202	.167	.176	.170	.175	.169	.176	.170	.187
Good 14									
Pass-through rate	.053	.083	.061	.104	.056	.063	.084	.056	.095
std err	.140	.138	.142	.143	.149	.141	.145	.137	.139
Good 0 (All goods)									
Pass-through rate	.042	.048	-.030	-.008	-.029	.007	.037	-.011	.050
std err	.058	.061	.065	.055	.065	.066	.055	.052	.061

Table 1.2m City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	St.L. Calg.	St.L. Edm.	St.L. Mont.	St.L. Otwa.	St.L. Qubc.	St.L. Reg.	St.L. Tor.	St.L. Van.	St.L. Win.
Good 1									
Pass-through rate	.118	.154	.055	-.265	-.012	-.017	-.027	-.125	.042
std err	.124	.132	.117	.111	.119	.113	.101	.102	.117
Good 2									
Pass-through rate	-.104	.024	-.090	.043	.031	-.105	.071	-.183	-.033
std err	.111	.122	.103	.119	.109	.136	.119	.121	.110
Good 3									
Pass-through rate	-.098	-.209	-.474	-.456	-.530	-.419	-.455	-.464	-.426
std err	.231	.229	.220	.219	.213	.218	.217	.223	.223
Good 4									
Pass-through rate	-.097	-.137	-.111	-.075	-.171	-.103	-.035	-.040	-.107
std err	.149	.161	.158	.160	.157	.161	.157	.169	.169
Good 5									
Pass-through rate	.980	.830	.607	.586	.636	.626	.669	.509	.609
std err	.616	.571	.507	.522	.515	.493	.538	.530	.523
Good 6									
Pass-through rate	.112	.018	-.007	-.022	.009	-.028	.009	.058	-.009
std err	.134	.121	.127	.125	.136	.131	.124	.122	.133
Good 7									
Pass-through rate	-.817	-.720	-.658	-.737	-.735	-.806	-.752	-.618	-.780
std err	.432	.448	.414	.418	.425	.460	.426	.408	.450
Good 8									
Pass-through rate	-.627	-.532	-.369	-.338	-.648	-.494	-.305	-.390	-.585
std err	.529	.557	.532	.543	.533	.557	.551	.513	.538
Good 9									
Pass-through rate	.428	.489	.653	.448	.643	.510	.366	.352	.428
std err	.468	.468	.464	.465	.477	.471	.448	.475	.460
Good 10									
Pass-through rate	.147	.141	-.043	.093	.028	.225	.111	-.080	.014
std err	.168	.161	.165	.189	.169	.216	.221	.170	.200
Good 11									
Pass-through rate	-.478	-.405	-.301	-.440	-.284	-.517	-.370	-.531	-.412
std err	.640	.601	.515	.531	.476	.623	.545	.618	.618
Good 12									
Pass-through rate	.158	.091	.019	.120	.050	.054	.047	.052	.115
std err	.162	.180	.152	.177	.142	.325	.162	.169	.132
Good 13									
Pass-through rate	-.273	-.169	-.266	-.226	-.187	-.301	-.209	-.190	-.238
std err	.240	.233	.236	.247	.234	.238	.234	.224	.249
Good 14									
Pass-through rate	.069	.079	.142	.108	.149	.106	.162	.029	.052
std err	.141	.135	.147	.153	.144	.140	.149	.143	.135
Good 0 (All goods)									
Pass-through rate	.078	.076	.002	-.024	-.004	.023	.046	-.010	.013
std err	.074	.075	.082	.079	.080	.077	.074	.071	.083

Table 1.2n

City-pair specific and good specific pass-through rates

US City Can. City Eq. 1.13	D.C. Calg.	D.C. Edm.	D.C. Mont.	D.C. Otwa.	D.C. Qubc.	D.C. Reg.	D.C. Tor.	D.C. Van.	D.C. Win.
Good 1									
Pass-through rate	.151	.186	.087	-.233	.020	.015	.006	-.093	.074
std err	.137	.143	.119	.118	.123	.117	.104	.104	.124
Good 2									
Pass-through rate	-.071	.057	-.057	.077	.064	-.072	.104	-.149	.000
std err	.092	.099	.082	.099	.084	.122	.095	.107	.096
Good 3									
Pass-through rate	.168	.057	-.208	-.190	-.264	-.153	-.189	-.198	-.160
std err	.164	.168	.134	.137	.134	.138	.135	.151	.162
Good 4									
Pass-through rate	.047	.007	.033	.070	-.027	.041	.109	.104	.037
std err	.120	.118	.124	.119	.124	.116	.121	.121	.115
Good 5									
Pass-through rate	.572	.422	.199	.178	.227	.218	.261	.100	.201
std err	.398	.369	.283	.299	.293	.299	.304	.310	.307
Good 6									
Pass-through rate	.228	.133	.109	.094	.124	.087	.124	.173	.106
std err	.203	.194	.205	.197	.187	.203	.195	.200	.199
Good 7									
Pass-through rate	-.409	-.312	-.250	-.328	-.327	-.398	-.344	-.210	-.372
std err	.436	.444	.416	.426	.429	.460	.432	.399	.439
Good 8									
Pass-through rate	-.985	-.889	-.726	-.696	-1.005	-.852	-.663	-.748	-.943
std err	.827	.843	.847	.837	.833	.845	.832	.800	.847
Good 9									
Pass-through rate	-.285	-.224	-.026	-.285	-.050	-.265	-.349	-.354	-.273
std err	.343	.348	.349	.346	.374	.348	.345	.337	.335
Good 10									
Pass-through rate	.151	.145	-.039	.097	.032	.229	.115	-.076	.018
std err	.147	.139	.132	.160	.131	.184	.194	.135	.177
Good 11									
Pass-through rate	.034	.107	.212	.072	.228	-.005	.143	-.019	.100
std err	.547	.511	.392	.407	.350	.532	.441	.522	.527
Good 12									
Pass-through rate	.214	.146	.075	.176	.106	.110	.103	.108	.170
std err	.145	.153	.130	.149	.124	.340	.137	.141	.109
Good 13									
Pass-through rate	.130	.233	.137	.176	.216	.101	.194	.213	.164
std err	.171	.159	.178	.175	.168	.168	.178	.161	.162
Good 14									
Pass-through rate	.160	.170	.233	.199	.240	.196	.253	.120	.143
std err	.155	.156	.154	.174	.166	.162	.166	.167	.156
Good 0 (All goods)									
Pass-through rate	.101	.099	.025	.000	.020	.046	.070	.014	.037
std err	.070	.071	.071	.066	.071	.067	.069	.059	.070

Table 1.3a

Equation 1.14

	Good 1	Good 2	Good 3
	US: Food at Home Can: Food from stores	US: Food away from home Can: Food from restaurants	US: Alcoholic Beverages Can: Alcoholic Beverages
Bdist	.000015*** (0.00000475)	0.00000465 (0.00000509)	0.00000616 (0.00000678)
Bbp	1.539*** (0.0362)	1.485*** (0.0368)	1.938*** (0.0468)
t-stat (Bbp=1)	14.86	13.2	20.04
R-squared	0.9547	0.9151	0.9544
Proportion of the border effect due to incomplete pass-through	**0.65**	**0.67**	**0.52**
Mean border effect (mi.)	**30**	**1301**	**10701**

	Good 4	Good 5
	US: Shelter Can: Shelter -.2135(Good 5)	US: Fuel and other utilities Can: Water, fuel and elec.
Bdist	0.000016** (0.00000758)	0.0002404*** (0.0000687)
Bbp	1.352*** (0.0675)	5.430*** (0.716)
t-stat (Bbp=1)	5.22	6.19
R-squared	0.8644	0.5922
Proportion of the border effect due to incomplete pass-through	**0.74**	**0.18**
Mean border effect (mi.)	**273**	**129**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies are included but not reported.

Table 1.3b

Equation 1.14	Good 6 US: Household Furn. & Op. Can: Housing exc. shelter	Good 7 US: Men's and Boy's Apparel Can: .8058(Men)+.1942(Boy)	Good 8 US: Women's and Girl's App. Can: .8355(Wom.)+.1645(Girl)
Bdist	0.000011** (0.00000518)	0.0000803*** (0.000025)	0.0002955** (0.0001479)
Bbp	1.250*** (0.036)	3.365*** (0.309)	11.94*** (1.28)
t-stat (Bbp=1)	6.95	7.66	8.55
R-squared	0.953	0.9185	0.8655
Proportion of the border effect due to incomplete pass-through	**0.8**	**0.3**	**0.08**
Mean border effect (mi.)	**230**	**1043**	**63190**

	Good 9 US: Footwear Can: Footwear	Good 10 US: Private Transportation Can: Private Transportation
Bdist	0.0000211 (0.0000356)	0.0000107* (0.00000564)
Bbp	1.097*** (0.293)	2.106*** (0.0434)
t-stat (Bbp=1)	0.33	25.47
R-squared	0.914	0.9459
Proportion of the border effect due to incomplete pass-through	**0.91**	**0.47**
Mean border effect (mi.)	**62**	**9030**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies are included but not reported.

Table 1.3c

Equation 1.14	Good 11 US: Public Transportation Can: Public Transportation	Good 12 US: Medical Care Can: Medical Care
Bdist	0.0001848*** (0.000053)	0.0000123 (0.0000101)
Bbp	12.269*** (0.413)	1.970*** (0.081)
t-stat (Bbp=1)	26.33	11.98
R-squared	0.9194	0.9317
Proportion of the border effect due to incomplete pass-through	**0.08**	**0.51**
Mean border effect (mi.)	**94871313**	**6324**

	Good 13 US: Personal Care Can: Personal Care	Good 14 US: Entertainment Can: .8567(Rec.)+.1433(Rd.)
Bdist	0.00000774 (0.0000106)	0.00000766 (0.00000547)
Bbp	1.420*** (0.0764)	1.274*** (0.0423)
t-stat (Bbp=1)	5.5	6.46
R-squared	0.915	0.9365
Proportion of the border effect due to incomplete pass-through	**0.7**	**0.79**
Mean border effect (mi.)	**407**	**232**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies are included but not reported.

Table 1.4a

Equation 1.17	Good 1 US: Food at Home Can: Food from stores	Good 2 US: Food away from home Can: Food from restaurants	Good 3 US: Alcoholic Beverages Can: Alcoholic Beverages
Bdist	.0000166*** (0.00000504)	0.00000607 (0.00000549)	0.0000121 (0.00000876)
Bbp	1.34568*** (0.0429578)	1.352333*** (0.0391823)	1.332464*** (0.0448949)
t-stat (Bbp=1)	8.05	8.99	7.41
R-squared	0.9464	0.9025	0.9322
Proportion of the border effect due to incomplete pass-through.	**0.74**	**0.74**	**0.75**
Mean border effect (mi.)	**16.3609**	**374.938**	**868.576**

	Good 4 US: Shelter Can: Shelter -.2135(Good 5)	Good 5 US: Fuel and other utilities Can: Water, fuel and elec.
Bdist	0.000016** (0.00000771)	.000263*** (0.000068)
Bbp	1.251469*** (0.0628414)	4.386963*** (0.6720885)
t-stat (Bbp=1)	4.00	5.04
R-squared	0.8636	0.5755
Percentage of the border effect due to incomplete pass-through.	**0.80**	**0.23**
Mean border effect (mi.)	**121.611**	**39.4216**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. City Dummies are included but not reported.

Table 1.4b

Equation 1.17	Good 6 US: Household Furn. & Op. Can: Housing exc. shelter	Good 7 US: Men's and Boy's Apparel Can: .8058(Men)+.1942(Boy)	Good 8 US: Women's and Girl's App. Can: .8355(Wom.)+.1645(Girl)
Bdist	0.0000111** (0.00000525)	0.0001065*** (0.0000261)	0.0003762*** (0.000144)
Bbp	1.162663*** (0.0359905)	1.747481*** (0.2887933)	3.835406*** (0.5588103)
t-stat (Bbp=1)	4.52	2.59	5.07
R-squared	0.9502	0.9023	0.8439
Proportion of the border effect due to incomplete pass-through.	**0.86**	**0.57**	**0.26**
Mean border effect (mi.)	**100.643**	**40.968**	**147.79**

	Good 9 US: Footwear Can: Footwear	Good 10 US: Private Transportation Can: Private Transportation
Bdist	0.0000226 (0.0000352)	0.0000131** (0.0000061)
Bbp	.8617368*** (0.220167)	1.910693*** (0.0480232)
t-stat (Bbp=1)	-0.63	18.97
R-squared	0.9151	0.9352
Percentage of the border effect due to incomplete pass-through.	**1.16**	**0.52**
Mean border effect (mi.)	**35.5365**	**1831.76**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. City Dummies are included but not reported.

Table 1.4c

Equation 1.17	Good 11 US: Public Transportation Can: Public Transportation	Good 12 US: Medical Care Can: Medical Care
Bdist	0.0002702*** (0.000071)	0.0000161 (0.0000102)
Bbp	6.862152*** (0.376003)	1.670908*** (0.0697443)
t-stat (Bbp=1)	15.59	9.62
R-squared	0.8421	0.9287
Proportion of the Border effect due to incomplete pass-through.	**0.15**	**0.60**
Mean border effect (mi.)	**21395.1**	**137.475**

	Good 13 US: Personal Care Can: Personal Care	Good 14 US: Entertainment Can: .8567(Rec.)+.1433(Rd.)
Bdist	0.0000103 (0.00000942)	0.00000862 (0.00000558)
Bbp	1.168995*** (0.066703)	1.216829*** (0.0414415)
t-stat (Bbp=1)	2.53	5.23
R-squared	0.9149	0.9332
Percentage of the border effect due to incomplete pass-through.	**0.86**	**0.82**
Mean border effect (mi.)	**111.047**	**98.6393**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. City Dummies are included but not reported.

Table 1.5a

Equation 1.19	Good 1		Good 2		Good 3	
	US: Food at Home Can: Food from stores		US: Food away from home Can: Food from restaurants		US: Alcoholic Beverages Can: Alcoholic Beverages	
	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20
Bdist	0.0000143**	0.0000142**	0.00000757	0.0000119	0.00000891	0.000011
	(0.00000454)	(0.00000439)	(0.0000054)	(0.0000075)	(0.00000797)	(0.0000105)
Bbord	0.0000531**	0.0001456**	0.0000817**	0.0002595**	0.0001601**	0.0003354**
	(0.00000325)	(0.00000312)	(0.00000698)	(0.00000909)	(0.00000891)	(0.0000115)
Proportion of the border effect due to incomplete pass-through	**0.64**		**0.69**		**0.52**	
Mean border effect (mi.)	**4**	**37**	**10**	**762**	**82**	**5866**

	Good 4		Good 5	
	US: Shelter Can: Shelter -.2135(Good 5)		US: Fuel and other utilities Can: Water, fuel and elec.	
	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20
Bdist	0.000018**	0.0000212**	0.0002016**	0.0002015**
	(0.00000756)	(0.0000092)	(0.0000657)	(0.0000663)
Bbord	0.0000545**	0.0002245**	0.0007911**	0.0009209**
	(0.0000108)	(0.0000123)	(0.0000879)	(0.0000882)
Proportion of the border effect due to incomplete pass-through	**0.76**		**0.14**	
Mean border effect (mi.)	**4**	**169**	**388**	**970**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * or **. City dummies are included but not reported. The mean border effect is computed using the Bbord estimate and the average of the good specific distance effect and the average distance effect of all goods. The proportion of the border effect is calculated as the Bbord of Eq. 1.19 divided by the Bbord of Eq. 1.20.

Table 1.5b

Equation 1.19	Good 6 US: Household Furn. & Op. Can: Housing exc. shelter		Good 7 US: Men's and Boy's Apparel Can: .8058(Men)+.1942(Boy)		Good 8 US: Women's and Girl's App. Can: .8355(Wom.)+.1645(Girl)	
	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20
Bdist	0.0000115**	0.0000155**	0.0000858**	0.0000898**	0.0003486**	0.0003525**
	(0.00000531)	(0.0000068)	(0.0000264)	(0.0000277)	(0.0001639)	(0.0001658)
Bbord	0.0000451**	0.0002134**	0.0003625**	0.0005061**	0.0016191**	0.0017723**
	(0.00000592)	(0.00000722)	(0.000035)	(0.0000363)	(0.0001869)	(0.0001886)
Proportion of the border effect due to incomplete pass-through	**0.79**		**0.28**		**0.09**	
Mean border effect (mi.)	**3**	**184**	**127**	**654**	**2569**	**4735**

	Good 9 US: Footwear Can: Footwear		Good 10 US: Private Transportation Can: Private Transportation	
	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20
Bdist	0.0000269	0.0000306	0.0000138**	0.0000178*
	(0.0000355)	(0.0000358)	(0.00000668)	(0.00000921)
Bbord	-0.0000145	0.0001477**	0.0001919**	0.0003586**
	(0.0000513)	(0.0000523)	(0.00000844)	(0.0000103)
Proportion of the border effect due to incomplete pass-through	**0**		**0.46**	
Mean border effect (mi.)	**1**	**21**	**141**	**5050**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * or **. City dummies are included but not reported. The mean border effect is computed using the Bbord estimate and the average of the good specific distance effect and the average distance effect of all goods. The proportion of the border effect is calculated as the Bbord of Eq. 1.19 divided by the Bbord of Eq. 1.20.

Table 1.5c

Equation 1.19	Good 11 US: Public Transportation Can: Public Transportation		Good 12 US: Medical Care Can: Medical Care	
	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20
Bdist	0.0002217** (0.00007)	0.0002242** (0.0000725)	0.0000159 (0.0000111)	0.0000185 (0.0000131)
Bbord	0.0019167** (0.0000863)	0.002091** (0.0000888)	0.0001645** (0.0000153)	0.0003394** (0.0000169)
Proportion of the border effect due to incomplete pass-through	**0.08**		**0.52**	
Mean border effect (mi.)	**677103**	**1784014**	**62**	**2993**

	Good 13 US: Personal Care Can: Personal Care		Good 14 US: Entertainment Can: .8567(Rec.)+.1433(Rd.)	
	Equation 1.19	Equation 1.20	Equation 1.19	Equation 1.20
Bdist	0.0000102 (0.000011)	0.000013 (0.0000121)	0.00000744 (0.00000548)	0.00000946 (0.00000696)
Bbord	0.0000595** (0.0000113)	0.0002181** (0.0000126)	0.0000479** (0.00000629)	0.0002075** (0.00000758)
Proportion of the border effect due to incomplete pass-through	**0.73**		**0.77**	
Mean border effect (mi.)	**5**	**245**	**4**	**239**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * or **. City dummies are included but not reported. The mean border effect is computed using the Bbord estimate and the average of the good specific distance effect and the average distance effect of all goods. The proportion of the border effect is calculated as the Bbord of Eq. 1.19 divided by the Bbord of Eq. 1.20.

Table 1.6a

Equation 1.21	Good 1 US: Food at Home Can: Food from stores		Good 2 US: Food away from home Can: Food from restaurants		Good 3 US: Alcoholic Beverages Can: Alcoholic Beverages	
	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22
Bdist	0.0000128**	0.0000128**	0.00000437	0.0000065	0.00000917	0.0000113
	(0.00000341)	(0.00000334)	(0.00000505)	(0.0000065)	(0.00000588)	(0.000081)
Bbord	0.0000343**	0.000129**	0.000053**	0.000211**	0.0000655**	0.000214**
	(0.00000791)	(0.00000776)	(0.00000637)	(0.00000852)	(0.0000085)	(0.0000119)
Proportion of the border effect due to incomplete pass-through	**.73**		**0.75**		**0.69**	
Mean border effect (mi.)	**3**	**52**	**7**	**1323**	**8**	**829**

	Good 4 US: Shelter Can: Shelter -.2135(Good 5)		Good 5 US: Fuel and other utilities Can: Water, fuel and elec.	
	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22
Bdist	0.0000729	0.00000942	0.000132**	0.00013**
	(0.00000456)	(0.0000059)	(0.0000632)	(0.0000636)
Bbord	0.00000829	0.000174**	0.000461**	0.000585**
	(0.0000072)	(0.0000825)	(0.0000869)	(0.0000871)
Proportion of the border effect due to incomplete pass-through	**0.95**		**0.21**	
Mean border effect (mi.)	**1**	**283**	**150**	**605**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * or **. City dummies are included but not reported. The mean border effect is computed using the Bbord estimate and the average of the good specific distance effect and the average distance effect of all goods. The proportion of the border effect is calculated as the Bbord of Eq. 1.21 divided by the Bbord of Eq. 1.22.

Table 1.6b

Equation 1.21

	Good 6		Good 7		Good 8	
	US: Household Furn. & Op.		US: Men's and Boy's Apparel		US: Women's and Girl's App.	
	Can: Housing exc. shelter		Can: .8058(Men)+.1942(Boy)		Can: .8355(Wom.)+.1645(Girl)	
	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22
Bdist	0.000009* (0.0000051)	0.0000113* (0.0000064)	0.0000801** (0.0000246)	0.0000838** (0.000026)	0.000217 (0.000143)	0.000219 (0.000146)
Bbord	0.0000403** (0.00000687)	0.000205** (0.00000848)	0.000348** (0.000029)	0.000491** (0.0000304)	0.001273** (0.000155)	0.001423** (0.000156)
Proportion of the border effect due to incomplete pass-through	**0.80**		**0.29**		**0.11**	
Mean border effect (mi.)	**4**	**633**	**193**	**1358**	**12897**	**35497**

	Good 9		Good 10	
	US: Footwear		US: Private Transportation	
	Can: Footwear		Can: Private Transportation	
	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22
Bdist	0.0000087 (0.0000366)	0.0000119 (0.0000338)	0.00000659 (0.00000439)	0.00000683 (0.00000498)
Bbord	-0.000051 (0.0000512)	0.00011** (0.0000519)	0.000102** (0.00000812)	0.000221** (0.0000107)
Proportion of the border effect due to incomplete pass-through	**1**		**0.54**	
Mean border effect (mi.)	**0**	**31**	**32**	**1802**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * or **. City dummies are included but not reported. The mean border effect is computed using the Bbord estimate and the average of the good specific distance effect and the average distance effect of all goods. The proportion of the border effect is calculated as the Bbord of Eq. 1.21 divided by the Bbord of Eq. 1.22.

Table 1.6c

Equation 1.21	Good 11 US: Public Transportation Can: Public Transportation		Good 12 US: Medical Care Can: Medical Care	
	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22
Bdist	0.000212** (0.0000577)	0.000214** (0.000059)	0.0000091 (0.0000046)	0.0000013 (0.000007)
Bbord	0.001445** (0.0000762)	0.001597** (0.000079)	0.0000972** (0.00000672)	0.000267** (0.0000087)
Proportion of the border effect due to incomplete pass-through	**0.10**		**.64**	
Mean border effect (mi.)	**55490**	**160166**	**24**	**21203**

	Good 13 US: Personal Care Can: Personal Care		Good 14 US: Entertainment Can: .8567(Rec.)+.1433(Rd.)	
	Equation 1.21	Equation 1.22	Equation 1.21	Equation 1.22
Bdist	0.00000170 (0.00000823)	0.00000334 (0.00000884)	0.0000068 (0.00000441)	0.0000087 (0.00000579)
Bbord	0.0000386** (0.0000109)	0.000194** (0.0000113)	0.0000441** (0.00000586)	0.000203** (0.0000069)
Proportion of the border effect due to incomplete pass-through	**0.80**		**0.78**	
Mean border effect (mi.)	**4**	**1092**	**4**	**783**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * or **. City dummies are included but not reported. The mean border effect is computed using the Bbord estimate and the average of the good specific distance effect and the average distance effect of all goods. The proportion of the border effect is calculated as the Bbord of Eq. 1.21 divided by the Bbord of Eq. 1.22.

Table 1.7

	Average of ALL pass-through estimates	Std. Dev. of ALL pass-through estimates	% of significant estimates	Average of significant pass-through estimates	Std. Dev. of significant pass-through estimates
Good 1	0.054	0.115	40.5%	0.041	0.164
Good 2	-0.016	0.069	22.2%	-0.028	0.105
Good 3	-0.085	0.121	61.1%	-0.132	0.121
Good 4	-0.014	0.078	24.6%	0.018	0.126
Good 5	0.143	0.238	71.4%	0.189	0.261
Good 6	-0.015	0.070	24.6%	-0.014	0.052
Good 7	0.055	0.261	74.6%	0.050	0.300
Good 8	-0.014	0.499	87.3%	-0.017	0.533
Good 9	0.040	0.225	75.4%	0.052	0.251
Good 10	0.032	0.088	25.4%	-0.022	0.129
Good 11	-0.038	0.181	44.4%	-0.005	0.118
Good 12	-0.061	0.096	44.4%	-0.106	0.103
Good 13	0.018	0.119	46.8%	0.004	0.156
Good 14	0.013	0.077	29.4%	0.027	0.123

Note: As the standard errors of the regression in Eq. 1.13 are not robust to heteroskedasticity there is the potential for incorrect measurement of significance of the pass-through estimates. In total only 83.4% of the pass-through estimates have homoskedastic errors based on a 5% confidence interval.

Table 1.8a

Goods and commodities	Goods and commodities
Food	**Food**
White bread, 1 kg (supermarket)	Beef: filet mignon (1 kg) (supermarket)
White bread, 1 kg (mid-priced store)	Beef: filet mignon (1 kg) (mid-priced store)
Butter, 500 g (supermarket)	Beef: steak, entrecote (1 kg) (supermarket)
Butter, 500 g (mid-priced store)	Beef: steak, entrecote (1 kg) (mid-priced store)
Margarine, 500 g (supermarket)	Beef: stewing, shoulder (1 kg) (supermarket)
Margarine, 500 g (mid-priced store)	Beef: stewing, shoulder (1 kg) (mid-priced store)
White rice, 1 kg (supermarket)	Beef: roast (1 kg) (supermarket)
White rice, 1 kg (mid-priced store)	Beef: roast (1 kg) (mid-priced store)
Spaghetti (1 kg) (supermarket)	Beef: ground or minced (1 kg) (supermarket)
Spaghetti (1 kg) (mid-priced store)	Beef: ground or minced (1 kg) (mid-priced store)
Flour, white (1 kg) (supermarket)	Veal: chops (1 kg) (supermarket)
Flour, white (1 kg) (mid-priced store)	Veal: chops (1 kg) (mid-priced store)
Sugar, white (1 kg) (supermarket)	Veal: fillet (1 kg) (supermarket)
Sugar, white (1 kg) (mid-priced store)	Veal: fillet (1 kg) (mid-priced store)
Cheese, imported (500 g) (supermarket)	Veal: roast (1 kg) (supermarket)
Cheese, imported (500 g) (mid-priced store)	Veal: roast (1 kg) (mid-priced store)
Cornflakes (375 g) (supermarket)	Lamb: leg (1 kg) (supermarket)
Cornflakes (375 g) (mid-priced store)	Lamb: leg (1 kg) (mid-priced store)
Yoghurt, natural (150 g) (supermarket)	Lamb: chops (1 kg) (supermarket)
Yoghurt, natural (150 g) (mid-priced store)	Lamb: chops (1 kg) (mid-priced store)
Milk, pasteurised (1 l) (supermarket)	Lamb: stewing (1 kg) (supermarket)
Milk, pasteurised (1 l) (mid-priced store)	Lamb: stewing (1 kg) (mid-priced store)
Olive oil (1 l) (supermarket)	Pork: chops (1 kg) (supermarket)
Olive oil (1 l) (mid-priced store)	Pork: chops (1 kg) (mid-priced store)
Peanut or corn oil (1 l) (supermarket)	Pork: loin (1 kg) (supermarket)
Peanut or corn oil (1 l) (mid-priced store)	Pork: loin (1 kg) (mid-priced store)
Potatoes (2 kg) (supermarket)	Ham: whole (1 kg) (supermarket)
Potatoes (2 kg) (mid-priced store)	Ham: whole (1 kg) (mid-priced store)
Onions (1 kg) (supermarket)	Bacon (1 kg) (supermarket)
Onions (1 kg) (mid-priced store)	Bacon (1 kg) (mid-priced store)
Mushrooms (1 kg) (supermarket)	Chicken: frozen (1 kg) (supermarket)
Mushrooms (1 kg) (mid-priced store)	Chicken: frozen (1 kg) (mid-priced store)
Tomatoes (1 kg) (supermarket)	Chicken: fresh (1 kg) (supermarket)
Tomatoes (1 kg) (mid-priced store)	Chicken: fresh (1 kg) (mid-priced store)
Carrots (1 kg) (supermarket)	Frozen fish fingers (1 kg) (supermarket)
Carrots (1 kg) (mid-priced store)	Frozen fish fingers (1 kg) (mid-priced store)
Oranges (1 kg) (supermarket)	Fresh fish (1 kg) (supermarket)
Oranges (1 kg) (mid-priced store)	Fresh fish (1 kg) (mid-priced store)

Table 1.8b

Goods and commodities	Goods and commodities
Food	**Clothing**
Apples (1 kg) (supermarket)	Business suit, two piece, medium weight (chain store)
Apples (1 kg) (mid-priced store)	Business suit, two piece, medium weight (mid-priced)
Lemons (1 kg) (supermarket)	Business shirt, white (chain store)
Lemons (1 kg) (mid-priced store)	Business shirt, white (mid-priced/branded store)
Bananas (1 kg) (supermarket)	Men's shoes, business wear (chain store)
Bananas (1 kg) (mid-priced store)	Men's shoes, business wear (mid-priced/branded store)
Lettuce (one) (supermarket)	Men's raincoat, Burberry type (chain store)
Lettuce (one) (mid-priced store)	Men's raincoat, Burberry type (mid-priced/branded store)
Eggs (12) (supermarket)	Socks, wool mixture (chain store)
Eggs (12) (mid-priced store)	Socks, wool mixture (mid-priced/branded store)
Peas, canned (250 g) (supermarket)	Dress, ready to wear, daytime (chain store)
Peas, canned (250 g) (mid-priced store)	Dress, ready to wear, daytime (mid-priced/branded store)
Tomatoes, canned (250 g) (supermarket)	Women's shoes, town (chain store)
Tomatoes, canned (250 g) (mid-priced store)	Women's shoes, town (mid-priced/branded store)
Peaches, canned (500 g) (supermarket)	Women's cardigan sweater (chain store)
Peaches, canned (500 g) (mid-priced store)	Women's cardigan sweater (mid-priced/branded store)
Sliced pineapples, canned (500 g) (supermarket)	Women's raincoat, Burberry type (chain store)
Sliced pineapples, canned (500 g) (mid-priced store)	Women's raincoat, Burberry type (mid-priced store)
Instant coffee (125 g) (supermarket)	Tights, panty hose (chain store)
Instant coffee (125 g) (mid-priced store)	Tights, panty hose (mid-priced/branded store)
Ground coffee (500 g) (supermarket)	Child's jeans (chain store)
Ground coffee (500 g) (mid-priced store)	Child's jeans (mid-priced/branded store)
Tea bags (25 bags) (supermarket)	Child's shoes, dresswear (chain store)
Tea bags (25 bags) (mid-priced store)	Child's shoes, dresswear (mid-priced/branded store)
Cocoa (250 g) (supermarket)	Child's shoes, sportswear (chain store)
Cocoa (250 g) (mid-priced store)	Child's shoes, sportswear (mid-priced/branded store)
Drinking chocolate (500 g) (supermarket)	Girl's dress (chain store)
Drinking chocolate (500 g) (mid-priced store)	Girl's dress (mid-priced/branded store)
Coca-Cola (1 l) (supermarket)	Boy's jacket, smart (chain store)
Coca-Cola (1 l) (mid-priced store)	Boy's jacket, smart (mid-priced/branded store)
Tonic water (200 ml) (supermarket)	Boy's dress trousers (chain store)
Tonic water (200 ml) (mid-priced store)	Boy's dress trousers (mid-priced/branded store)
Mineral water (1 l) (supermarket)	**Tobacco**
Mineral water (1 l) (mid-priced store)	Cigarettes, Marlboro (pack of 20) (supermarket)
Orange juice (1 l) (supermarket)	Cigarettes, Marlboro (pack of 20) (mid-priced store)
Orange juice (1 l) (mid-priced store)	Cigarettes, local brand (pack of 20) (supermarket)
	Cigarettes, local brand (pack of 20) (mid-priced store)
	Pipe tobacco (50 g) (average)

Table 1.8c

Goods and commodities	Goods and commodities
Alcohol	**Household Supplies**
Wine, common table (1 l) (supermarket)	Soap (100 g) (supermarket)
Wine, common table (1 l) (mid-priced store)	Soap (100 g) (mid-priced store)
Wine, superior quality (700 ml) (supermarket)	Laundry detergent (3 l) (supermarket)
Wine, superior quality (700 ml) (mid-priced store)	Laundry detergent (3 l) (mid-priced store)
Wine, fine quality (700 ml) (supermarket)	Toilet tissue (two rolls) (supermarket)
Wine, fine quality (700 ml) (mid-priced store)	Toilet tissue (two rolls) (mid-priced store)
Beer, local brand (1 l) (supermarket)	Dishwashing liquid (750 ml) (supermarket)
Beer, local brand (1 l) (mid-priced store)	Dishwashing liquid (750 ml) (mid-priced store)
Beer, top quality (330 ml) (supermarket)	Insect-killer spray (330 g) (supermarket)
Beer, top quality (330 ml) (mid-priced store)	Insect-killer spray (330 g) (mid-priced store)
Scotch whisky, six years old (700 ml) (supermarket)	Light bulbs (two, 60 watts) (supermarket)
Scotch whisky, six years old (700 ml) (mid-priced store)	Light bulbs (two, 60 watts) (mid-priced store)
Gin, Gilbey's or equivalent (700 ml) (supermarket)	Batteries (two, size D/LR20) (supermarket)
Gin, Gilbey's or equivalent (700 ml) (mid-priced store)	Batteries (two, size D/LR20) (mid-priced store)
Vermouth, Martini & Rossi (1 l) (supermarket)	Frying pan (Teflon or good equivalent) (supermarket)
Vermouth, Martini & Rossi (1 l) (mid-priced store)	Frying pan (Teflon or good equivalent) (mid-priced)
Cognac, French VSOP (700 ml) (supermarket)	Electric toaster (for two slices) (supermarket)
Cognac, French VSOP (700 ml) (mid-priced store)	Electric toaster (for two slices) (mid-priced store)
Liqueur, Cointreau (700 ml) (supermarket)	Laundry (one shirt) (standard high-street outlet)
Liqueur, Cointreau (700 ml) (mid-priced store)	Laundry (one shirt) (mid-priced outlet)
Personal Care	Dry cleaning, man's suit (standard high-street outlet)
Aspirins (100 tablets) (supermarket)	Dry cleaning, man's suit (mid-priced outlet)
Aspirins (100 tablets) (mid-priced store)	Dry cleaning, woman's dress (standard high-street)
Razor blades (five pieces) (supermarket)	Dry cleaning, woman's dress (mid-priced outlet)
Razor blades (five pieces) (mid-priced store)	Dry cleaning, trousers (standard high-street outlet)
Toothpaste with fluoride (120 g) (supermarket)	Dry cleaning, trousers (mid-priced outlet)
Toothpaste with fluoride (120 g) (mid-priced store)	**Recreation**
Facial tissues (box of 100) (supermarket)	Compact disc album (average)
Facial tissues (box of 100) (mid-priced store)	Television, colour (66 cm) (average)
Hand lotion (125 ml) (supermarket)	Kodak colour film (36 exposures) (average)
Hand lotion (125 ml) (mid-priced store)	Cost of developing 36 colour pictures (average)
Shampoo & conditioner in one (400 ml) (supermarket)	International foreign daily newspaper (average)
Shampoo & conditioner in one (400 ml) (mid-priced)	Daily local newspaper (average)
Lipstick (deluxe type) (supermarket)	International weekly news magazine (Time) (average)
Lipstick (deluxe type) (mid-priced store)	Paperback novel (at bookstore) (average)
Man's haircut (tips included) (average)	Three-course dinner for four people (average)
Woman's cut & blow dry (tips included) (average)	Personal computer (64 MB) (average)
	Four best seats at theatre or concert (average)
	Four best seats at cinema (average)

Table 1.9

Equation 1.24	Food	Alcohol	Household Sup.	Recreation
Bdist	-9.26E-07 (7.75E-07)	2.30E-07 (4.53E-07)	-3.17E-07 (6.51E-07)	-2.77E-07 (0.00000204
Bbp	3.891*** (0.544)	1.759*** (0.348)	2.968*** (0.428)	4.405*** (1.427)
t-stat (Bbp=1)	5.31	2.18	4.6	2.39
R-squared	0.6519	0.6152	0.7154	0.4896
Proportion of the border effect due to incomplete pass-through	**0.26**	**0.57**	**0.34**	**0.23**
Mean border effect (mi.)	**N/A**	**e^23668**	**N/A**	**N/A**

	Personal Care	Tobacco	Clothing
Bdist	1.30E-07 (7.93E-07)	1.07E-07 (7.14E-07)	-3.79E-07 (5.61E-07)
Bbp	1.729*** (0.564)	9.098*** (0.889)	2.398*** (0.633)
t-stat (Bbp=1)	1.29	9.11	2.21
R-squared	0.6717	0.8915	0.6408
Proportion of the border effect due to incomplete pass-through	**0.58**	**0.11**	**0.42**
Mean border effect (mi.)	**e^41230**	**N/A**	**N/A**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the Bdist of the good in question; if Bdist is negative the calculation can not be made. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies and Good Dummies are included but not reported.

Figure 1.1a

Distribution of $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$

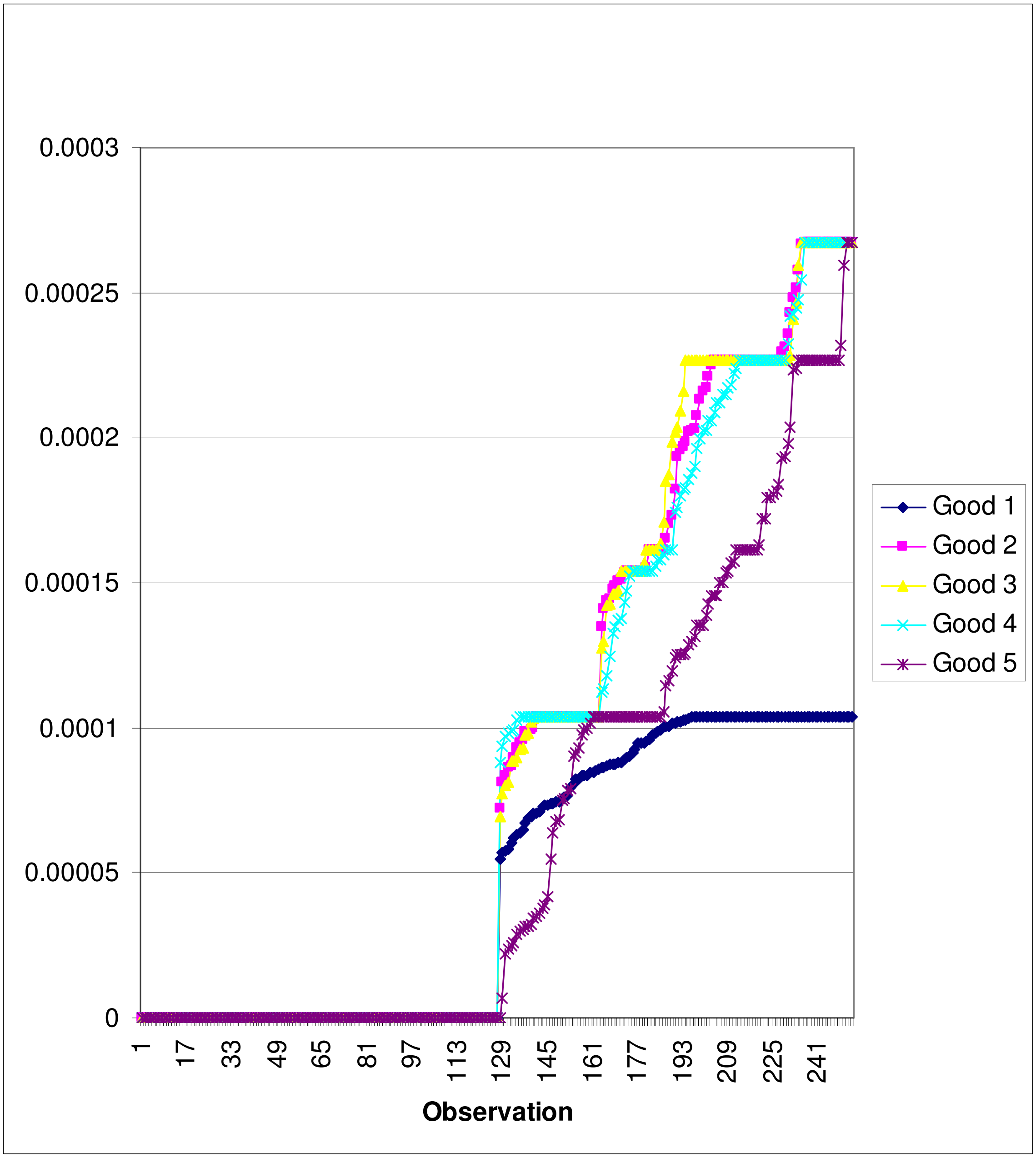


Figure 1.1b

Distribution of $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$

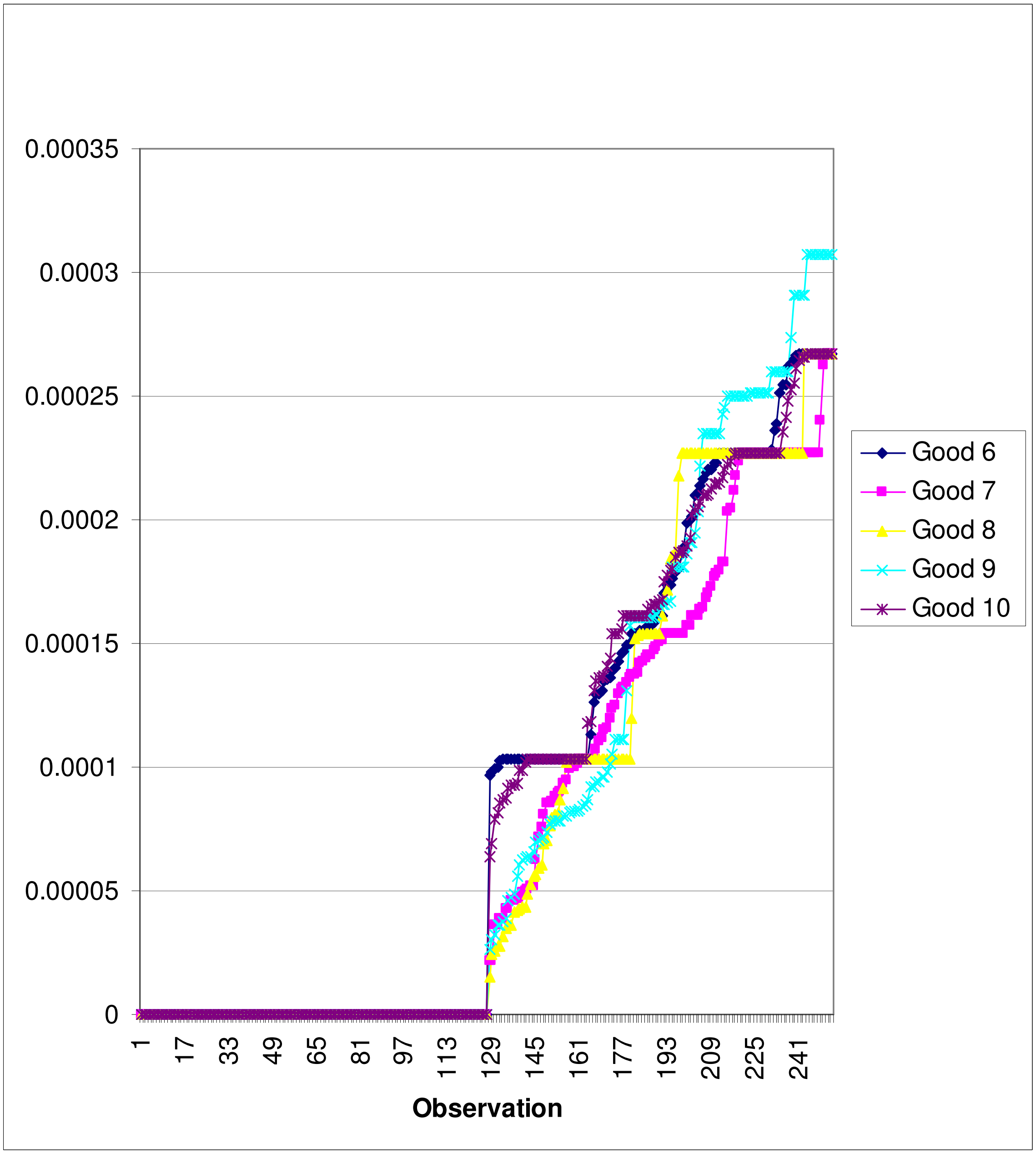


Figure 1.1c

Distribution of $I_{bord,ij}(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$

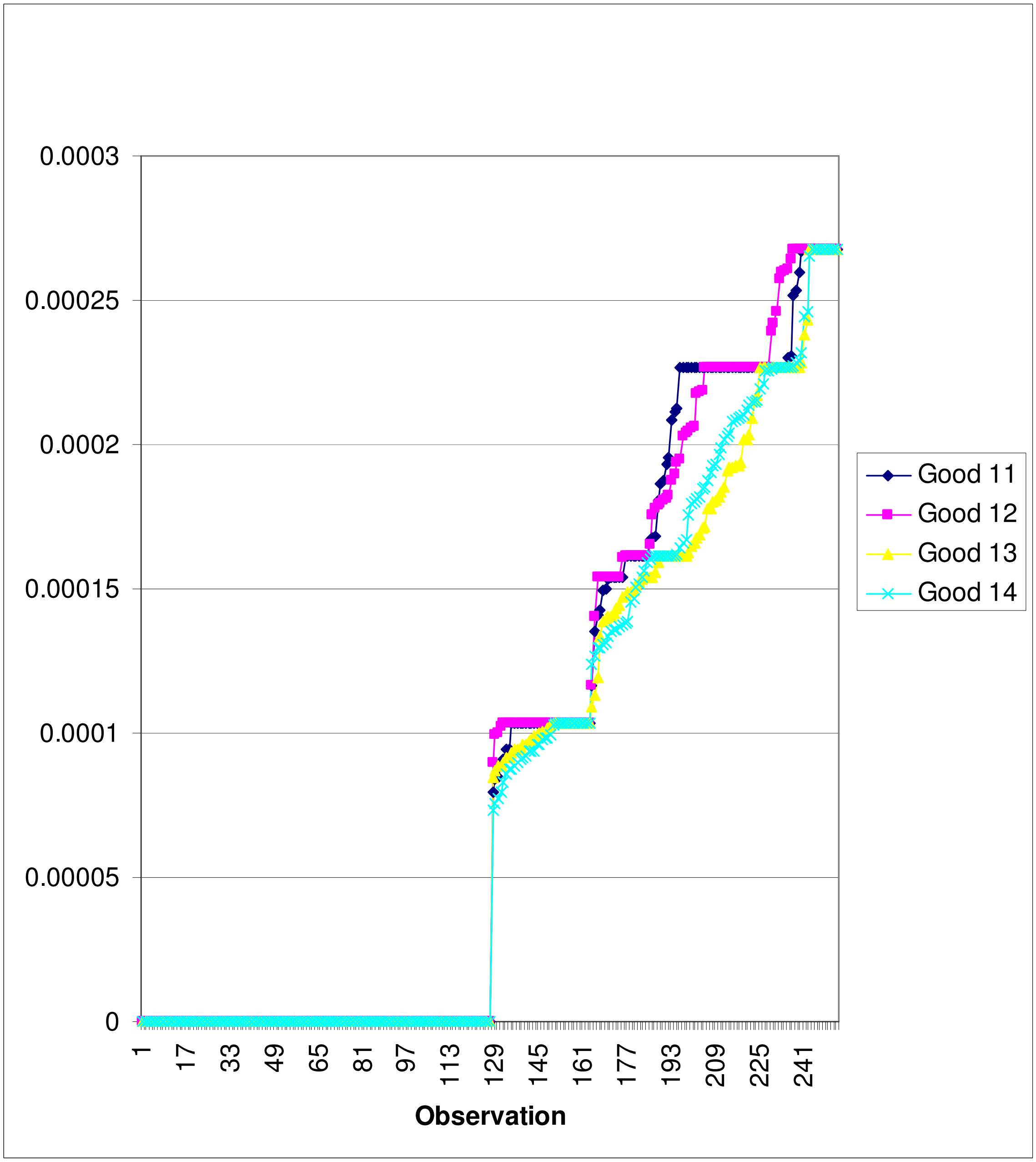


Figure 1.2

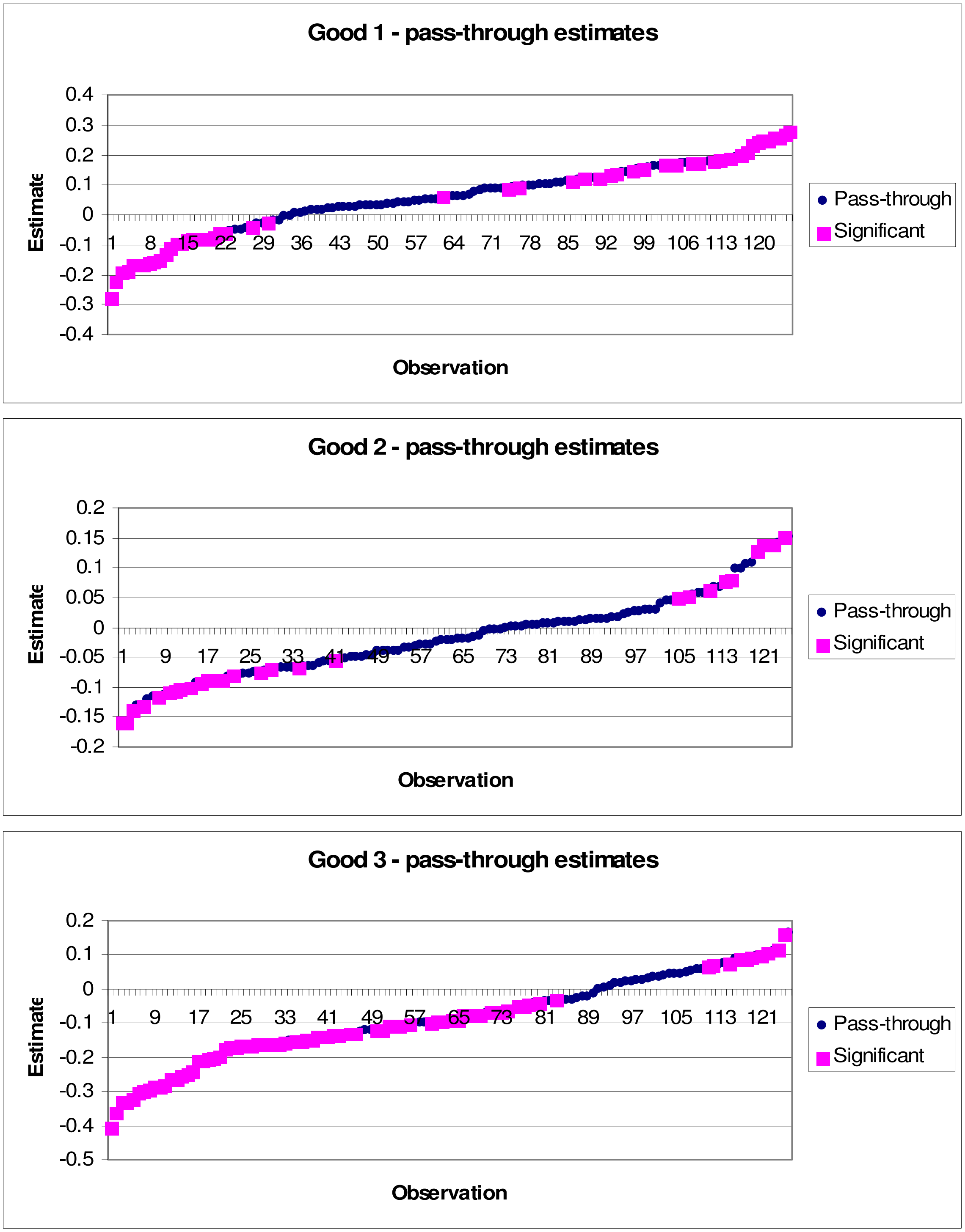
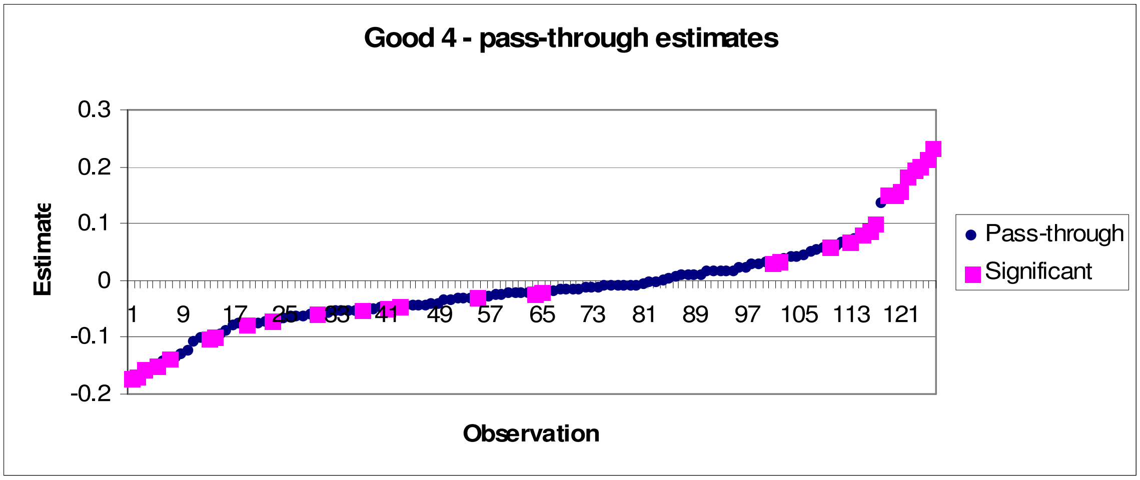
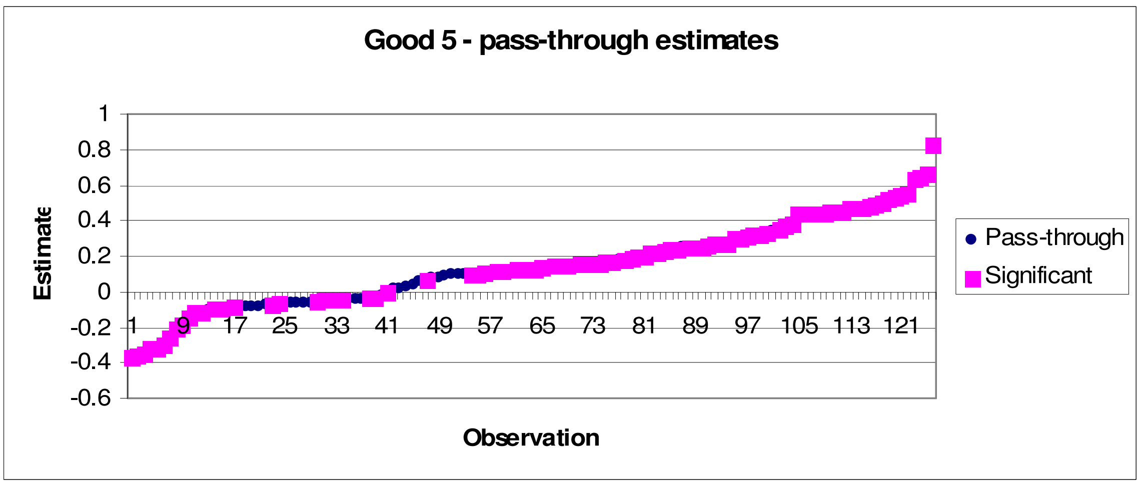

Good 1 - pass-through estimates
Estimate
Observation
Pass-through
Significant
Good 2 - pass-through estimates
Estimate
Observation
Pass-through
Significant
Good 3 - pass-through estimates
Estimate
Observation
Pass-through
Significant

Figure 1.2 (cont.)





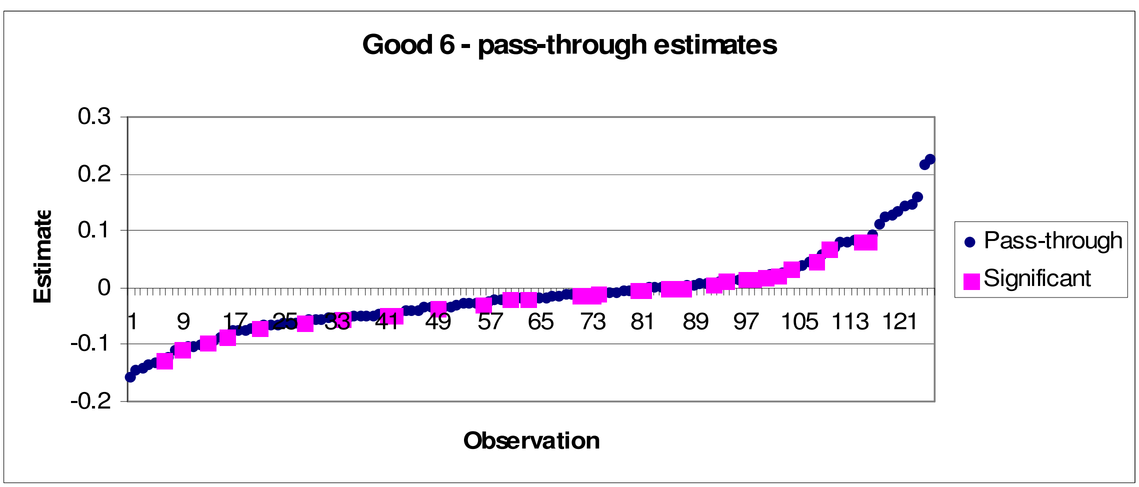
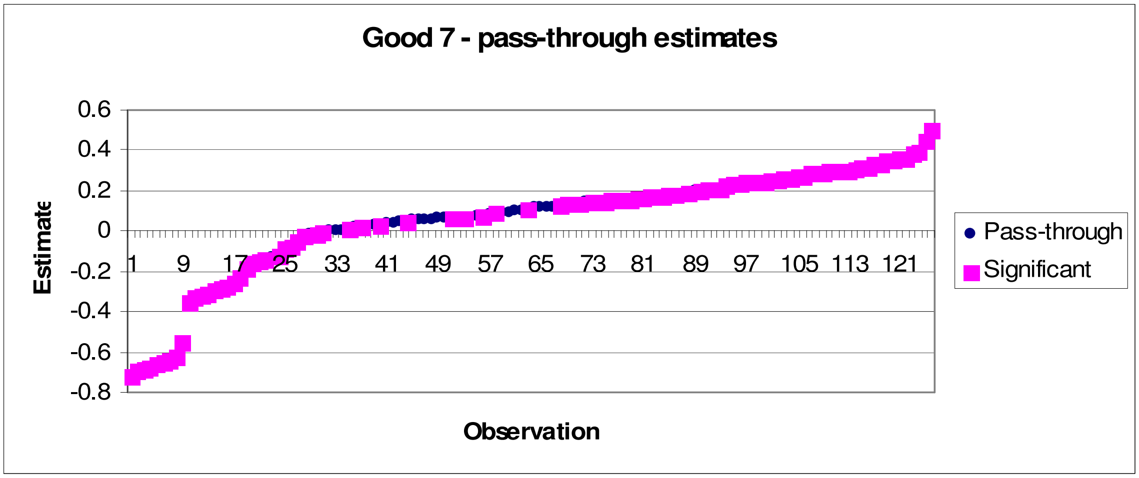
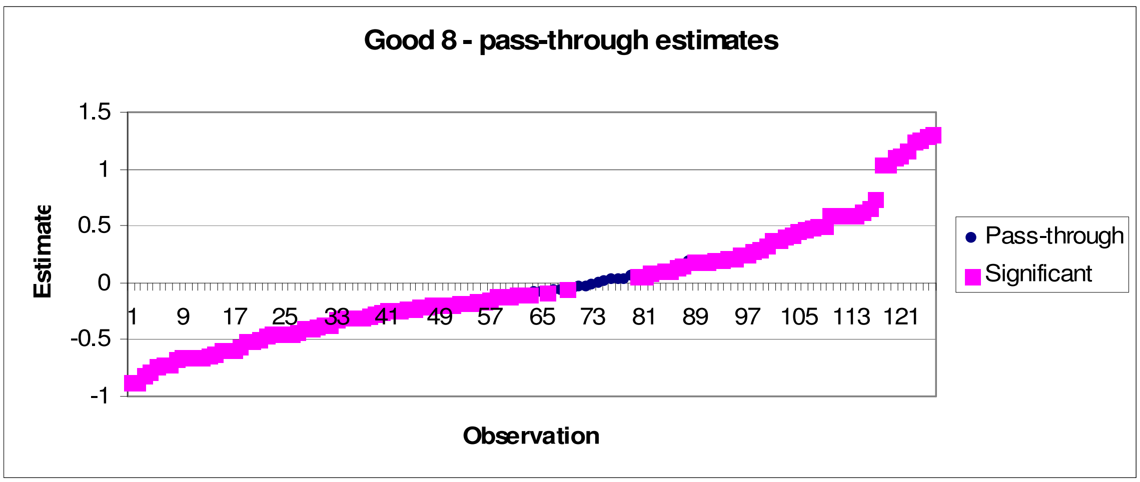


Figure 1.2 (cont.)





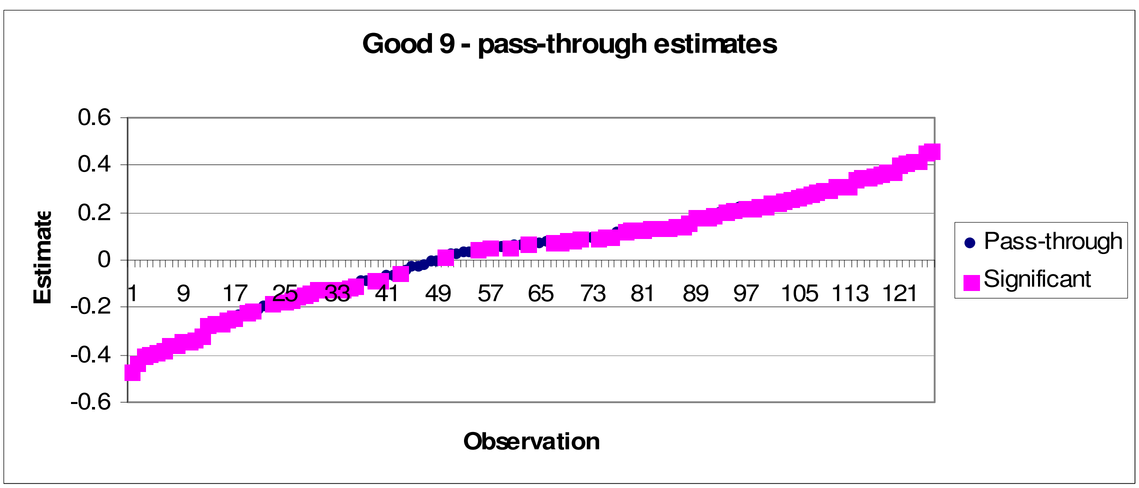
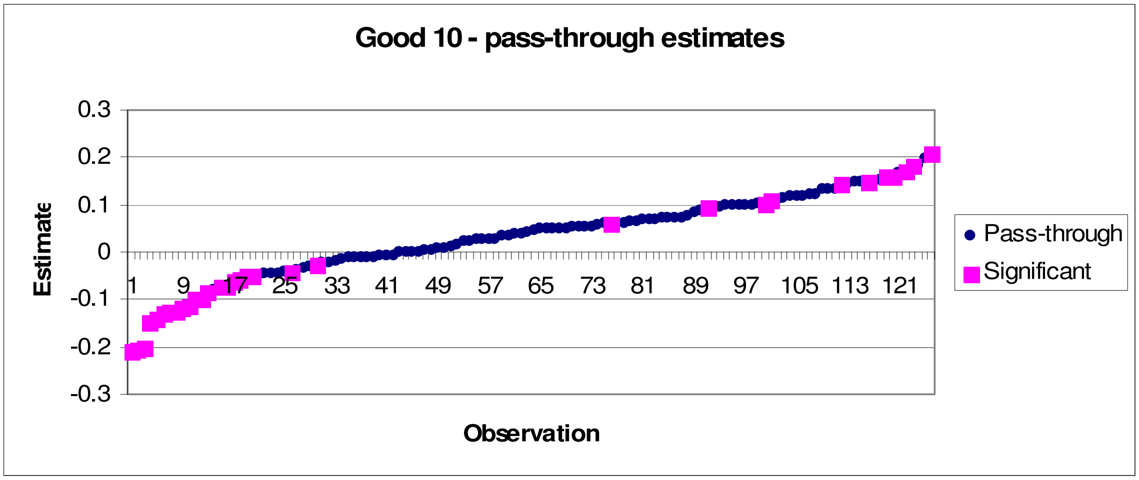
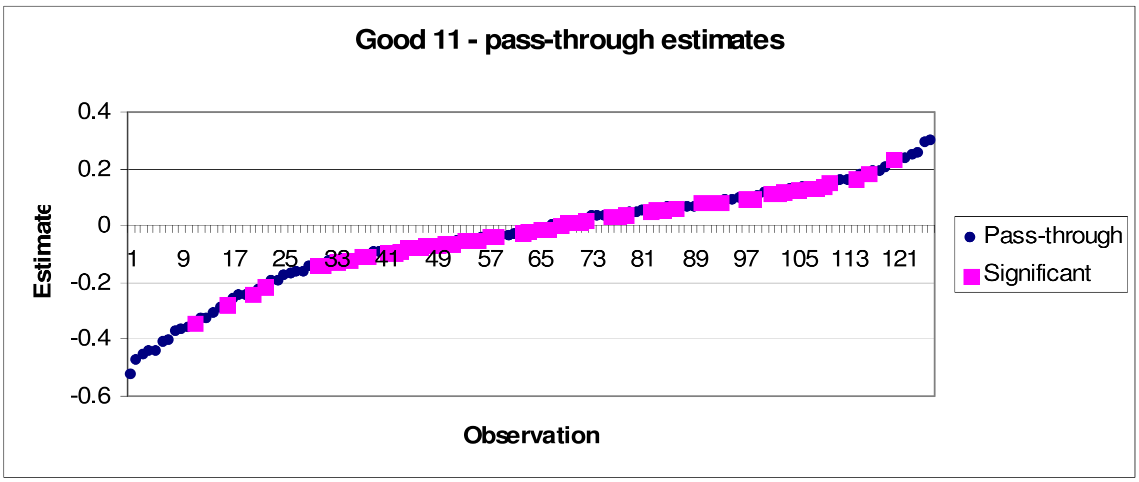


Figure 1.2 (cont.)





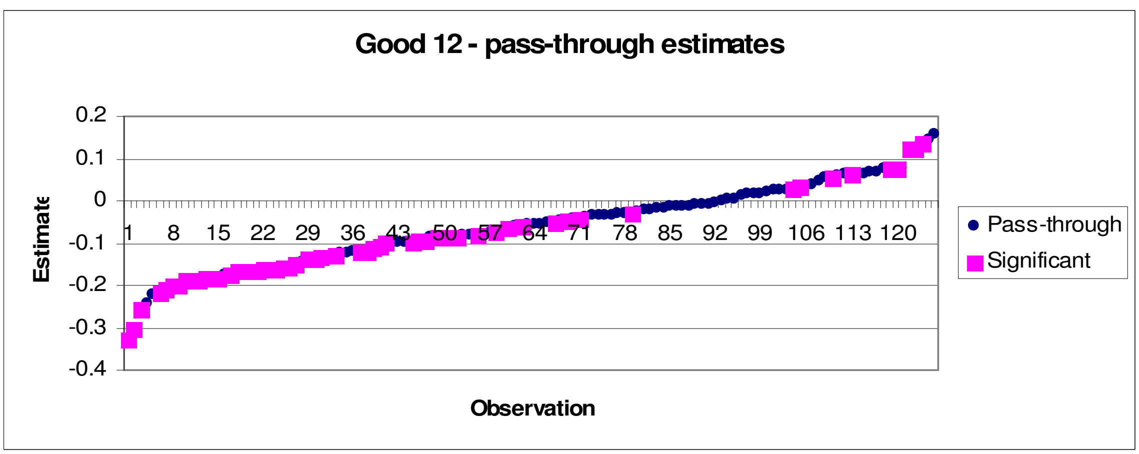
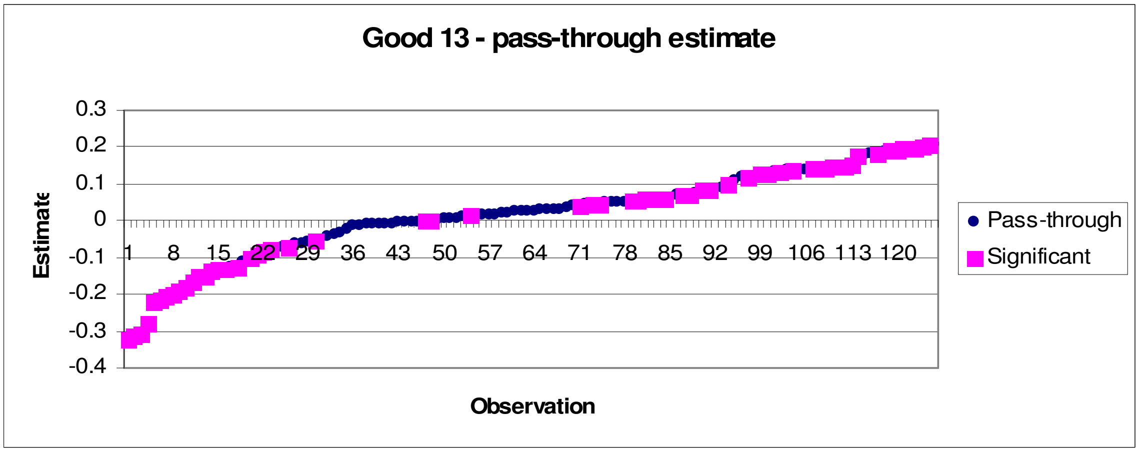
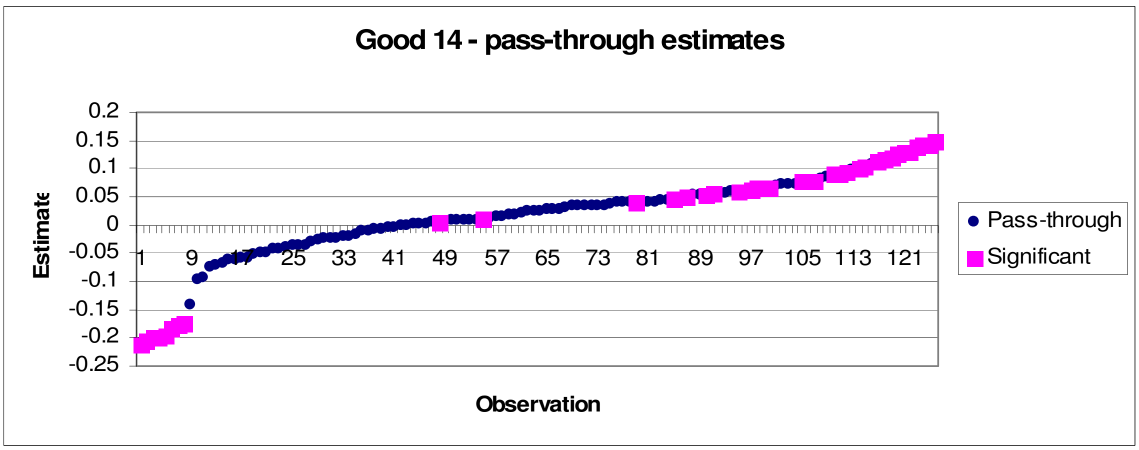


Figure 1.2 (cont.)





CHAPTER 2

EXCHANGE RATE PASS-THROUGH INTO U.S. IMPORTS: THE ROLE OF THE EXPORTING COUNTRY

2.1 Introduction

Using U.S. import data of 96,739 unit value observations from 57 countries of 253 goods, I find a significant, positive relationship between the country specific pass-through rate and the exporter's long term monetary volatility or the exporter's long term average inflation. Short-term price volatility significantly decreases the pass-through rate. This provides evidence for the effect of short term and long term inflation given in Taylor (2000). The IIT index and exporter's market share both significantly increase the good specific pass-through rate but not the country specific pass-through rate.

There has been a large amount of research on the determinants of exchange rate pass-through over the last 10 years. The work of Frankel, Parsley and Wei (2005) finds that distance, tariffs, per-capita GDP, GDP, wages, long-term inflation and exchange rate volatility all significantly affect the pass-through coefficient for a variety of price measurements. Devereux and Yetman (2003) further substantiate the positive relationship between long-term inflation and exchange rate pass-through.

Of utmost relevance for this paper are the procedures employed by Yang (1997) as well as Campa and Goldberg (2002). For these papers, a two-stage regression framework is used to determine the sign and significance of several possible determinants of the pass-through rate. Yang finds that greater product differentiation leads to greater exchange rate pass-through. Campa and Goldberg find evidence that high rates of long-term inflation in the importing country lead to higher pass-through rates. Also, Campa and Goldberg find that the country's imputed elasticity tends to hold more explanatory power than variables concerning the importing country's macroeconomic condition. The imputed elasticity is the aggregate good specific pass-through rate for the importing country; the variable is designed to control for the good composition of trade flows.

Yet, the datasets used by Yang (1997) and Campa and Goldberg (2002) bear some limitations.

Yang's dataset cannot identify the exporting country and only has one importing country. As a result, Yang cannot test macroeconomic variables and is limited solely to microeconomic explanations. In addition, Yang can only test the determinants of good specific pass-through rates, *not* country specific pass-through rates.

Campa and Goldberg's data uses import indexes from 25 OECD countries for 5 aggregated good categories: Food, Energy, Raw Materials, Manufactured Products and Non-Manufactured Products. Again, it is not possible to identify the exporting country. Consequently, the authors can only use macroeconomic statistics pertaining to the importing country but *not* the exporting country's macroeconomic situation. Also, because the data includes only 5 good categories, the authors can only test country specific pass-through rates, *not* good specific pass-through rates.

The dataset used in this paper represents the most recent figures studied to date: with observations drawn of 3-digit SITC import data from 2000-2003 as posted by the USITC. This represents the largest sample studied to date: 96,739 observations culled from 253 goods originating from 57 exporting countries during 16 quarterly time periods.

One advantage to this data is the ability to identify the exporting country, with the corresponding disadvantage of only one importing country: enabling us to study the importance of macroeconomic variables from the exporting country for the first time. However, because the dataset has only one importing country, it is not possible to estimate the affect of the importing country's macroeconomic variables.

A second advantage of this data is the ability to test the determinants of both country specific pass-through rates and good specific pass-through rates. The country specific pass-through rates represent the pass-through coefficient of Country A's exports into the United States. The good specific pass-through rates are calculated for each of the 253 3-digit SITC goods.

In this dataset, microeconomic determinants tend to affect good specific pass-through rates significantly, but not country specific pass-through rates. Macroeconomic conditions in the exporting country tend to affect both good and country specific pass-through rates significantly.

I find the theoretical work of Taylor (2000) to be empirically relevant. As Taylor suggests, long-term high inflation increases the pass-through rate while short-term price instability decreases the pass-through rate. The data herein supports Taylor's conclusion. Long-term inflation in the exporting country, working through channel of long-term money supply volatility in the exporting country, has a significant, positive relationship with the pass-through rate. Meanwhile, short-term price volatility in the exporting country has a significant, negative relationship with good and country specific pass-through rates. Taylor's model would suggest that it is the *persistence* of price changes that create greater pass-through. As short-term changes are viewed as less persistent, less exchange rate pass-through occurs. Long-term inflation, being more persistent, tends to boost the degree of pass-through.

Both the Intra-Industry Trade Index, a measure of product differentiation, and the exporter's share of the U.S. market significantly increase good specific pass-through rates, but have no significant effect on country specific pass-through rates. This corresponds to the predictions made in Bachetta and van Wincoop (2002). As the Intra-Industry Trade Index increases so too does the level of product differentiation: the greater the level of product differentiation, the less competitive the market. Likewise, the larger the exporter's market share, the less competitive the market. In Bachetta and van Wincoop's model less competition makes it more likely for exporter's to use the importing country's currency to denominate their price (local currency pricing); as a result, pass-through rates should be smaller for goods with less competition. Another microeconomic variable, the imputed elasticity is insignificant in this dataset.

The outline of this paper is as follows. In section 2.2 I will review both the empirical and theoretical research that has already been conducted on this topic, highlighting important factors that help to determine the rate of pass-through. Section 2.3 concerns the data and methodology to be used in this study. Section 2.4 will assess the results while section 2.5 concludes.

2.2 Theoretical and Empirical Literature Review

Before establishing the data and methodology of this paper it is necessary to review both the theoretical and empirical work that has come before. First, the theoretical papers of importance will be discussed. Second, the empirical papers will be examined to see what findings have been made regarding the theory.

Because the data used in this study has only one importer but many exporters, I will focus on the previous literature on the context of a single importer with many exporters. In this way we can examine what the previous literature would suggest given the dataset of this paper.

Taylor (2000) states that the decline in pass-through during the 1990's may be due to an environment of persistent low inflation. How does he come to this conclusion? I examine Taylor's simplest model below.

Suppose the demand for the firm's product, q_t, is given by the following linear demand curve.

$$q_t = \beta(\overline{p}_t - p_t) + \varepsilon_t \tag{2.1}$$

ε_t is a random component to the demand. The firm is allowed to sets its price, p_t, every fourth period. The price of other differentiated goods in the market is $\overline{p}_t$, which is the four-period average of recent prices set by other groups of firms, $\overline{p}_t = (p_t^* + p_{t-1}^* + p_{t-2}^* + p_{t-3}^*)/4$.

The firm's expected profit for the four periods in which the price is set is given below.

$$\pi = \sum_{i=0}^{3} E_t\big((p_t - c_{t+i})q_{t+i}\big) \tag{2.2}$$

The cost parameter, c_t, is a function of both the costs of production *and* the exchange rate. By substituting Eq. 2.1 into Eq. 2.2 and differentiating with respect to the firm's price, the optimal price can be calculated.

$$p_t = 0.125 \sum_{i=0}^{3} E_t \left(c_{t+i} + \overline{p}_{t+i} - \varepsilon_t / \beta \right) \qquad (2.3)$$

If there is a permanent increase in the cost, then .5 of that permanent cost will pass-through to the price of the firm. However, if the cost increase occurs in only one period, then only .125 of that cost increase will pass-through to the firm's price. Persistent changes will have greater pass-through to the firm's price; fleeting changes have smaller pass-through to the price.

Thus, the degree to which a firm reacts to a change in cost is dependent upon how permanent the cost change is (regardless of the source of the cost change, be it from an input, tax or exchange rate change). Thus, firms are more willing to pass-through any exchange rate changes to the price of their goods if they believe that the exchange rate change is lasting.

According to Taylor, if there is a large difference in the inflation rate of the exporting country and the inflation rate of the importing country then it is more likely that exchange rate changes are persistent; thus, higher exchange rate pass-through will occur. Conversely, if there is only a small difference in the inflation rate of the exporting country and the inflation rate of the importing country then the firm may consider exchange rate changes to be short-lived. Pass-through of the fleeting exchange rate changes will be low.

For the dataset in this paper, the importing country is always the United States. Long-term inflation in the United States is fairly low compared to other countries. What would Taylor's mode predict? If the exporting country has high long-term inflation then the prices of goods from that exporting country should exhibit greater pass-through.

Thus for the purposes of this paper's dataset, high long term inflation in the exporting country should be correlated with higher exchange rate pass-through in the prices of goods from that exporting country. Less persistent or short-lived price instability should be correlated with lower exchange rate pass-through. These predictions will be tested in section 2.4.

It is not possible to consider the determinants of exchange rate pass-through without examining the literature on the currency denomination of trade. The choice of currency denomination by a single firm can be representative of the entire country. Indeed, exchange rate pass-through can be viewed as merely the aggregation of currency denomination choices by individual firms. If the majority of exporters set their prices in their own currency, i.e. producer currency pricing, then exchange rate pass-through will be high. However, if the majority of exporters set their prices in the currency of their trading partners, i.e. local currency pricing, then exchange rate pass-through will be low.

Devereux and Engel (2001) consider the optimal currency denomination from the viewpoint of an exporting firm[11]. Mixing aspects of Obstfeld and Rogoff (1998) and Friberg (1998), Devereux and Engel model price setting behavior for periods in which the exchange rate is not yet realized. The exchange rate is a function of the money supply of the importing country and exporting country. When the level of money growth is comparable between the two countries the exchange rate is fairly stable; exporting firms employ local currency pricing so that the cash flows from sales are stable (exchange rate pass-through will be low). If the exporting country has large monetary volatility relative to the importing country then exporters will tend to invoice in the importer's currency. However, if the exporting country tends to have very stable monetary policy relative to the importing country, then the exporting firm would have an incentive to use producer currency pricing.

[11] Further extensions are given in Devereux, Engel and Storgaard (2004).

I focus on these results within the context of this study. The importing country, the United States, has relatively stable money growth. The money growth volatility of the exporting countries in this dataset varies. According to Devereux and Engel, those exporting countries with high money growth volatility will see their firms choose local currency pricing; the exporter's money growth volatility should correspond to lower exchange rate pass-through.

I contrast the results of Devereux and Engel (2001) with those of Taylor (2000). Long-term monetary instability has a tendency to lead to persistent inflation[12]. In Taylor's model, persistent inflation in the exporting country leads to persistent exchange rate movements and *greater* exchange rate pass-through. In Devereux and Engel, monetary instability in the exporting country will lead to *lower* pass-through.

The nature of the disagreement is in the exports of goods from countries with more volatile money growth. Taylor and Lucas (1972) would suggest that the price of these exports would exhibit high exchange rate pass-through; Devereux and Engel disagree.

Bachetta and van Wincoop (2002) continue the theoretical analysis of the currency denomination of trade. The authors show that increased competition will make it more likely that an exporting firm will choose local currency pricing. The more competitive the market, the smaller the exchange rate pass-through should be.

Consider a simple model where an exporting firm must choose to denominate their price in the importing country's currency (*I*) or the exporting country's currency (*E*). The firm must choose between two profit functions.

$$\begin{aligned} \pi_I &= ep_I(p_I^{-\mu}) - cp_I^{-\mu} \\ \pi_E &= p_E(p_E^{-\mu}e^{\mu}) - cp_E^{-\mu}e^{\mu} \end{aligned} \tag{2.4}$$

[12] A foundation for the non-neutrality of money can be found in Lucas (1972).

The firm's demand is given by $q = p^{-\mu}$ where the elasticity of demand is given by μ. The marginal cost is denoted by *c* and the future, unknown exchange rate is *e*. As the exchange rate is unknown, the firm would prefer to denominate their price in the currency that offers the smallest variance of their profit.

$$\begin{aligned} V(\pi_I) &= p_I^{2-2\mu} V(e) \\ V(\pi_E) &= (p_E^{2-2\mu} + c^2 p_E^{-2\mu} - 2cp_E^{1-2\mu}) V(e^{\mu}) \end{aligned} \tag{2.5}$$

The more competition in the market for the good, the larger μ becomes, $V(\pi_I)$ decreases while $V(\pi_E)$ increases. Conversely, suppose the market for the firm's good is perfectly inelastic, $\mu = 0$. In the perfectly inelastic market $V(\pi_E) = 0$; the firm will prefer to use producer currency pricing and the resulting pass-through rate is high in the uncompetitive market. On the other hand, the more competition there is for the firm's product, the more likely the firm will use local currency pricing; exchange rate pass-through will fall.

Through their modeling framework Bachetta and van Wincoop highlight two variables for the measurement of international competition: market share and product differentiation. The greater the exporter's market share and product differentiation, the less competition in the market: and the more likely that the exporter will engage in producer currency pricing. Thus, higher exporter market share and greater product differentiation should result in larger pass-through coefficients[13]. The dataset used in this paper allows us to test the effect of exporter market share and product differentiation on exchange rate pass-through.

[13] This mirrors the pricing power argument in Taylor (2000).

One element not modeled in the above papers is the cost of obtaining foreign currency[14]. Black (1991) describes how transaction costs, specifically the bid-ask spread, encourage the use of vehicle currencies. If the models of currency denomination have relevance to exchange rate pass-through then it is likely that larger bid-ask spreads should entail larger pass-through coefficients. Why? Because the firm would prefer not to pay the transaction cost of obtaining foreign currency. By using producer currency pricing, the firm forces *buyers* to pay the exchange rate transaction cost. A large bid-ask spread, would denote a large transaction cost of obtaining foreign currency. Thus, if exporters choose the currency in which to invoice, then a large bid-ask spread would mean that local currency pricing is more costly than producer currency pricing. The larger the bid-ask spread, the more likely that exporting firms will choose producer currency pricing. Thus, the bid-ask spread, or transaction cost of obtaining foreign currency, should be positively related to the pass-through coefficient.

With a theoretical review in place, I turn to the empirical record. Yang (1997) implements a two-stage regression framework. The first stage is used to find the exchange rate pass-through coefficient a_{1k}.

$$\ln\left(\frac{MP_{k,t}}{MP_{k,t-1}}\right) = a_{1k}\ln\left(\frac{E_t}{E_{t-1}}\right) + a_{2k}\ln\left(\frac{PP_{k,t}}{PP_{k,t-1}}\right) + a_{3k}\ln\left(\frac{MP_{k,t-1}}{MP_{k,t-2}}\right) + v_{k,t} \qquad (2.6)$$

$MP_{k,t}$ represents the U.S. import price index value at time *t* for industry *k*. E_t is the exchange rate index for the U.S. dollar. $PP_{k,t}$ is the U.S. producer price index value. Yang

[14] The decrease in bid-ask spreads in foreign currency markets has been dramatic over the last 20 years. Thus, as the transaction costs involved have been of decreasing importance it is not surprising that this additional variable has been left out of the theoretical literature.

uses 64 nonoverlapping three-digit and four-digit SIC industries from 1980 to 1987 as a sample. Thus, the author ends up with one pass-through coefficient, $\hat{a}_{1k}$, for each industry.

The second stage uses the good specific pass-through rates as a dependent variable in the following regression:

$$\hat{a}_{1k} = c_0 + c_1 PD_k + c_2 EMC_k + c_3 MR_k + u_k \tag{2.7}$$

All RHS variables are taken from U.S. data sources[15]. PD_k is a measurement of product differentiation for industry *k*. EMC_k is a measure of marginal cost elasticity as given by a capital to labor ratio while MR_k is the ratio of total imports to total supply for industry *k*. Four different measures for product differentiation are tested by the author: the ratio of scientists and engineers to total employment, the ratio of non-production workers to total employment, advertising intensity and the intra-industry trade index. Of the four variables that describe product differentiation, only advertising intensity is found to be insignificant. The three other measures have a significant and positive effect on the pass-through coefficient: as the model of Bachetta and van Wincoop (2002) would imply.

While Yang (1997) uses only microeconomic data as possible determinants of the good specific pass-through coefficient, Campa and Goldberg (2002) explore the importance of macroeconomic variables as well. The aim of Campa and Goldberg's first stage regression is to estimate country specific pass-through coefficients. The authors include GDP growth of the importing country as well as lagged "wage growth" variables meant to capture the costs for a basket of exporters[16]. The price data employed are quarterly import indexes from 25 OECD countries of 5 broadly defined goods covering 1977 to 1999.

[15] For a complete list please see the Data Appendix in Yang (1997).

[16] The creation of the "wage growth" variables involves a price index, nominal and real exchange rate series. The construction is given in better detail in Campa and Goldberg (2002).

Unfortunately, it is not possible to pinpoint the exporter for the five goods in question; thus, only the macroeconomic conditions of the importing country are considered in the second stage.

The second stage regression, with the country specific pass-through rate, γ, used as the dependent variable is as follows:

$$\begin{aligned}\Delta\gamma = \beta_1 \Delta \ln money_t^j + \beta_2 \Delta \ln inflation_t^j + \beta_3 \Delta \ln exchvol_t^j + \beta_4 \Delta \ln GDP_t^j \\ + \beta_5 \Delta \ln imputed_t^j + \alpha^j + \alpha_t + v_t^j\end{aligned} \quad (2.8)$$

Eq. 2.8 includes the importer's average money growth rate, the importer's average inflation rate, exchange rate volatility, the importer's real GDP and an imputed elasticity variable. *j* represents the importing country and *t* is the time. α^j and α_t correspond to country and time dummies respectively.

The imputed elasticity variable, $imputed_t^j$, represents the importer's aggregate pass-through elasticity: the sole microeconomic variable tested. $imputed_t^j$ is designed to track the dynamic level of import composition for the five different goods. Specifically, the exchange rate pass-through coefficient for each of the five goods is estimated over the entire sample period. The imputed elasticity variable is then weighted by the import share values of the five goods, Energy (E), Food (F), Raw Materials (RM), Manufacturing (M) and Non-manufacturing (NM), as shown below:

$$\begin{aligned}imputed_t^j = \frac{ValueF_t^j}{ValueTotal_t^j}\gamma_F^j + \frac{ValueE_t^j}{ValueTotal_t^j}\gamma_E^j + \frac{ValueRM_t^j}{ValueTotal_t^j}\gamma_{RM}^j \\ + \frac{ValueM_t^j}{ValueTotal_t^j}\gamma_M^j + \frac{ValueNM_t^j}{ValueTotal_t^j}\gamma_{NM}^j\end{aligned} \quad (2.9)$$

The authors find the imputed elasticity variable to be highly significant. The significance of the imputed elasticity variable is, perhaps, not surprising given the risks of endogeneity between the imputed elasticity variable and the pass-through coefficient. Overall, the authors find that the imputed elasticity variable holds almost all of the Eq. 2.8's explanatory value. The importing country's macroeconomic variables are found to have limited impact. Despite the statistical insignificance, the authors note that there is some evidence that greater inflation in the importing country and exchange rate volatility lead to larger exchange rate pass-through.

While Yang (1997) tests only microeconomic explanations for variations in good specific pass-through rates, Campa and Goldberg (2002) test the effect of the importing country's macroeconomic situation and the imputed elasticity on country specific pass-through rates. The dataset in this paper allows us to test the effect of the exporting country's macroeconomic situation along with microeconomic concerns (imputed elasticity, exporter's market share and product differentiation) on *both* country and good specific pass-through rates.

Given the framework developed by Yang (1997) and Campa and Goldberg (2002), there is evidence that microeconomic variables are of great importance to the level of exchange rate pass-through. Taylor (2000) explains the importance of long-term inflation, short-term price volatility and exchange rate volatility. Devereux and Engel (2002) note the consequences of monetary instability. Bachetta and van Wincoop (2002) stress the effects of international competition as evidenced by market share and product differentiation. In section 2.3, I will develop a modeling framework to test the findings of these papers described in section 2.2.

2.3 Data and Methodology

The prices studied in this paper are created using 3-digit SITC unit value data composed by the U.S. International Trade Commission. Collected on a quarterly basis from 2000 to 2003, the prices represent the most recent data studied to date. As a result of using this data, there is only one importing country: the United States. The exporting country can be identified for 57 countries with varying degrees of exchange rate independence. The countries are categorized as having a banded exchange rate regime, managed floating exchange rate regime, common monetary union (Euro zone member) or independently floating exchange rate regime. For details on these exporting countries please see Table 2.1[17].

The first-stage regression in this paper finds the country specific pass-through rate, γ_j, using three different methods:

$$\ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) = \alpha_1 + \alpha_2 t + \alpha_3 \ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right) + \gamma_j \ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right) + \alpha_4 \ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right) + \varepsilon_{k,t} \qquad (2.10a)$$

$$\begin{aligned} \ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) &= \alpha_1 + \alpha_2 t + \alpha_3 \ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right) + \gamma_j \ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right) + \alpha_4 \ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right) \\ &+ \alpha_4 Vol(\Delta \ln money_{US,t}) + \alpha_5 Vol(\Delta \ln stcpi_{US,t}) + \alpha_6 ltinfav_{US,t} + \varepsilon_{k,t} \end{aligned} \qquad (2.10b)$$

$$\begin{aligned} \ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) &= \alpha_1 + \alpha_2 t + \alpha_3 \ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right) + \gamma_j \ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right) + \alpha_4 \ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right) \\ &+ \alpha_5 Vol(\Delta \ln money_{US,t}) + \alpha_6 Vol(\Delta \ln stcpi_{US,t}) + \alpha_7 ltinfav_{US,t} \\ &+ \alpha_8 IIT_{k,t} + \alpha_9 expshr_{j,k,t} + \varepsilon_{k,t} \end{aligned} \qquad (2.10c)$$

[17] These categories are as given by the IMF document "Classification of Exchange Rate Arrangements and Monetary Policy Frameworks" dated June 30, 2004.

$p_{j,k,t}$ represents the unit value of good *k* at time *t* from exporting country *j*. $p_{US,k,t}$ represents the unit value of good *k* at time *t* for U.S. exports. $e_{j,t}$ is the average quarterly exchange rate between the U.S. and country *j* at time *t*. The tariff rate of good *k* at time *t* from country *j* is given by $\tau_{j,k,t}$. In Eq. 2.10b and Eq. 2.10c the coefficients α_5, α_6 and α_7 are included to control for changes in the importing country's macroeconomic situation. α_5 captures the volatility of quarterly U.S. money growth (over 4 years). α_6 is the coefficient on short-term (2 year) quarterly U.S. CPI volatility. α_7 denotes the effect of long-term (5 year) annual U.S. average inflation. In Eq. 2.10c the Inter-Industry Trade Index and exporter's market share are included to control for good specific effects when estimating the country specific pass-through rate. A theoretical justification for Eq. 2.10 is located in the Appendix.

Within Eq. 2.10 there is a U.S. price variable, an exchange rate variable and a tariff variable. As shown in Chapter 3, there is a theoretical link between these variables at a micro level; firms use this data when making their own price-setting decisions. While Eq. 2.10 is a standard regression formulation used recently in Campa and Goldberg (2002), Coughlin and Pollard (2004) and Yang (1997), there is the theoretical potential for an unstable level of multicollinearity among the relevant RHS variables.

However, the data used in Eq. 2.10 is aggregated into a more macro level statistic, weakening the potential of an unstable level of multicollinearity. One way to test this is to see if there is a condition index statistic greater than 10. For Eq. 2.10a the condition index statistic is 1.7 while the condition index statistic of Eq. 2.10c is 12.7. This suggests that any unstable level of multicollinearity originates from the additional control variables related to money supply, short-term and long-term inflation, IIT index and the exporting country's market share but not from the U.S. price variable, exchange rate variable and tariff variable.

Each regression equation is undertaken once for each of the 57 exporting countries[18]. The pass-through coefficients are estimated using a total of 96,739 observations. I find reason to believe Eq. 2.10a and Eq. 2.10b estimate the *statistically* best country specific pass-through rate. However, I believe that economic theory would require the control of microeconomic characteristics when estimating country specific pass-through rates; leading me to believe that Eq. 2.10c leads to the best *economic* estimates of country specific pass-through rates. Regardless, the results from all three methods tend to produce very similar results. For a more detailed discussion of model selection please see the Appendix (where a multiple exchange rate lag structure is used to find the pass-through coefficient, Eq. B.11). Also, pass-through coefficients estimated by Eq. 2.10 can be found in Table B.2 of the Appendix.

Eq. 2.10 is regressed via Weighted Least Squares. Specifically, observations are weighted by the total value of the imports of good *k* at time *t*. As a result, those observations with greater total import value are given more weight. Because unit value data tends to be more volatile than other price data, those observations with the greatest total value are likely to produce more accurate unit values. Thus, observations with greater total import value should be weighted by the total value of imports in order to produce more accurate estimates of the pass-through rate[19].

[18] For the same reason as Campa and Goldberg (2002), namely the rejection of a cointegration hypothesis, an error correction model was not applied.

[19] Campa and Goldberg use a Weighted Least Squares method that aims to do the same: to reduce the importance of more noisy LHS variables.

The country specific pass-through rates as estimated are representative of the total value of all exports from country *j*. That is, γ_j represents the exchange rate pass-through estimates for an exporting country's goods; this is not a traditional pass-through coefficient based on the perspective of an importer. Instead, the estimates of Eq. 2.10 represent the exchange rate pass-through for the United States from each of the 57 exporting countries studied.

The exchange rate pass-through estimates become dependent variables in the following second-stage regression motivated by Yang (1997) and Campa and Goldberg (2002). Again, the observations are weighted as in Eq. 2.10 with greater weight being placed on countries with a greater total value of imports.

$$\begin{aligned}\hat{\gamma}_j = \beta_1 + \beta_2 I_B + \beta_3 I_M + \beta_4 I_E + \beta_5 BAspread_j + \beta_6 exvol_j + \beta_7 \frac{GDP_j}{GDP_{US}} \\ + \beta_8 \frac{percapitaGDP_j}{percapitaGDP_{US}} + \beta_9 ltinfav_j + \beta_{10} stcpivol_j + \beta_{11} mnyvol_j \\ + \beta_{12} expshr_j + \beta_{13} sumIIT_j + \beta_{14} ImpElst_j + \beta_{15} dist_j + \beta_{16} tariffav_j + \varepsilon_j\end{aligned} \tag{2.11}$$

The descriptive statistics for these RHS variables are given in Table 2.2. Predictions of signs for the coefficients in Eq. 2.11 are given Table 2.3.

I_B, I_M, and I_E are indicator variables for countries that have either a banded exchange rate, managed floating exchange rate or are members of the Euro zone respectively. $BAspread_j$ is the difference between the bid and ask price divided by the reported exchange rate as averaged over the investigation period for exporting country *j* ($BAspread_j = Mean\left(\frac{ask_{j,t} - bid_{j,t}}{e_{j,t}}\right)$).

β_6 is the coefficient on exchange rate volatility. β_7 and β_8 are the coefficients on exporter GDP relative to importer GDP and exporter per capita GDP relative to importer per capita GDP. The construction of GDP and per capita GDP are similar to that of Frankel, Parsley and Wei (2005).

$ltinfav_j$ is the average annual inflation rate of the exporting country over the five years previous to the observation period. β_{10} represents the standard deviation of quarterly CPI changes in the exporting country over two years previous to the observation period. β_{11} is the coefficient on the standard deviation of quarterly money growth over four years in the exporting country. $expshr_j$ denotes the import share of country *j* relative the total value of all imports into the U.S and is included to capture the effect of market share. $sumIIT_j$ is the Intra Industry Trade Index for each of the *k* 3-digit SITC goods as weighted by total value of imports of good *k* divided by the total value of all imports from country *j* ($sumIIT_j = \sum_{k=1}^{K} \frac{TotalValueK_j}{TotalValue_j} IIT_k$). IIT_k is calculated as in Yang (1997) in order to test the effects of product differentiation. $ImpElst_j$ is the imputed elasticity measure from Campa and Goldberg.

$ImpElst_j$ represents the value-weighted pass-through rate of all 253 goods. Its construction is as follows:

$$ImpElst_j = \sum_{k=0}^{253} \frac{Value_{k,j}}{TotalValue_j} \gamma_k \tag{2.12}$$

γ_k represents the good specific pass-through rate as estimated by the regression equation below which is estimated once for each of the 253 goods.

$$\ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) = \alpha_1 + \alpha_2 t + \alpha_3 \ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right) + \gamma_k \ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right)$$
$$+ \alpha_4 \frac{GDP_j}{GDP_{US}} + \alpha_5 expshr_{j,k,t} + \alpha_6 dist_j + \alpha_7 \ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right) + \varepsilon_{j,t} \qquad (2.13)$$

The next section will examine the results of regressing Eq. 2.11 to determine what factors affect the rate of exchange rate pass-through.

2.4 Results

The results of testing Eq. 2.11 are given in Table 2.4a, Table 2.4b and Table 2.4c. Table 2.4a contains results for Eq. 2.11 when the country specific pass-through coefficients are estimated by Eq. 2.10a. Table 2.4b has results when the country specific pass-through estimates are estimated via Eq. 2.10b. Finally, Table 2.4c holds the results when the LHS variable is the country specific pass-through estimate from Eq. 2.10c. The results in Table 2.4a, Table 2.4b and Table 2.4c are only marginally different.

In the first column of all three tables the full model is regressed (Reg. 1). The bid-ask spread, the exporter's per capita GDP, the exporter's short-run CPI volatility and the exporter's monetary volatility are all statistically significant.

The bid-ask spread is significant and has a positive relationship with the country specific pass-through rate: lending credence to the models in which the exporting firm chooses the currency of denomination. If the bid-ask spread is large, then it is costly for the firm to denominate its price in the importing country's currency. Instead, the firm would prefer to avoid the large exchange rate transaction cost and denominate its price in the exporting country's currency. Aggregated over the decisions of all firms in that exporting country, a larger bid-ask spread results in a larger pass-through rate. Thus, the positive effect of the bid-ask spread on the pass-through rate is as expected. The coefficient on the bid-ask spread tends to support the importance of literature on the currency denomination of trade.

However, the positive relationship between the bid-ask spread and the pass-through rate could also be due to the bid-ask spread's correlation with exchange rate volatility. If there is a large degree of exchange rate volatility then exporting firms would tend to adjust their price more often, thereby raising the pass-through rate[20]. It is also true that the bid-ask spread may approximate financial risk. The larger the bid-ask spread, the more risky it is to engage in currency trading. Exporting firms would recognize the risk of the exchange rate and would tend to denominate their price in their own currency so as to limit their own exposure to the exchange rate.

Similar to Frankel, Parsley and Wei (2005), the exporter's per capita GDP remains a significant contributor to the pass-through coefficient. All three tables tend to suggest that the larger the per capita GDP of the exporting nation, the higher the level of pass-through of goods from that exporting nation. The coefficient on the exporter's per capita GDP may be an indication of the strength of the exporting country's currency. If the exporting country's currency is sufficiently robust, the exporting firm may be more likely to denominate its price in its own currency; thereby raising the pass-through rate.

The results concerning the exporter's short-term CPI volatility and monetary volatility are less straightforward. For the coefficient on monetary volatility, I see some evidence that Taylor (2000) warrants attention concerning pass-through. And unfortunately, I see evidence that Devereux and Engel (2001) are wrong about monetary volatility. Reg. 1 suggests that greater monetary volatility tends to increase exchange rate pass-through. The

[20] Gopinath and Rigobon (2006) empirically study the positive relationship between exchange rate volatility and the frequency of price adjustment for U.S. imported goods.

importance of the coefficient on monetary volatility may be due to monetary instability's effect on long-term inflation rates. From Lucas (1972), we know that the money supply has an effect on the general price level. If monetary volatility can create inflation, then it may be that the significance of the coefficient on quarterly money growth volatility is due to money's effect on long-term inflation.

If we accept that greater monetary volatility causes higher inflation, then Taylor's explanation for exchange rate pass-through seems to be accurate. First, long-term monetary instability creates persistent high inflation. In Taylor's model persistent high inflation leads to persistent exchange rate changes. If the exchange rate changes, or cost changes, are long-lasting then Taylor would suggest higher pass-through. Thus, an exporting country with volatile money growth may start a chain of events leading to greater exchange rate pass-through for the importing country. In Reg. 3, there is evidence for the impact of monetary volatility on long-term inflation. When the volatility of money growth is removed as an explanatory variable, the coefficient on long-term inflation becomes significantly positive in Table 2.4a, Table 2.4b and Table 2.4c[21].

However, as Taylor (2000) cautions "less persistence of costs reduces the size of the pass-through coefficient." I find support for Taylor's statement in the coefficient on short-term CPI volatility. After controlling for long-term inflation, greater short-term CPI volatility appears to *decrease* exchange rate pass-through. If these short-term movements are considered to be fleeting, then Taylor would suggest that firms would not react to any exchange rate changes that these short-term movements would cause. These fleeting changes will decrease the estimated pass-through rate.

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[21] Further concerns regarding the importance of monetary volatility and the inclusion of EU countries are addressed in the Appendix.

The exporting firm must consider the risk of the exchange rate. If the exporting country's price volatility is short-lived, then the effect of the price volatility on the exchange rate will also be short-lived. As such, the exporting firm's price may exhibit low pass-through because the long-term exchange rate risk is low; there is less need to adjust prices as the exchange rate is not moving to a different long-term range. Conversely, if there is persistent monetary volatility (or persistent inflation) in the exporting country, then there may be inherent risk in the long-term exchange rate. An exporting firm could react to the risk of the exchange rate by denominating its price in its own currency; reducing its own exposure to exchange rate risk and increasing its price's pass-through.

There must be caution when analyzing these results. The possibility of multicollinearity is evident when a number of macroeconomic variables are present on the RHS. With large multicollinearity the standard errors for coefficients can be inflated, leading to a greater risk of Type II error; wrongly dismissing variables that truly are significant. For measurement purposes a condition index statistic can be calculated to test the degree of multicollinearity present. An index value greater than 10 is an indication of instability. The condition index statistic for the full model of Reg. 1 is 6.4. And while this index number is not greater than 10, it is unpleasantly high.

Reg. 2 removes the most insignificant variables, the managed float dummy, distance and the tariff rate, in order to reduce the condition index statistic to more congenial level. As the managed float dummy, distance and the tariff rate are the most insignificant variables, the risks of an omitted variable bias are lessened. The resulting condition index statistic is a more palatable 4.38. For this reason, I consider the estimates in Reg. 2 to be the most robust. Fortunately, the results of Reg. 2 and Reg. 1 are very much alike[22].

The importance of microeconomic versus macroeconomic explanations for exchange rate pass-through is highlighted in Campa and Goldberg (2002). The authors note that the imputed elasticity, a microeconomic variable, provides almost all of their model's explanatory power. I eliminate the macroeconomic and microeconomic variables in Reg. 4 and Reg. 5 respectively. I find that macroeconomic variables provide the greatest contribution to the model's explanatory power. The lack of importance for microeconomic explanations may be caused by the difference in data construction between Campa and Goldberg's paper and this paper. Whereas Campa and Goldberg only aggregate the good specific pass-through rate over 5 goods, this paper uses 253 goods. As a result, it is much less likely that microeconomic variables, when all 253 goods are combined to create a single country-wide microeconomic variable, will hold statistical significance.

This dataset can only draw conclusions about the effects of the exporting country's macroeconomic variables. For all observations there is only one importer, the United States. As such, it is not appropriate to directly compare the results herein with those of Campa and Goldberg. The latter can only make use of the *importing* country's macroeconomic data, while this dataset can only draw conclusions about the *exporting* country's macroeconomic condition.

It would be careless to ignore those variables that are statistically insignificant. Having an exchange rate regime with a banded float tends to decrease exchange rate pass-through as would be expected from a less volatile exchange rate. The managed float dummy

[22] The literature including Calvo and Reinhart (2002) would suggest that I_M and I_B are predetermined by many of the macroeconomic variables used in Eq. 2.6. As such I don't think a great deal of explanatory power is lost by excluding I_M.

is insignificant in all formulations except that of Reg. 4 where it maintains its expected sign. EU membership is correlated with higher exchange rate pass-through, though the impact is insignificant. Exchange rate volatility has the expected sign, though it too is insignificant. The exporter's GDP, or country size, tends to decrease exchange rate pass-through.

Bachetta and van Wincoop (2002) would suggest that the larger the exporter's share of the market the greater the exchange rate pass-through should be. The authors would also propose that a larger IIT index number would translate into more product differentiation and higher exchange rate pass-through. The sign of the variable on exporter's market share reflects the predicted positive sign while the cumulative IIT index is not as theory would predict. The insignificant coefficient on cumulative IIT may be the result of using 253 possible goods; aggregating over all 253 goods to calculate a country-wide variable may hide the true impact of any good specific effects.

In addition, the imputed elasticity variable is insignificant. The sign of the coefficient is negative; the opposite of what Campa and Goldberg (2002) would predict. The insignificant, negative coefficient on imputed elasticity may also be the result of aggregating over 253 goods.

Because the RHS variables in Eq. 2.11 are widely different in size and scale, it is difficult to compare the magnitude of these coefficients. Table 2.5 reports the effect of a 10% increase in each of the RHS variables from their mean on the pass-through rate given the estimates in Reg. 2 of Table 2.4c[23]. The largest absolute effects are those of monetary volatility, the exporter's per capita GDP, the exporter's short-term CPI volatility and the bid-ask spread.

[23] I choose the estimates from Table 2.4c as it represents pass-through estimates from Eq. 2.10c: the model which makes use of all U.S. macroeconomic variables and microeconomic controls. Reg. 2 is preferred because it minimizes the risks of multicollinearity while maximizing the number of RHS variables.

In addition to using the good specific pass-through rates, γ_k, to construct $ImpElst_j$, I use γ_k as a LHS variable in the following regression equation used to find the determinants of the good specific pass-through rate.

$$\begin{aligned}\hat{\gamma}_k = \beta_1 + \beta_2 SumBAspread_k + \beta_3 Sum\frac{percapitaGDP_j}{percapitaGDP_{US}} + \beta_4 Sumstcpivol_k + \\ \beta_4 Summnyvol_k + \beta_5 expshr_k + \beta_6 IIT_k + \varepsilon_k\end{aligned} \quad (2.14)$$

The four non-microeconomic variables above are aggregated over all 57 countries according to the total value of exports from country *j* of good *k* relative to the total value of all exports of good *k* in order to represent the affect of each country's impact on the good specific pass-through rate. I use these four non-microeconomic variables as they have proven to be significant determinants of the country specific pass-through rate. With Eq. 2.14, I will test the impact of these non-microeconomic variables on good specific pass-through rates. Descriptive statistics for all of the RHS variables in Eq. 2.14 are given in Table 2.6.

Table 2.7 presents results for the Weighted Least Squares regression outlined in Eq. 2.14.

The sign and significance of the four non-microeconomic variables in Reg. 1 of Table 2.7 are similar to the results from Table 2.4. The cumulative bid-ask spread and the cumulative money volatility are both positive and significant just as in Eq. 2.11. The cumulative short-run CPI volatility is negative and significant. The cumulative per capita GDP measure is insignificant and the coefficient is the opposite sign.

Despite being aggregated over 57 countries, the bid-ask spread, short-term CPI volatility and monetary volatility impact the good specific pass-through rates in a similar manner to their impact on country specific pass-through rates.

The microeconomic variables, IIT index and exporter's market share, are significant determinants of the good specific pass-through rates. The coefficients on both variables are positive: just as Bachetta and van Wincoop (2002) would suggest.

I eliminate the macroeconomic, microeconomic and exchange rate based variable in Reg. 2, Reg. 3 and Reg. 4 respectively. For good specific pass-through rates macroeconomic, microeconomic and the bid-ask spread all represent a significant portion of Eq. 2.14's explanatory power.

Because the RHS variables in Eq. 2.14 vary widely in size, Table 2.8 presents the effect of a 10% increase in each of the RHS variables from their mean on the pass-through rate. The coefficient estimates come from Reg. 1 of Table 2.7.

To summarize, the regression results from Eq. 2.11 and Eq. 2.14 suggest that the bid-ask spread, short-term CPI volatility, per capita GDP and monetary volatility are important determinants of both country specific and good specific pass-through rates. The microeconomic variables, IIT index and exporter's market share, are important determinants of good specific pass-through rates but may not necessarily have a significant influence on country specific pass-through rates.

2.5 Conclusion

The rate of exchange rate pass-through is found to be significantly and positively related to the bid-ask spread and the exporter's per capita GDP. Just as Taylor (2000) predicts, the exporter's long-term inflation, working through the channel of the exporter's monetary volatility, is found to significantly increase the country specific pass-through rate. The exporter's short-term price volatility is found to significantly decrease exchange rate pass-through. Microeconomic factors, the IIT index and the exporter's market share, significantly increase the good specific pass-through rate but may not have a clear effect on country specific pass-through.

Table 2.1 List of countries and exchange rate regimes

Country	Exchange Rate Regime	Country	Exchange Rate Regime
Australia	Independent Float	Mexico	Independent Float
Austria	Euro	Netherlands	Euro
Bangladesh	Managed Float	New Zealand	Independent Float
Belgium	Euro	Nigeria	Managed Float
Brazil	Independent Float	Norway	Independent Float
Canada	Independent Float	Pakistan	Managed Float
Chile	Independent Float	Papau New Guinea	Independent Float
Columbia	Independent Float	Paraguay	Independent Float
Croatia	Managed Float	Peru	Independent Float
Cyprus	Banded Float	Philippines	Independent Float
Czech Republic	Managed Float	Poland	Independent Float
Denmark	Banded Float	Portugal	Euro
Egypt	Managed Float	Romania	Banded Float
Finland	Euro	Russia	Managed Float
France	Euro	Singapore	Managed Float
Germany	Euro	Slovenia	Banded Float
Ghana	Managed Float	South Africa	Independent Float
Greece	Euro	South Korea	Independent Float
Hungary	Banded Float	Spain	Euro
Iceland	Independent Float	Sri Lanka	Independent Float
India	Managed Float	Sweden	Independent Float
Indonesia	Managed Float	Switzerland	Independent Float
Ireland	Euro	Taiwan	Independent Float
Israel	Independent Float	Thailand	Managed Float
Italy	Euro	Turkey	Independent Float
Japan	Independent Float	United Kingdom	Independent Float
Kazakhstan	Managed Float	Uruguay	Independent Float
Kenya	Managed Float	Vietnam	Managed Float
Luxembourg	Euro		

Note: These definitions come from the IMF document “Classification of Exchange Rate Arrangements and Monetary Policy Framework” dated June 30, 2004.

Table 2.2

Descriptive Statistics for the RHS variables in Eq. 2.11

Independent Variable	Mean	Std. Dev.
Distance	5502.02	2172.01
Tariff	0.02721	0.03060
Bid-Ask Spread	0.00252	0.00476
Exchange Rate Volatility	0.00018	0.00015
GDP (Exporting Country/US)	0.03276	0.06829
Per capita GDP (Exporting Country/US)	0.35436	0.34991
Average Annual CPI Inflation (Long-Term)	9.05702	13.65461
Quarterly CPI growth volatility (Short-Term)	0.01087	0.00919
Quarterly Money growth Volatility (Long-Term)	0.06093	0.04567
Exporter's Share of Market	0.01564	0.02864
Cumulative IIT Index	0.49191	0.17293
Imputed Pass-through Elasticity	0.84980	0.23871

Note: Descriptive Statistics are based on observations from all 57 exporting countries.

Table 2.3 Expected signs for the RHS variables in Eq. 2.11

Independent Variable	Expected effect on pass-through coefficient
Banded Exchange Rate Regime	- (author)
Managed Float Exchange Rate Regime	- (author)
Euro-Zone member	?
Distance	?
Tariff Rate	?
Bid-Ask Spread	+ (Black, author)
Exchange Rate Volatility	+ (C&G)
GDP (exporter/importer)	? (FP&W)
Per capita GDP (exporter/importer)	+ (FP&W)
Average Annual CPI Inflation (Long-Term)	+ (Taylor, D&Y, C&G)
Quarterly CPI growth volatility (Short-Term)	- (Taylor)
Quarterly Money growth Volatility (Long-Term)	+ (D&E) OR - (Taylor)
Exporter's Share of Market	+ (Yang, B& vW)
Cumulative IIT Index	+ (Yang, B& vW)
Imputed Elasticity	+ (C&G)

Note: The above represent my interpretations of what the author's works would predict.
They do not necessarily represent the views of those authors referenced.

Table 2.4a

Equation 2.11 - (57 Obs.) LHS = Country specific pass-through Pass-through generated by Eq. 2.10a	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Reg. 5
Banded Exchange Rate Dummy	*-4.135*	*-4.153*	*-4.411*	*-3.494*	*-4.564*
	(3.174)	(3.053)	(3.325)	(3.308)	(2.923)
Managed Float Dummy	*-0.098*		*-0.602*	*-2.703***	*-0.044*
	(1.444)		(1.496)	(1.237)	(1.393)
EU Dummy	*1.328*	*1.32*	*-0.101*	*-0.043*	*1.057*
	(1.200)	(1.083)	(1.073)	(1.054)	(0.929)
Distance	*0.0000205*		*0.0000741*	*-0.0000574*	*-0.0000931*
	(0.0002541)		(0.0002653)	(0.0002473)	(0.0001603)
Tariff Rate	*-1.46*		*-13.69*	*-4.93*	*-1.13*
	(18.14)		(18.16)	(17.79)	(17.5)
Bid-Ask Spread	*660.6***	*660.3***	*575.5**	*360.7*	*655.1***
	(275.6)	(264.9)	(286.3)	(274.2)	(242.5)
Exchange Rate Volatility	*99.5*	*127.8*	*1498.2*	*881.6*	*-117.6*
	(2210.6)	(2048.4)	(2226.2)	(2121.1)	(2015.7)
GDP	*-3.672*	*-3.682*	*-2.823*		*-3.877*
(Exporting Country/U.S.)	(4.015)	(3.740)	(4.191)		(3.528)
Per capita GDP	*4.176***	*4.257***	*2.055*		*4.228***
(Exporting Country/U.S.)	(2.061)	(1.730)	(1.927)		(1.876)
Average Annual CPI Inflation (Long-Term)	*0.0859*	*0.0850*	*0.1327***		*0.0814*
(Exporting Country)	(0.0661)	(0.0550)	(0.0659)		(0.0623)
Quarterly CPI growth volatility (Short-Term)	*-180.3***	*-180.5***	*-225.9***		*-175.5***
(Exporting Country)	(89.7)	(71.6)	(91.6)		(86.8)
Quart. Money growth Volatility (Long-Term)	*34.1***	*34.6***			*31.8***
(Exporting Country)	(15.0)	(13.5)			(14.0)
Exporter's Share of Market	*5.828*	*5.502*	*1.285*	*-1.742*	
	(9.312)	(5.231)	(9.536)	(9.120)	
Cumulative IIT Index	*-0.505*	*-0.455*	*-1.676*	*-1.271*	
	(3.577)	(3.421)	(3.712)	(3.001)	
Imputed Elasticity	*-0.473*	*-0.48*	*-0.212*	*-0.467*	
(Cumulative good specific pass-through)	(1.180)	(1.130)	(1.231)	(1.164)	
Constant	*-2.649*	*-2.659*	*0.983*	*1.894*	*-2.256*
	(3.025)	(2.376)	(2.693)	(2.236)	(1.546)
Adjusted R-squared	**0.1462**	**0.2042**	**0.0614**	**0.012**	**0.1931**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * and ** respectively. As the regressions are weighted by the total value of each country's imports, the parameter values for significance are more strict.

Table 2.4b

Equation 2.11 - (57 Obs.) LHS = Country specific pass-through Pass-through generated by Eq. 2.10b	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Reg. 5
Banded Exchange Rate Dummy	*-4.436*	*-4.546*	*-4.762*	*-3.721*	*-5.251*
	(3.718)	(3.606)	(3.900)	(3.944)	(3.448)
Managed Float Dummy	*0.978*		*0.382*	*-2.501**	*1.091*
	(1.692)		(1.755)	(1.475)	(1.643)
EU Dummy	*1.419*	*1.076*	*-0.272*	*-0.006*	*1.000*
	(1.406)	(1.279)	(1.258)	(1.257)	(1.096)
Distance	*0.000132*		*0.0001955*	*0.0000782*	*-0.0000493*
	(0.0002977)		(0.0003111)	(0.0002948)	(0.0001891)
Tariff Rate	*-1.38*		*-15.86*	*-6.75*	*-0.83*
	(21.25)		(21.30)	(21.20)	(20.65)
Bid-Ask Spread	*620.8**	*628.3**	*520.1**	*255.4*	*628.8***
	(322.9)	(312.9)	(335.8)	(326.9)	(286.0)
Exchange Rate Volatility	*510.0*	*-24.7*	*2165.5*	*931.9*	*60.1*
	(2589.4)	(2419.4)	(2610.8)	(2528.5)	(2377.7)
GDP	*-5.240*	*-4.274*	*-4.234*		*-5.83*
(Exporting Country/U.S.)	(4.703)	(4.417)	(4.915)		(4.161)
Per capita GDP	*5.710***	*4.903***	*3.200*		*5.753***
(Exporting Country/U.S.)	(2.414)	(2.044)	(2.260)		(2.212)
Average Annual CPI Inflation (Long-Term)	*0.0932*	*0.064*	*0.1485**		*0.0863*
(Exporting Country)	(0.0774)	(0.0650)	(0.0773)		(0.0735)
Quarterly CPI growth volatility (Short-Term)	*-226.4***	*-184.7***	*-280.3***		*-218.5***
(Exporting Country)	(105.0)	(84.6)	(107.5)		(102.3)
Quart. Money growth Volatility (Long-Term)	*40.3***	*38.0***			*37.1***
(Exporting Country)	(17.5)	(16.0)			(16.5)
Exporter's Share of Market	*9.170*	*3.775*	*3.793*	*1.864*	
	(10.908)	(6.178)	(11.183)	(10.872)	
Cumulative IIT Index	*-1.352*	*-1.408*	*-2.738*	*-1.604*	
	(4.190)	(4.040)	(4.353)	(3.577)	
Imputed Elasticity	*-0.781*	*-0.888*	*-0.472*	*-0.924*	
(Cumulative good specific pass-through)	(1.382)	(1.335)	(1.444)	(1.388)	
Constant	*-3.341*	*-1.810*	*0.959*	*1.823*	*-3.000*
	(3.543)	(2.806)	(3.158)	(2.665)	(1.823)
Adjusted R-squared	**0.1074**	**0.1541**	**0.0164**	**-0.0698**	**0.1446**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * and ** respectively. As the regressions are weighted by the total value of each country's imports, the parameter values for significance are more strict.

Table 2.4c

Equation 2.11 - (57 Obs.) LHS = Country specific pass-through Pass-through generated by Eq. 2.10c	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Reg. 5
Banded Exchange Rate Dummy	*-4.400*	*-4.571*	*-4.721*	*-3.685*	*-5.386*
	(3.491)	(3.390)	(3.681)	(3.774)	(3.264)
Managed Float Dummy	*0.599*		*0.013*	*-2.916***	*0.754*
	(1.589)		(1.657)	(1.411)	(1.556)
EU Dummy	*1.427*	*1.028*	*-0.233*	*0.198*	*1.014*
	(1.320)	(1.202)	(1.187)	(1.203)	(1.038)
Distance	*0.0001581*		*0.0002204*	*0.0001407*	*-0.0000394*
	(0.0002795)		(0.0002937)	(0.0002821)	(0.000179)
Tariff Rate	*2.61*		*-11.61*	*-4.18*	*3.04*
	(19.95)		(20.11)	(20.29)	(19.55)
Bid-Ask Spread	*649.9***	*665.6***	*550.9**	*294.6*	*666.9***
	(303.2)	(294.2)	(317.0)	(312.8)	(270.8)
Exchange Rate Volatility	*1180.7*	*779.9*	*2806.3*	*1328.0*	*628.0*
	(2431.4)	(2274.3)	(2464.5)	(2419.6)	(2251.1)
GDP	*-6.274*	*-5.241*	*-5.287*		*-7.177**
(Exporting Country/U.S.)	(4.416)	(4.152)	(4.640)		(3.940)
Per capita GDP	*5.916***	*5.119***	*3.451*		*6.003***
(Exporting Country/U.S.)	(2.267)	(1.921)	(2.133)		(2.095)
Average Annual CPI Inflation (Long-Term)	*0.0720*	*0.0470*	*0.1263**		*0.0659*
(Exporting Country)	(0.0727)	(0.0611)	(0.0729)		(0.0696)
Quarterly CPI growth volatility (Short-Term)	*-212.8***	*-183.2***	*-265.7***		*-204.3***
(Exporting Country)	(98.6)	(79.5)	(101.4)		(96.9)
Quart. Money growth Volatility (Long-Term)	*39.6***	*36.8***			*36.1***
(Exporting Country)	(16.5)	(15.0)			(15.6)
Exporter's Share of Market	*10.027*	*3.576*	*4.747*	*4.275*	
	(10.242)	(5.808)	(10.557)	(10.404)	
Cumulative IIT Index	*-1.840*	*-1.788*	*-3.201*	*-2.032*	
	(3.934)	(3.798)	(4.109)	(3.423)	
Imputed Elasticity	*-1.018*	*-1.102*	*-0.714*	*-1.227*	
(Cumulative good specific pass-through)	(1.298)	(1.255)	(1.363)	(1.328)	
Constant	*-3.158*	*-1.445*	*1.064*	*1.751*	*-3.117**
	(3.327)	(2.638)	(2.981)	(2.550)	(1.726)
Adjusted R-squared	**0.1847**	**0.2256**	**0.0920**	**-0.0148**	**0.2056**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * and ** respectively. As the regressions are weighted by the total value of each country's imports, the parameter values for significance are more strict.

Table 2.5 Effect of a 10% increase in RHS variable on pass-through coefficient

Independent Variable	Change in pass-through coefficient
Bid-Ask Spread	0.1639
Exchange Rate Volatility	0.0207
GDP	0.0172
Per capita GDP	0.1814
Average Annual CPI Inflation (Long-Term)	0.0426
Quarterly CPI growth volatility (Short-Term)	-0.1992
Quarterly Money growth Volatility (Long-Term)	0.2242
Exporter's Share of Market	0.0056
Cumulative IIT Index	-0.0880
Imputed Elasticity	-0.0936

Note: The change in the pass-through coefficient is based on a 10% increase from the variable's mean described in Table 2.2. Coefficient estimates come from Table 2.4c, Regression 2.

Table 2.6

Descriptive Statistics for the RHS variables in Eq. 2.14

Independent Variable	Mean	Std. Dev.
Cumulative Bid-Ask Spread	0.0010	0.0008
Cumulative per capita GDP (Exporting Country/US)	0.4486	0.1920
Cumulative quarterly CPI growth volatility (Short-Term)	0.0078	0.0038
Cumulative quarterly money growth volatility (Long-Term)	0.0545	0.0263
Cumulative exporter's share of market	0.0501	0.0402
IIT Index	0.6146	0.2681

Note: Descriptive Statistics are based on observations from all 253 available 3-digit SITC goods.

Table 2.7

Equation 2.14 - (253 Obs.) LHS = Good specific pass-through estimate Pass-through estimates are generated in Eq. 2.13	Reg. 1	Reg. 2	Reg. 3	Reg. 4
Cumulative Bid-Ask Spread	*335.4***	*599.5***	*168.5*	
	(117.7)	(90.5)	(108.9)	
Cumulative per capita GDP	*-0.0084*		*0.4518*	*-0.581*
(Exporting Country/U.S.)	(0.607)		(0.613)	(0.581)
Cumulative quarterly CPI growth volatility (Short-Term)	*-29.12***		*-32.87***	*-22.52*
(Exporting Country)	(14.08)		(14.29)	(14.09)
Cumulative quarterly money growth volatility (Long-Term)	*12.94***		*16.54***	*12.79***
(Exporting Country)	(4.28)		(4.28)	(4.34)
Cumulative exporter's share of market	*3.306***	*3.374***		*2.889***
	(0.97)	(1.016)		(0.972)
IIT Index	*0.447***	*0.622***		*0.246*
	(0.164)	(0.166)		(0.150)
Constant	*-0.387*	*-0.360**	*-0.137*	*0.315*
	(0.563)	(0.193)	(0.574)	(0.513)
Adjusted R-squared	**0.2397**	**0.1505**	**0.1951**	**0.2177**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * and ** respectively. As the regressions are weighted by the total value of each country's imports, the parameter values for significance are more strict.

Table 2.8 Effect of a 10% increase in RHS variable on pass-through coefficient

Independent Variable	Change in pass-through coefficient
Cumulative Bid-Ask Spread	0.0347
Cumulative per capita GDP (Exporting Country/US)	-0.0004
Cumulative quarterly CPI growth volatility (Short-Term)	-0.0227
Cumulative quarterly money growth volatility (Long-Term)	0.0705
Cumulative exporter's share of market	0.0166
IIT Index	0.0275

Note: The change in the pass-through coefficient is based on a 10% increase from the variable's mean described in Table 2.6. Coefficient estimates come from Table 2.7, Regression 1.

CHAPTER 3

CURRENCY INVOICING: THE ROLE OF 'HERDING' AND EXCHANGE RATE VOLATILITY

3.1 Introduction

Using a dynamic model of optimal currency invoicing in the presence of an endogenous frequency of price adjustment, I find that exporting firms will "herd" in their choice between local currency pricing (LCP), producer currency pricing (PCP) and vehicle currency pricing (VCP). *By "herding" the firm chooses a currency of denomination based on maintaining a stable unit of account so that the firm's price and the competition's price are affected by the exchange rate in a similar manner*. A volatile exchange rate amplifies the impulse to "herd" with respect to all other factors including the firm's cost and demand structure. Counterintuitively, this suggests that heightened exchange rate volatility may result in a greater likelihood that a representative firm denominates the price of their good in the more volatile currency if the firm's competitors are already using the more volatile currency.

Why is the question of currency of denomination important? Currency denomination choices by exporting firms can affect the aggregate price level in the importing country. For example, if exporting firms tend to use LCP and update their price infrequently then the effects of exchange rate movements on inflation in the importing country are muted as the exporters' prices are more stable in the importing country's currency[24]. Conversely, if exporting firms have greater use of PCP or VCP and more frequent price adjustment then the importing country's aggregate price may be more unstable as the aggregate price is more acutely affected by movements in volatile exchange rates[25]. As many countries allow their exchange rates to fluctuate more freely, exporting firms in those countries are faced with more volatile exchange rates[26]. This paper will study how increasing exchange rate volatility may affect the currency invoicing decision of those exporting firms.

The most important improvement made by this paper for the theoretical literature on currency denomination is the inclusion of an endogenous frequency of price adjustment. Because the model in this paper allows the firm to choose how "sticky" their price will be, we are better able to observe the degree to which exporting firms will "herd". Again, a firm "herds" to maintain a stable relationship between the exporter's price and the comparative price in the importing country. Because the representative firm is allowed to choose its frequency of price adjustment, the desire to "herd" may be based on how often the exporter chooses to adjust its price. Additionally, we can better study the effects of exchange rate volatility because the firm can react to high exchange rate volatility by either changing their currency of denomination *or* frequency of price adjustment.

I vary different exogenous variables in the model to create thousands of different scenarios. Each scenario represents a hypothetical industry. A representative firm must optimize within that hypothetical industry given a set of exogenous parameters. The

[24] This is the case in the U.S. as exporters to the U.S. tend to use LCP.

[25] Such is the case in East Asian economies where PCP and VCP are prevalent.

[26] Most notably, China's removal of a pegged exchange rate with the dollar in 2005.

scenarios are not necessarily related to any specific existing industry. Instead the scenarios are designed to capture optimal firm behavior within a hypothetical industry to control for different values of the exogenous parameters that may affect the representative firm's decisions.

The motivation for the model in this paper comes from Friberg (1998) and Goldberg and Tille (2005)[27]. The dynamic model in this paper represents an expansion of the theoretical literature on currency denomination by giving the representative exporting firm the ability to optimize across four dimensions; allowing the firm to choose its price, frequency of price adjustment, currency of denomination and allowing the firm choose whether or not to engage in forward currency contracts.

One recent study that examines optimal currency denomination is Floden and Wilander (2006). The authors' main finding is to show that exporting firms engaging in PCP tend to change their price more often than firms using LCP. The results in this paper corroborate this finding. I find that the average frequency of price adjustment for firms using PCP is 8.58 monthly periods while the average price adjustment for firms using LCP is 9.28 monthly periods. In addition, I find that exporters using VCP adjust their price the most often with an average frequency of price adjustment of 6.18 monthly periods.

The results from the dynamic model of this paper are summarized here. First, I show how the representative firm's cost and revenue functions, forward currency contracts and exchange rate transaction costs affect the firm's optimal currency of denomination. Second, I find that exporting firms are willing to "herd" when choosing their currency of denomination. Third, I find that high exchange rate volatility amplifies the firm's impulse to "herd" relative to all other considerations such as the shape of the firm's cost and demand

[27] Comments made in Engel (2005) were helpful as well.

function. Increasing the volatility of the importer/exporter exchange rate intensifies the probability that exporters will “herd” in all three currencies: the local currency, the producer’s currency or the vehicle currency. Also, high volatility in the vehicle/exporter exchange rate increases the probability that the firm will “herd” in its choice between the vehicle currency and the local currency. Counterintuitively, this suggests that heightened exchange rate volatility may *increase* the likelihood that exporters will use the more volatile currency to denominate their price if the firm’s market is already suited to “herding”.

The layout of this paper is as follows. In section 3.2, there is a brief literature review. Section 3.3 contains a basic description of the dynamic model. Section 3.4 analyzes the results from the model. Section 3.5 concludes.

3.2 Review

Recently, many theoretical models detail an exporting firm’s choice of currency denomination. This includes work by Bachetta and van Wincoop (2005), Devereux, et al. (2004) and others. I will highlight two papers that are the most pertinent given the model introduced in this paper. The two papers are Friberg (1998) and Goldberg and Tille (2005).

In Friberg (1998), an exporter must choose between VCP, PCP or LCP. The firm may choose whether or not it will engage in forward currency contracts, though it is constrained to an exogenous frequency of price adjustment. The author shows that the firm’s optimal choice of currency denomination is based in part on the shape of the demand and cost functions. Because the firm is risk averse, the exporter will use forward currency contracts when using LCP or VCP. The firm’s choice of either LCP or VCP is dependent on the relative variances of the two relevant exchange rates; with the exporter preferring to invoice in the currency with a sufficiently low exchange rate variance.

The model in section 3.3, similar to Friberg (1998), will include varied cost and demand functions and will allow the firm to choose whether or not to use forward currency contracts.

In Goldberg and Tille (2005) the exporter is not limited to a discrete choice of PCP, VCP or LCP. Instead, the firm is allowed to denominate the price of its good in a basket of currencies. There are no forward currency contracts and the frequency of price adjustment is exogenous. The authors highlight the importance of "herding." The desire to "herd" is based on denominating the firm's price in a basket of currencies that is similar to the basket of currencies that affect the targeted price index in the importer's market. The authors denote the exogenous market shares of competing brands invoiced in the three currencies to create the firm's "herding" impulse. As a result, "herding" keeps a stable unit of account; maintaining a more stable relationship between the firm's price and the targeted price index in the importing country[28].

In section 3.3, the model will consider the firm's desire to "herd" when the exporter is *forced* into a discrete choice of PCP, LCP or VCP. The firm's "herding" impulse in this paper comes directly from Goldberg and Tille's basket of currencies with exogenous invoicing shares. In addition, the cost and demand functions in this paper's model are similar to those used by Goldberg and Tille (2005).

[28] Goldberg and Tille (2005) use the term "herding" based on the expected basket of currencies that may affect the targeted price index. Fukuda and Ono (2006) refer to this effect as the "history" of currency denomination choices. The history of previous currency denomination decisions creates the expectation of currency invoicing weights in Goldberg and Tille's basket.

Unlike Friberg (1998) and Goldberg and Tille (2005), the model in section 3.3 allows firms to choose their frequency of price adjustment. The menu cost used in this paper is similar to that given in Devereux and Yetman (2005). From Engel (2005,4), "the underlying assumption of modern models of price stickiness is that it is costly to set a price." By combining aspects of Friberg (1998) and Goldberg and Tille (2005) and adding an endogenous frequency of price adjustment along with transaction costs of obtaining foreign currency[29], the dynamic model will control for the many dimensions that may affect an individual firm's choice of invoicing currency while specifically studying the effect of exchange rate volatility on that choice.

3.3 Model

In this section, I will highlight basic details regarding the dynamic model used to compute the firm's optimal behavior. In Section 3.4, I analyze the results from the model.

The exporting firm is allowed to optimize simultaneously over four dimensions. One, the firm sets its price[30]. Two, the firm must choose one of three currencies in which to denominate the price: the producer's currency, the local currency or a vehicle currency. Three, the firm must set their frequency of price adjustment. Four, the firm must decide whether or not to engage in forward currency contracts.

Based on Goldberg and Tille (2005) an exporting firm faces one of the following three direct demand functions for their product based on their currency of denomination decision:

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[29] Black (1991) contains a useful analysis regarding the effects of exchange rate transaction costs.

[30] Of course, by setting their price, the firm also sets their input quantity and output quantity.

$$q_{ij,t} = \left[\frac{p_{ij,t}^{i}}{P_t^i}\right]^{-\lambda} OR \;\; q_{ij,t} = \left[\frac{p_{ij,t}^{j} e_{ij,t}(1+\tau_{ij})}{P_t^i}\right]^{-\lambda} OR \;\; q_{ij,t} = \left[\frac{p_{ij,t}^{k} e_{ik,t}(1+\tau_{ik})}{P_t^i}\right]^{-\lambda} \tag{3.1}$$

The direct demand function is determined by the firm's decision to engage in LCP ($p_{ij,t}^{i}$), PCP ($p_{ij,t}^{j}$) or VCP ($p_{ij,t}^{k}$). Where the quantity that the firm sells is denoted by $q_{ij,t}$, *i* denotes the importing country and *j* denotes the location of the exporting firm as country *j*. The time subscript is *t*. $p_{ij,t}^{c}$ denotes the price set in currency *c* by a firm in country *j* that is exporting to country *i*. The comparative price index in the importing country *i* at time *t* is denoted by P_t^i. $e_{ij,t}$, the exogenously determined exchange rate, is the currency of country *i* per one unit of country *j*'s currency at time *t*. $\lambda > 1$ denotes the firm's elasticity of substitution which is exogenous. Under both PCP and VCP, buyers in country *i* face an exogenously determined transaction cost of obtaining foreign currency *c*, $(1+\tau_{ic})$. A list of variables and their description is located in Table C.1 of the Appendix.

The firm uses a production technology with decreasing returns to scale where the sole input, labor, is given below as a function of the output quantity:

$$L_t\left(q_{ij,t}\right) = \alpha^{\frac{1}{\alpha}}\left(q_{ij,t}\right)^{\frac{1}{\alpha}} \qquad 0 < \alpha \le 1 \tag{3.2}$$

Where α is the exogenously determined returns to scale parameter and L_t is the labor input for the exporting firm purchased at a wage of $w_{j,t}$.

The firm must optimize in its choice of LCP, PCP or VCP and in choosing whether or not to use forward currency contracts. A forward currency rate between currencies *j* and *k* at time *t* is denoted by $f_{jk,t}$ and is determined by an efficient forward market. In the objective function below the indicator variables I_{PCP}, I_{LCP} and I_{VCP} denote the firm's use of PCP, LCP and VCP respectively ($I_{PCP} + I_{LCP} + I_{VCP} = 1$). Likewise, I_F is an indicator variable equal to one when the exporting firm is making use of forward currency contracts. The firm's objective function is given:

$$\begin{aligned} U(\pi_t) = \mathrm{I}_{\mathrm{PCP}}\, \pi_t^j\left(p_{ij,t}^j, K_P\right) + \mathrm{I}_{\mathrm{LCP}}\left((1-\mathrm{I}_{\mathrm{F}})\pi_t^{ie}\left(p_{ij,t}^{ie}, K_{Le}\right) + \mathrm{I}_{\mathrm{F}}\, \pi_t^{if}\left(p_{ij,t}^{if}, K_{Lf}\right)\right) + \\ \mathrm{I}_{\mathrm{VCP}}\left((1-I_F)\pi_t^{ke}\left(p_{ij,t}^{ke}, K_{Ve}\right) + \mathrm{I}_{\mathrm{F}}\, \pi_t^{kf}\left(p_{ij,t}^{kf}, K_{Vf}\right)\right) \end{aligned} \tag{3.3}$$

The exporting firm is faced with five different profit functions. The firm's choice of currency of denomination and the firm's decision whether or not to access forward currency contracts determines which of the five profit functions the exporter will use. The five discounted profit functions are based on the optimal price and optimal frequency of price adjustment, $K \geq 1$. The five profit functions are listed below with the quantity sold determined by the appropriate demand function from Eq. 3.1.

If $I_{PCP} = 1$, then

$$\begin{aligned} E_t\pi_t^j\left(p_{ij,t}^j, K_P\right) = (1-F)\left(p_{ij,t}^j q_{ij,t} - w_{j,t}L_t\left(q_{ij,t}\right)\right) + E_t\left(\sum_{s=t+1}^{t+K_P}\beta^{s-t}\left(p_{ij,t}^j q_{ij,s} - w_{j,s}L_s\left(q_{ij,s}\right)\right)\right) \\ + \beta^{K_P+1}E_t\pi_{t+K_P+1}^j\left(p_{ij,t+K_P+1}^j, K_P\right) \end{aligned} \tag{3.4}$$

If $I_{LCP} = 1$ and $I_F = 0$, then

$$\begin{aligned} E_t\pi_t^{ie}\left(p_{ij,t}^{ie}, K_{Le}\right) = (1-F)\left(p_{ij,t}^{ie} e_{ji,t}(1-\tau_{ij})q_{ij,t} - w_{j,t}L_t\left(q_{ij,t}\right)\right) \\ + E_t\left(\sum_{s=t+1}^{t+K_{Le}}\beta^{s-t}\left(p_{ij,t}^{ie} e_{ji,s}(1-\tau_{ij})q_{ij,s} - w_{j,s}L_s\left(q_{ij,s}\right)\right)\right) \\ + \beta^{K_{Le}+1}E_t\pi_{t+K_{Le}+1}^{ie}\left(p_{ij,t+K_{Le}+1}^{ie}, K_{Le}\right) \end{aligned}$$

If $I_{VCP} = 1$ and $I_F = 0$, then

$$\begin{aligned} E_t\pi_t^{ke}\left(p_{ij,t}^{ke}, K_{Ve}\right) = (1-F)\left(p_{ij,t}^{ke} e_{jk,t}(1-\tau_{jk})q_{ij,t} - w_{j,t}L_t\left(q_{ij,t}\right)\right) \\ + E_t\left(\sum_{s=t+1}^{t+K_{Ve}}\beta^{s-t}\left(p_{ij,t}^{ke} e_{jk,s}(1-\tau_{jk})q_{ij,s} - w_{j,s}L_s\left(q_{ij,s}\right)\right)\right) \\ + \beta^{K_{Ve}+1}\,E_t\pi_{t+K_{Ve}+1}^{ke}\left(p_{ij,t+K_{Ve}+1}^{ke}, K_{Ve}\right) \end{aligned}$$

If $I_{LCP} = 1$ and $I_F = 1$, then

$$E_t \pi_t^{if}\left(p_{ij,t}^{if}, K_{Lf}\right) = (1-F)\left(p_{ij,t}^{if} f_{ji,t-1}(1-\tau_{ij}) q_{ij,t} - w_{j,t} L_t\left(q_{ij,t}\right)\right)$$
$$+ E_t\left(\sum_{s=t+1}^{t+K_{Lf}} \beta^{s-t}\left(p_{ij,t}^{if} f_{ji,s-1}(1-\tau_{ij}) q_{ij,s} - w_{j,s} L_s\left(q_{ij,s}\right)\right)\right)$$
$$+ \beta^{K_{Lf}+1} E_t \pi_{t+K_{Lf}+1}^{if}\left(p_{ij,t+K_{Lf}+1}^{if}, K_{Lf}\right)$$

If IVCP = 1 and IF = 1, then

$$E_t \pi_t^{kf}\left(p_{ij,t}^{kf}, K_{Vf}\right) = (1-F)\left(p_{ij,t}^{kf} f_{jk,t-1}(1-\tau_{jk}) q_{ij,t} - w_{j,t} L_t\left(q_{ij,t}\right)\right)$$
$$+ E_t\left(\sum_{s=t+1}^{t+K_{Vf}} \beta^{s-t}\left(p_{ij,t}^{kf} f_{jk,s-1}(1-\tau_{jk}) q_{ij,s} - w_{j,s} L_s\left(q_{ij,s}\right)\right)\right)$$
$$+ \beta^{K_{Vf}+1} E_t \pi_{t+K_{Vf}+1}^{kf}\left(p_{ij,t+K_{Vf}+1}^{kf}, K_{Vf}\right)$$

The menu cost, charged only in period *t* when the price is changed, is denoted by (1-*F*)[31]. The exporter must choose a frequency of price adjustment, $K \geq 1$. As a result, the firm has at least some degree of uncertainty. A very large *K* allows the firm to avoid the menu cost but makes the exporter less able to respond to changes in the market.

Simultaneously the firm chooses its price, currency of denomination, frequency of price adjustment and chooses whether or not to engage in a forward currency contract. To what extent will the firm "herd"? What role does exchange rate volatility play?

In order to formulate an answer to these questions, I will take advantage of a dynamic model calibrated to real data and based on monthly time periods. The model must generate exchange rates, forward currency rates, wage inflation, and the price index of the targeted market. I use an assortment of values for the exogenous variables α (returns to scale in production technology), λ (elasticity of substitution for the firm's product), $w_{j,0}$ (the initial wage), and the transaction costs τ_{ik}, τ_{kj} and τ_{ij} to control for their different effects.

First, I generate three exchange rates as random walks. A "no arbitrage" condition, $1 \geq e_{ij,t}(1-\tau_{ij}) e_{jk,t}(1-\tau_{kj}) e_{ki,t}(1-\tau_{ki})$, will restrict the exchange rate data

[31] This is similar to the menu cost used in Devereux and Yetman (2005)

generation process. I follow Friberg (1998) and allow forward currency markets to be efficient so that the forward rate is equal to the expected future exchange rate. The wage, $w_{j,t}$, is sticky[32]; it grows based on movements in the shadow wage. The shadow wage is built on a randomly determined inflation rate.

The dynamic model will process thousands of different hypothetical industries, where each industry uses different values of the model's exogenous variables. In each hypothetical industry a representative firm will optimize. More details regarding the dynamic model are given in the Appendix.

The comparative price index in the targeted importing country is generated in the following manner:

$$\ln(P_t^i) = \ln(P_{t-1}^i) + \delta_{ij} \ln\left(\frac{e_{ij,t}}{e_{ij,t-1}}\right) + \delta_{ik} \ln\left(\frac{e_{ik,t}}{e_{ik,t-1}}\right) + v_t \qquad (3.5)$$

δ_{ij} and δ_{ik} represent the rate of exchange rate pass-through in the targeted market's price index, P_t^i. I set δ_{ij} and δ_{ik} to values ranging from 0 to 1 in order to see the effect of these pass-through rates on the firm's optimal currency of denomination.

Why should δ_{ij} and δ_{ik} have an effect on the firm's choice of currency denomination? Because the firm may wish to "herd". *By "herding" the firm chooses a currency of denomination based on maintaining a stable unit of account so that the firm's price and the competition's price are affected by the exchange rate in a similar manner.* The easier it is to keep a stable relationship between the firm's price and the competition's price, the less often the firm will have to adjust its price and pay menu costs.

[32] This is as Chodhri, Faruquee and Hakura (2005) would promote.

When the firm uses PCP, the exporter sets its price relative to the price index at an optimal ratio, $\dfrac{p_{ij,t}^{j} e_{ij,t}}{P_t^i}^{*}$. Because the firm's price is sticky, it is unable to maintain that optimal ratio when either P_t^i or $e_{ij,t}$ changes. For example, if $K_P = 1$ then the firm would like to maintain the following optimal ratio for both periods in which its price is set.

$$\frac{p_{ij,t}^{j} e_{ij,t+1}}{P_{t+1}^i}^{*} = \frac{p_{ij,t}^{j} e_{ij,t}}{P_t^i}^{*} \tag{3.6}$$

Substituting Eq. 3.6 into Eq. 3.5 and we get an approximation that, ideally for the representative firm, would hold more closely:

$$\ln\left(\frac{e_{ij,t+1}}{e_{ij,t}}\right) \approx \delta_{ij} \ln\left(\frac{e_{ij,t+1}}{e_{ij,t}}\right) + \delta_{ik} \ln\left(\frac{e_{ik,t+1}}{e_{ik,t}}\right) + v_{t+1}^{\;*} \tag{3.7}$$

When δ_{ij} = 1, the firm should find it optimal to "herd". The price index is very sensitive to movements in $e_{ij,t}$, most likely because many other firms are using currency *j* when invoicing the good. Thus, a representative exporter should prefer to join the "herd" of firms already using currency *j*[33]. By joining the "herd", the firm is better able to maintain a stable unit of account.

In the next section, I will analyze the results from the dynamic model as it pertains to "herding" and exchange rate volatility.

3.4 Results

As noted in section 3.3, in each different hypothetical industry a representative firm must optimize. I highlight the firm's desire to "herd" and the effect of exchange rate volatility on the firm's currency denomination decision. I generate results from three

[33] The "herd" of firms already using currency *j* generate the large δ_{ij}.

models: a baseline model with exchange rate volatilities taken roughly from the US/Canada, US/Mexico and Mexico/Canada exchange rates, a model with high importer/exporter exchange rate volatility and a model with high vehicle/exporter exchange rate volatility.

How do the exogenous parameters in the firm's revenue and cost function affect the firm's optimal invoicing currency? By examining the firm's optimal invoicing currency within the baseline model a few patterns arise as shown in Table 3.1. One, as the production technology, α, becomes larger and approaches constant returns to scale firms will be more likely to adjust their price less often and use PCP or LCP. Two, if the elasticity of demand for the firm's product, λ, becomes larger then firms will adjust their price more often and use VCP. Three, as the firm's marginal cost or initial wage increases the firm will likely adjust its price more often and use VCP. Four, as might be expected, if the transaction cost of obtaining the vehicle currency is higher then the firm will be less likely to use VCP.

To what extent does a firm "herd" under the baseline model? Table 3.2 provides results of the currency invoicing choices made by a representative exporting firm in 5,625 different scenarios. δ_{ij}, the pass-through rate of the exporter's currency to the targeted price index in the importing country's market, is *positively* correlated with the number of firms who use PCP and *negatively* correlated with the number of firms that use LCP. When δ_{ij} = 0, 33% of firms use PCP while 38% of firms use LCP. A pass-through rate of .25 (δ_{ij} = .25) increases the proportion of firms using PCP to 47% while the proportion of firms using LCP falls to 24%. The firm will "herd" when choosing between LCP or PCP.

Likewise, if δ_{ik} gets larger, the firm is more likely to use VCP and less likely to use LCP. If the pass-through rate δ_{ik} rises from 0 to .25, then the proportion of firms using the vehicle currency rises from 9% to 16% while the proportion of firms invoicing in the local currency falls from 34% to 26%.

Why does the firm "herd" when choosing between LCP and PCP or when choosing between VCP and LCP? When δ_{ik} = 1, using VCP allows for the optimal ratio $\frac{p_{ij,t}^{k} e_{ik,t}}{P_t^i}^{*}$ to be maintained more easily over time; the firm has selected a currency with a stable *unit of account* relative to the targeted price and access to forward currency contracts can mitigate the volatility of cash flows from the importing country helping to create stability in the *store of value* effect of money. Likewise, when δ_{ij} is large "herding" in PCP provides a stable *unit of account* while PCP always results in a stable *store of value* as the cash flows are already denominated in the exporter's currency. However, if both δ_{ij} and δ_{ik} are small, then using LCP will result in a more stable *unit of account* while the access to forward currency contracts mitigates the potentially volatile *store of value* effect.

But what if the volatility of the importer/exporter exchange rate rises and all other factors, the firms' cost and demand functions, remain unchanged? The firm will be more likely to "herd" in their choice between LCP and PCP. Figure 3.1 plots the shares of the 5,625 representative firms with respect to δ_{ij}, the pass-through coefficient of the importer/exporter exchange rate to the targeted price in the importing country. Under the baseline model when δ_{ij} = 0, 33% of firms use PCP and 38% of firms use LCP. However, if there is high volatility in the importer/exporter exchange rate, then only 24% of firms use PCP while the proportion of firms using LCP rises to 51% when δ_{ij} = 0. Indeed, for all 5,625 hypothetical industries the correlation between I_{PCP} and δ_{ij} rises from .327 in the baseline model to .439 in the high importer/exporter exchange rate volatility model; meanwhile the correlation between I_{LCP} and δ_{ij} decreases from -.130 in the baseline model to -.238 in the high importer/exporter exchange rate volatility model. The increased exchange rate volatility heightens the firms' impulse to herd with respect to all other factors including their cost and demand functions.

In addition, increasing the volatility of the importer/exporter exchange rate increases the firms' desire to "herd" when choosing between LCP and VCP. Figure 3.2 plots the shares of the 5,625 representative firms with respect to δ_{ik}, the pass-through coefficient of the importer/vehicle exchange rate to the targeted price in the importing country. When $\delta_{ik} = 0$ and there is an increase in the volatility of the importer/exporter exchange rate the share of firms invoicing in the vehicle currency drops from 9% to 4% while the share of firms invoicing in the local currency rises from 34% to 44%. However, with increased importer/exporter exchange rate volatility and $\delta_{ik} = 1$ the share of firms using VCP rises from 20% to 23% while the share of firms using LCP falls from 22% to 20%. For all 5,625 representative firms, the correlation between I_{VCP} and δ_{ik} rises from .095 in the baseline model to .188 in the high importer/exporter exchange rate volatility model; meanwhile, the correlation between I_{LCP} and δ_{ik} falls from -.109 to -.174. Again, the "herding" impulse is heightened due to the increased importer/exporter exchange rate volatility.

But what happens if the vehicle/exporter exchange rate increases in volatility? The results are similar: an increased likelihood of "herding" behavior in the choice of currency of denomination. In Figure 3.3, when $\delta_{ik} = 0$ the share of firms using LCP rises from 34% in the baseline model to 41% in the high vehicle/exporter exchange rate volatility model: at the same time the share of firms using VCP falls from 9% to 1%. Yet, for δ_{ik} = 1 the proportion of firms invoicing in the vehicle currency increases (from 20% to 40%), and the share of firms using LCP falls (from 20% to 18%), with heightened volatility in the vehicle/exporter exchange rate. For the 5,625 representative firms in the large vehicle/exporter exchange rate volatility model the correlation between I_{VCP} and δ_{ik} is .356 compared to .095 in the baseline model while the correlation between I_{LCP} and δ_{ik} falls from -.109 to -.179. The impulse to "herd" is relatively more important for representative firms in the presence of increased vehicle/exporter exchange rate volatility.

Counterintuitively, the results herein suggest that high exchange rate volatility may increase the likelihood of an exporting firm invoicing in the more volatile currency when the firm's competitors have already established a dominant invoicing currency and pass-through rates. For example, if the market is suited to "herding" in the vehicle currency (firms in the industry use the vehicle currency so that δ_{ik} is large) then heightened exchange rate volatility will increase the likelihood of a given exporting firm denominating their price in the vehicle currency. Likewise, if the market is positioned to "herding" in the producer's currency (firms in the industry use the producer's currency so that δ_{ij} is large) and there is an increase in the volatility of the importer/exporter exchange rate then a representative exporter is more likely to use PCP. However, if both δ_{ik} and δ_{ij} are small then increased exchange rate volatility increases the likelihood that exporting firms will use LCP.

One concern with the no-triangular arbitrage constraint on the exchange rate generation in the model is that the constrained exchange rate will necessarily have a greater variance then the other two exchange rates. In the baseline model, the constrained exchange rate is the exporter/importer exchange rate.

Additionally, it is possible to change which exchange rate is constrained. I run a model with a constrained vehicle/importer exchange rate. This increases the variance of the vehicle/importer exchange rate relative to the other exchange rates.

The results from the high vehicle/importer exchange rate variance model corroborate with the main results from this paper. First, representative firms "herd". If there is higher pass-through of the *exporter/importer* exchange rate, δ_{ij}, then firms would be more likely to use PCP and less likely to use LCP. Also, if there is higher pass-through of the *vehicle/importer* exchange rate, δ_{ik}, then firms would be more likely to use VCP and less likely to use LCP.

For the high vehicle/importer exchange rate variance model, the correlation coefficient between the firms that use PCP and δ_{ij} is .138 while the correlation coefficient between the firms that use LCP and δ_{ij} is -.187. Likewise, the correlation coefficient between the firms that use VCP and δ_{ik} is .353 while the correlation coefficient between the firms that use LCP and δ_{ik} is -.273. Firms continue to "herd".

These results also attest to the second finding in this paper; the representative firms' desire to "herd" is positively related to the volatility of the exchange rate. In the paper's baseline model, the correlation of firms that use PCP and δ_{ij} was .327. However, when the volatility of the *exporter/importer* exchange rate is *decreased*, as in this constrained vehicle/importer exchange rate model, the correlation of firms that use PCP and δ_{ij} falls to .138; decreased volatility of the exchange rate decreases the likelihood of "herding". Also, in the paper's baseline model, the correlation of firms that use VCP and δ_{ik} is .095. Yet, when the volatility of the *vehicle/importer* exchange rate is *increased*, as in this constrained vehicle/importer exchange rate model, the correlation of firms that use VCP and δ_{ik} rises to .353. Again, we see a positive relationship between "herding" behavior and the volatility of the exchange rate.

3.5 Conclusion

The dynamic model in this paper allows the exporting firm to maximize profits via four decisions; their price, currency of denomination, frequency of price adjustment as well as their choice to engage in forward currency contracts.

The main contribution is to show that an exporter will "herd" between the choice of PCP and LCP or between the choice of LCP and VCP. High exchange rate volatility increases the impetus for the firm to "herd". All of this is predicated on various characteristics of the firm's demand, production technology, wage and the transaction costs of obtaining foreign currency.

Perhaps the most important implication for the relationship between optimal currency denomination and exchange rate volatility is the invoicing of Chinese exports. Exchange rate pass-through into the prices of US goods is very low, while the US/Chinese exchange rate has been unpegged, increasing exchange rate volatility. The results herein suggest that Chinese firms, which already tend to "herd" by using the dollar to invoice exports to the United States, will likely retain the use of the dollar as an invoicing currency *because* the increased exchange rate volatility makes "herding" more important.

The results herein may also explain, counterintuitively, why the majority of Thai and Korean exports still tend to be denominated in the US dollar after those countries established independently floating exchange rates with the US dollar in 1997, creating greater exchange rate volatility (Fukuda and Ono (2006)).

Table 3.1

SUR: Impact of exogenous variables on freq. of price adjustment (*K*) and invoicing currency

	Seemingly Unrelated Reg.			Seemingly Unrelated Reg.		
	optimal *K*	**PCP**	**LCP**	**optimal *K***	**PCP**	**VCP**
alpha: prod. technology	4.43** (0.234)	0.071** (0.0218)	0.318** (0.0192)	4.43** (0.234)	0.071** (0.0218)	-0.0389** (0.0152)
lambda: elasticity of demand	-2.02** (0.0278)	-0.0018 (0.00258)	-0.0267** (0.00227)	-2.02** (0.0278)	-0.0018 (0.00258)	0.0284** (0.00181)
pass-through of exporter's currency	-0.933** (0.188)	0.456** (0.0174)	-0.158** (0.0153)	-0.933** (0.188)	0.456** (0.0174)	-0.298** (0.0122)
pass-through of vehicle Currency	-1.42** (0.188)	0.032* (0.0174)	-0.0132** (0.0153)	-1.42** (0.188)	0.032* (0.0174)	0.100** (0.0122)
initial wage	-0.00168** (0.000632)	-0.00020** (0.000059)	-0.00036** (0.000052)	-0.00168** (0.000632)	-0.00020** (0.000059)	0.00016** (0.000041)
transaction cost of vehicle's ex. rate market	2.74** (1.06)	0.661** (0.0988)	0.474** (0.087)	2.74** (1.06)	0.661** (0.0988)	-1.136** (0.0691)
Constant	14.30** (0.282)	0.212** (0.0262)	0.310** (0.0230)	14.30** (0.282)	0.212** (0.0262)	0.479** (0.0183)
R-squared	0.5047	0.1377	0.1184	0.5047	0.1377	.2471

Note: Significance at the 90% and 95% level is denoted with a * and ** respectively.

Table 3.2

Evidence of "Herding" in the baseline model

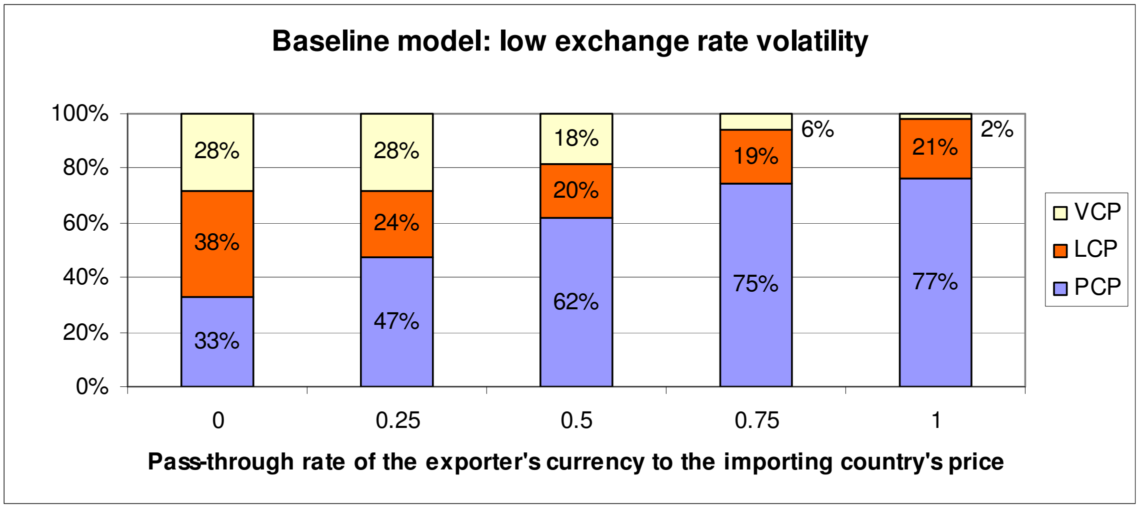
		δ_{ik}: 0	0.25	0.5	0.75	1
PCP	δ_{ij} = 0	27%	29%	31%	38%	41%
LCP	0	63%	48%	38%	24%	19%
VCP		10%	22%	31%	38%	40%
PCP		41%	43%	49%	53%	51%
LCP	0.25	42%	26%	19%	16%	17%
VCP		16%	32%	32%	30%	32%
PCP		65%	61%	61%	61%	61%
LCP	0.5	26%	19%	18%	17%	19%
VCP		9%	20%	21%	22%	20%
PCP		76%	78%	74%	74%	71%
LCP	0.75	20%	16%	18%	21%	22%
VCP		4%	6%	8%	5%	7%
PCP		76%	80%	74%	78%	75%
LCP	1	19%	20%	21%	22%	24%
VCP		5%	0%	4%	0%	1%

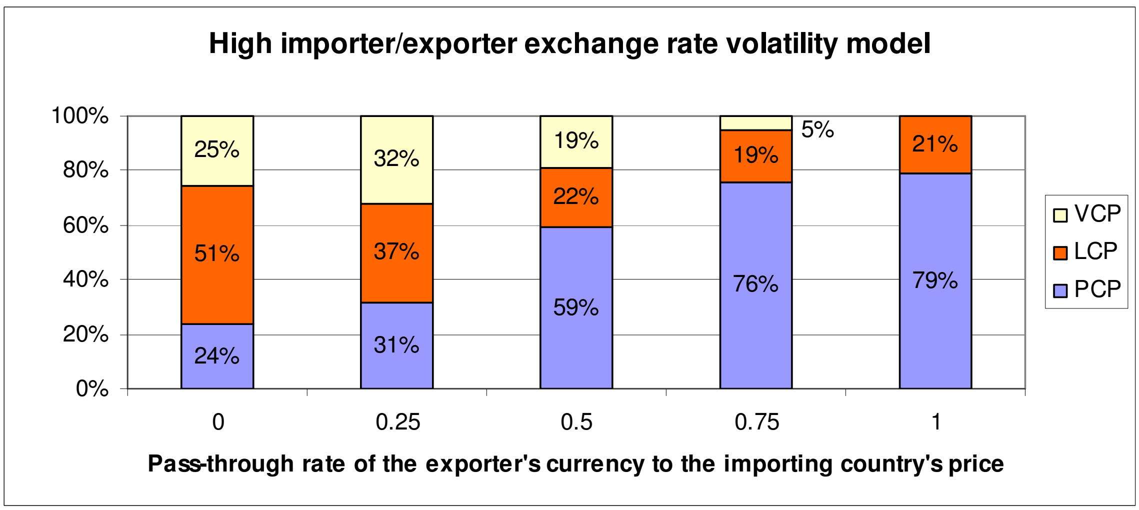
Note: δ_{ij} is the pass-through rate of currency *j* (the exporter's currency) to the price index in the importing country *i*. And δ_{ik} is the pass-through rate of currency *k* (the vehicle currency) to the price index in the importing country *i*.

Each square represents the proportion of firms that use a particular currency denomination given the 225 industries for which δ_{ik} and δ_{ij} take their designated values. Sums do not round to 1 in all cases due to rounding.

Figure 3.1

"Herding" with PCP and LCP: high importer/exporter exchange rate volatility.

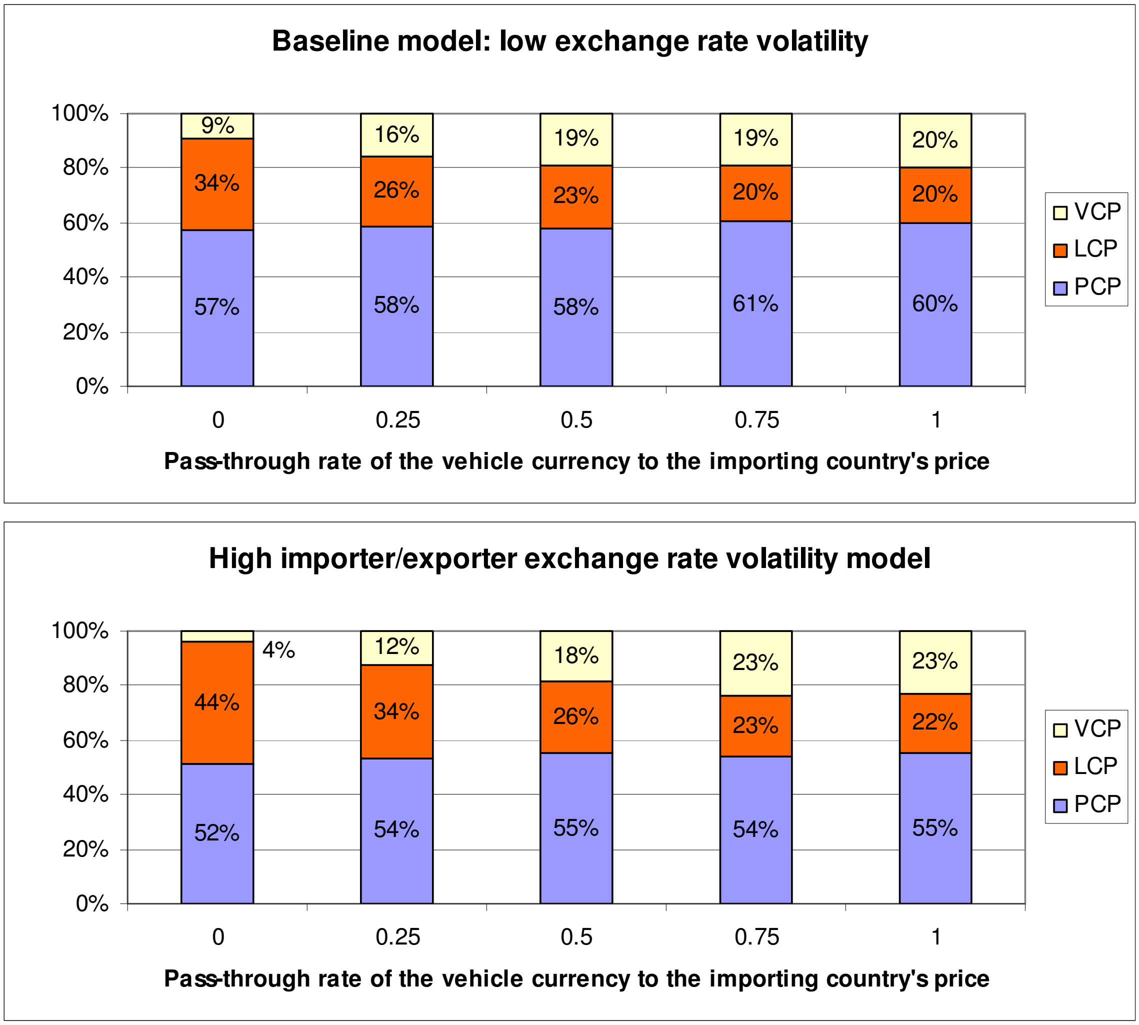




Note: For the high importer/exporter exchange rate volatility model, the variance of the importer/exporter exchange rate is roughly 4 times greater than in the baseline model. Sums do not round to 100% in all cases due to rounding.

Figure 3.2

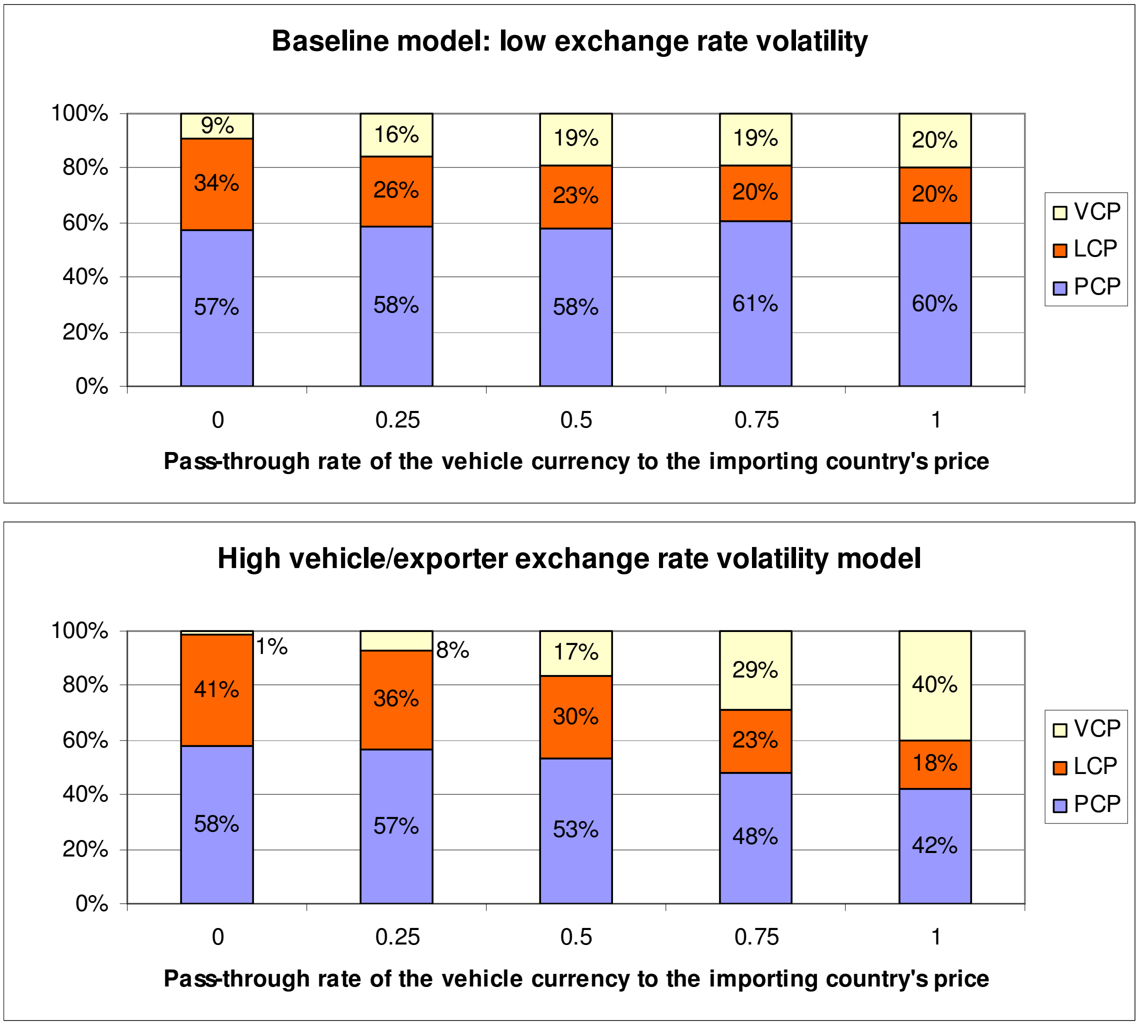
"Herding" with VCP and LCP: high importer/exporter exchange rate volatility.



Note: For the high importer/exporter exchange rate volatility model, the variance of the importer/exporter exchange rate is roughly 4 times greater than in the baseline model. Sums do not round to 100% in all cases due to rounding.

Figure 3.3

"Herding" with VCP and LCP: high vehicle/exporter exchange rate volatility.



Note: For the high vehicle/exporter exchange rate volatility model, the variance of the vehicle/exporter exchange rate is roughly 4 times greater than in the baseline model. Sums do not round to 100% in all cases due to rounding.

Appendix A

A1. The formation of β_{bp} .

If we write Eq. 1.7 without city dummies, the constant, the distance control or the error term we have the following equation.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)=\beta_{bp}I_{bord,ij}(1-\gamma)^2V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) \quad \text{(A.1)}$$

When cities *i* and *j* are in different countries $I_{bord,ij}$ = 1. Also, if γ is estimated by Eq. 1.5 then we can rewrite Eq. A.1 as below.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)=$$
$$\beta_{bp}\left(1-\frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) \quad \text{(A.2)}$$

Note that the estimate for γ as shown in Eq. A.2 will only be true if the estimate is consistent and there is no multicollinearity between $Z_{ij,t}$ and $\ln\left(\frac{e_t}{e_{t-1}}\right)$ *or* if the estimate is from a simple regression. As shown in Table A.4 there is little evidence for inconsistency when using Eq. 1.13 to estimate the pass-through rate. As for multicollinearity, the highest condition index statistic found in Eq. 1.13 for all cross-border city pairs is 1.41; any value under 10 is considered stable.

Distributing the RHS of Eq. A.2.

$$V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)-\ln\left(\frac{e_t}{e_{t-1}}\right)\right)=$$

$$\beta_{bp}\left(V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)+\frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)$$

(A.3)

Dividing by the parenthetical term in the RHS to isolate β_{bp} and distributing the term in the LHS.

$$\frac{V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)+V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)}{\left(V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)+\frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)}=\beta_{bp}$$

(A.4)

Now if we use Eq. 1.5 and replace $V\left(\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)$ in the LHS's numerator.

$$\frac{V\left(\gamma\ln\left(\frac{e_t}{e_{t-1}}\right)+\psi Z_{ij,t}+\mu_t\right)+V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)}{\left(V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)+\frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)}=\beta_{bp}$$

(A.5)

If Eq. 1.5 is consistently estimated, then $Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \mu_t\right) = Cov(Z_{ij,t}, \mu_t) = 0.$

$$\frac{V(\psi Z_{ij,t} + \mu_t) + \gamma^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) + V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) - 2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)}{\left(V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) - 2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right) + \frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)} = \beta_{bp}$$

(A.6)

Replacing γ as it is estimated in Eq. 1.5.

$$\frac{V(\psi Z_{ij,t} + \mu_t)}{\left(V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) - 2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right) + \frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)} +$$

$$\frac{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) - 2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right) + \frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}}{\left(V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right) - 2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right) + \frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)} = \beta_{bp}$$

(A.7)

Separating the numerator and simplifying.

$$\frac{V(\psi Z_{ij,t}+\mu_t)}{\left(V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)-2Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)+\frac{Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right),\ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right)-\ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)^2}{V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)}\right)}+1=\beta_{bp}$$

(A.8)

Recall that the denominator is the portion of the border effect due to incomplete pass-through of a volatile exchange rate. The numerator represents the portion of the border effect due to all other reasons as given from Eq. 1.5.

If the numerator is half the size of the denominator then 2/3 of the border effect must necessarily be due to incomplete pass-through of a volatile exchange rate; β_{bp} = 3/2 and the proportion of the border effect caused by incomplete pass-through of a volatile exchange rate is $1/\beta_{bp}$ = 2/3.

In an extreme example, suppose the numerator = 0. Then for some pass-through rate of γ the entire border effect is due to incomplete pass-through of a volatile exchange rate; β_{bp} = 1 and the proportion of the border effect caused by incomplete pass-through of a volatile exchange rate is $1/\beta_{bp}$ = 1.

Additionally, with notation most recently used by Gorodnichenko and Tesar (2005) we can replicate Eq. A.8. If we discard the constant, distance control and any other controls we have the following regression equation.

$$\sigma_{ij}=\beta UC_{ij}+\gamma_U UU_{ij}+\gamma_C CC_{ij}+\sum_{s=1}^{N}\alpha_s D_s \qquad \text{(A.9)}$$

Where σ_{ij} is the standard LHS variable given in Eq. 1.1, *UCij*, *UUij*, *CCij* are the border dummy, the US-US dummy and the Canada-Canada dummy respectively. City dummies are given by *Ds*. The estimate of the border effect from Gorodnichenko and Tesar (2005) is $\hat{\beta} = \beta - \frac{1}{2}(\gamma_U + \gamma_C)$. Thus, the estimate of the border effect is given by the additional volatility caused by crossing the border (β) minus the average within country volatility ($\frac{1}{2}(\gamma_U + \gamma_C)$). From Cheung and Lai (2006), the border effect, β, can be separated into a non-exchange rate border effect, π, and an exchange rate border effect, ξ. The estimation procedure outlined in section 1.3 replaces the border dummy with ξ. When using ξ as in Eq. 1.7 the following relationship is approximately achieved.

$$\beta_{bp}\xi \approx \hat{\beta} = \beta - \tfrac{1}{2}(\gamma_U + \gamma_C) = \pi + \xi - \tfrac{1}{2}(\gamma_U + \gamma_C) \qquad \text{OR}$$

$$\beta_{bp} \approx 1 + \frac{\pi - \frac{1}{2}(\gamma_U + \gamma_C)}{\xi} \tag{A.10}$$

In the RHS term, the denominator is the exchange rate's contribution to the border effect while the numerator is the average non-exchange rate border effect that is greater than the average within country volatility. Eq. A.10 necessarily mirrors Eq. A.8. The existence of the country heterogeneity effect which is not controlled for in Eq. A.8 or Eq. A.10 is addressed in section A.2 of the Appendix.

Cheung and Lai (2006) also attempt to determine the exchange rate border effect, ξ. The authors propose that ξ is as follows:

$$\xi = AVG\left[V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)\right] - 2AVG\left[Cov\left(\ln\left(\frac{e_t}{e_{t-1}}\right), \ln\left(\frac{p_{i,t}}{p_{i,t-1}}\right) - \ln\left(\frac{p_{j,t}}{p_{j,t-1}}\right)\right)\right] \tag{A.11}$$

The ξ proposed in this paper is $(1-\gamma)^2 V\left(\ln\left(\frac{e_t}{e_{t-1}}\right)\right)$. When the average pass-through rate is very small, Cheung and Lai's exchange rate border effect and the exchange rate border effect in this paper are very similar; but when the average pass-through rate is larger the difference is magnified as shown in Table A.1. The average pass-through rate for the data in Engel in Rogers (1996), studied in this paper and in Cheung and Lai (2006), is .04. Not surprisingly, the results in Cheung and Lai are very similar to those in this paper. However, if the pass-through rate was greater than .5, then Cheung and Lai's methodology would suggest that the exchange rate border effect is *negative* even though the exchange rate is not fully reflected in the intercity nominal price volatility; suggesting that the method outlined in section 1.3 is preferable.

Finally, essentially only Eq. 1.5 is necessary to estimate the proportion of the border effect that is due to incomplete pass-through of a volatile exchange rate as β_{bp} could be calculated as in Eq. A.8. However, using Eq. 1.7 along with the additional distance, city dummies and any other additional control variables allow us to test the significance of β_{bp}. If we simply used Eq. 1.5 and determined β_{bp} through Eq. A.8 then we would risk an omitted variable bias from the lack of distance, city or other controls.

Equally, we could discard Eq. 1.5 and use only Eq. 1.7 by simply calculating the denominator of Eq. A.8. Indeed, the job of Eq. 1.5 is simply to find the necessary covariance between the relative prices and the exchange rate.

A.2 Country Heterogeneity Control

As pointed out by both Gorodnichenko and Tesar (2005) and Cheung and Lai (2006) the traditional estimation method, given in Eq. 1.1, may leave the border effect estimation tainted by within-country effects. If both the number of cities in each country is not the same *and* average city price variation is not the same across countries then a bias may seep into the estimation of the border effect as the benchmark group, within-country city pairs, is heterogeneous.

Based on the findings of Gorodnichenko and Tesar (2005) and Cheung and Lai (2006) I can control for the country heterogeneity effect. The method outlined in Gorodnichenko and Tesar (2005) imposes the condition that the average city price variation is equal to zero in each country. Thus, the average city price variation is the same across countries and no country heterogeneity bias exists. However, in order to calculate the border effect using this method we must assume that the average city price variation is equal across countries *before* the condition is imposed; this is not an optimal assumption. The method used in Cheung and Lai (2006) drops a sufficient number of cities from the dataset so that each country has the same number of cities. Thus, because each country in the resulting dataset has the same number of cities the country heterogeneity bias is eliminated. This method is also, perhaps, not optimal. In order to calculate the border effect a sample randomization must take place, discarding valuable data.

Nonetheless, I will make use of the method introduced in Cheung and Lai (2006) and drop the necessary number of cities from the dataset. For the price index data from Engel and Rogers (1996), I retain all 9 Canadian cities and the 9 cities in the U.S. that come first alphabetically. For the commodity price data from the Economist Intelligence Unit, I retain all 4 Canadian cities and the 4 cities in the U.S. that come first alphabetically. This is a sample randomization assuming that the names of U.S. cities have no correlation with city specific characteristics. Results from the Engel and Rogers (1996) dataset are presented in Table A.2 (using Eq. 1.14) while results from the Economist Intelligence Unit are given in Table A.3 (using Eq. 1.16).

For the Engel and Rogers (1996) price index data, the estimated proportion of the border effect due to incomplete pass-through of a volatile exchange rate is very similar to the findings in Table 1.3. The results from the Economist Intelligence Unit are also similar to their associate findings in Table 1.5. However, there are two exceptions. In Table A.3, Personal Care and Recreation have very different estimated proportions of the border effect due to the nominal price/nominal exchange rate relationship. The estimate of β_{bp} is not significant from zero in both cases. The inability to find a significant β_{bp} would suggest that there is no border effect for these two goods when controlling for the country heterogeneity effect.

Table A.1

Average Pass-through rate	Witte (2006) average exchange rate border effect	Cheung and Lai (2006) average exchange rate border effect
0	*V(et)*	*V(et)*
0.04	**.9216*V(et)***	**.92*V(et)***
1	.81*V(et)*	.8*V(et)*
0.25	.5625*V(et)*	.5*V(et)*
0.5	.25*V(et)*	0
1	0	- *V(et)*

Table A.2a

Equation 1.14	Good 1 US: Food at Home Can: Food from stores	Good 2 US: Food away from home Can: Food from restaurants	Good 3 US: Alcoholic Beverages Can: Alcoholic Beverages
Bdist	0.0000241*** (0.00000733)	-0.00000197 (0.00000487)	0.0000115 (0.00000946)
Bbp	1.512*** (0.037)	1.438*** (0.052)	1.878*** (0.057)
t-stat (Bbp=1)	13.97	8.37	15.48
R-squared	0.9926	0.982	0.9903
Proportion of the border effect due to incomplete pass-through	**0.66**	**0.7**	**0.53**
Mean border effect (mi.)	**41**	**24760**	**45938**

	Good 4 US: Shelter Can: Shelter -.2135(Good 5)	Good 5 US: Fuel and other utilities Can: Water, fuel and elec.
Bdist	0.0000209*** (0.00000803)	0.0001216 (0.0000842)
Bbp	1.256*** (0.091)	6.067*** (0.896)
t-stat (Bbp=1)	2.81	5.66
R-squared	0.9731	0.9118
Proportion of the border effect due to incomplete pass-through	**0.8**	**0.16**
Mean border effect (mi.)	**460**	**14845**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies are included but not reported.

Table A.2b

Equation 1.14	Good 6 US: Household Furn. & Op. Can: Housing exc. shelter	Good 7 US: Men's and Boy's Apparel Can: .8058(Men)+.1942(Boy)	Good 8 US: Women's and Girl's App. Can: .8355(Wom.)+.1645(G.)
Bdist	0.00000389 (0.00000361)	0.0000397** (0.00002)	0.0001001 (0.0001297)
Bbp	1.415*** (0.036)	3.045*** (0.196)	13.989*** (1.931)
t-stat (Bbp=1)	11.56	10.45	6.73
R-squared	0.9932	0.9923	0.9587
Proportion of the border effect due to incomplete pass-through	**0.71**	**0.33**	**0.07**
Mean border effect (mi.)	**6305**	**25064**	**1.87E+13**

	Good 9 US: Footwear Can: Footwear	Good 10 US: Private Transportation Can: Private Transportation
Bdist	0.0000574* (0.0000319)	0.0000155** (0.00000792)
Bbp	1.212** (0.51)	2.064*** (0.049)
t-stat (Bbp=1)	0.42	21.8
R-squared	0.9772	0.9858
Proportion of the border effect due to incomplete pass-through	**0.82**	**0.48**
Mean border effect (mi.)	**48**	**41351**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies are included but not reported.

Table A.2c

Equation 1.14	Good 11 US: Public Transportation Can: Public Transportation	Good 12 US: Medical Care Can: Medical Care
Bdist	0.0002734*** (0.0000773)	0.0000121 (0.0000128)
Bbp	11.766*** (0.452)	1.980*** (0.093)
t-stat (Bbp=1)	23.8	10.58
R-squared	0.9743	0.9695
Proportion of the border effect due to incomplete pass-through	**0.09**	**0.51**
Mean border effect (mi.)	**1081351**	**72497**

	Good 13 US: Personal Care Can: Personal Care	Good 14 US: Entertainment Can: .8567(Rec.)+.1433(Rd.)
Bdist	0.00000662 (0.0000106)	0.0000039 (0.00000437)
Bbp	1.479*** (0.085)	1.288*** (0.038)
t-stat (Bbp=1)	5.65	7.66
R-squared	0.9899	0.9926
Proportion of the border effect due to incomplete pass-through	**0.68**	**0.78**
Mean border effect (mi.)	**3639**	**1851**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the average Bdist of all other goods and the Bdist of the good in question. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies are included but not reported.

Table A.3

Equation 1.24

	Food	Alcohol	Household Sup.	Recreation
Bdist	-0.00000126 (0.00000247)	-4.76E-08 (0.00000188)	-0.00000088 (0.00000185)	0.00000115 (0.00000717)
Bbp	2.316** (0.991)	1.453 (0.987)	2.921*** (0.806)	0.705 (1.955)
t-stat (Bbp=1)	1.33	0.46	2.38	-0.15
R-squared	0.6754	0.605	0.7283	0.5626
Proportion of the border effect due to incomplete pass-through	**0.43**	**0.69**	**0.34**	**1.42**
Mean border effect (miles)	**N/A**	**N/A**	**N/A**	**e^1887**

	Personal Care	Tobacco	Clothing
Bdist	0.00000146 (0.00000226)	-0.00000273 (0.00000355)	4.96E-07 (0.00000277)
Bbp	0.924 (0.95)	8.612*** (1.321)	2.720** (1.182)
t-stat (Bbp=1)	-0.08	5.95	1.46
R-squared	0.7228	0.8545	0.642
Proportion of the border effect due to incomplete pass-through	**1.08**	**0.12**	**0.37**
Mean border effect (miles)	**e^1962**	**N/A**	**e^17000**

Note: Robust standard errors are in parenthesis. Significance at the 10%, 5% and 1% level is denoted by *, ** or *** respectively. The Mean Border Effect is calculated using the Bdist of the good in question; if Bdist is negative the calculation can not be made. If the estimation of Bdist is insignificant then the Mean Border Effect can not be easily interpreted. City Dummies and Good Dummies are included but not reported.

Table A.4

Number (out of 126) of cross-border city pairs where the DWH test fails

	Pass-through estimates via Eq. 1.13	**Pass-through estimates via Eq. 1.13 and an additional lagged relative price variable**
Good 1	2	2
Good 2	2	1
Good 3	2	13
Good 4	2	1
Good 5	16	15
Good 6	7	2
Good 7	8	1
Good 8	7	3
Good 9	16	5
Good 10	9	7
Good 11	26	18
Good 12	12	10
Good 13	3	1
Good 14	4	1
Percentage	6.58%	4.54%

Note: The failure rate is based on a 95% confidence interval. The necessary DWH statistic was calculated using the residuals of an AR(1) regression of the change in the exchange rate.

Appendix B

B.1 Theoretical justification of Eq. 10

In order to compute the pass-through rate, we can start from the export price of good *k* from country *j* at time *t*, $p_{j,k,t}$. Let the price of the good be denominated in the U.S. dollar (the importer's currency for this paper). Using Feenstra (1995) as a baseline, suppose the price is computed by the following function.

$$p_{j,k,t} = (1+\tau_{j,k,t})\mu_{j,k,t}\phi_{j,k,t}(x_{k,t}, w_{j,t})e_{j,t} \quad \text{(B.1)}$$

$\mu_{j,k,t}$ represents the markup over the marginal cost, $\phi_{j,k,t}$. The marginal cost is a function of two other variables. One, the good specific element, $x_{k,t}$ ($x_{k,t}$ can be considered the quantity produced of good *k* at time *t*). Two, the export country specific costs, $w_{j,t}$ ($w_{j,t}$ can be considered the wage in country *j* at time *t*). The exchange rate is denoted by $e_{j,t}$ and the tariff/transportation costs are denoted by $(1+\tau_{j,k,t})$.

Under perfect competition the markup is equal to 1, $\mu_{j,k,t} = 1$. But, suppose that the market for good *k* is somewhat imperfect. Under imperfect competition, the markup is likely to be a function of the competitor's price in the United States, the exchange rate and the marginal cost[B1]. The greater the degree of imperfection in the market, the greater the markup will be.

$$\mu_{j,k,t} = \mu_{j,k,t}\left(p_{US,k,t}, e_{j,t}, \phi_{j,k,t}(x_{k,t}, w_{j,t})\right) \quad \text{(B.2)}$$

Inverting Eq. B.2.

$$\phi_{j,k,t}(x_{k,t}, w_{j,t}) = \mu^{-1}_{j,k,t}(\mu_{j,k,t}, p_{US,k,t}, e_{j,t}) = \theta_{j,k,t}\left(\mu_{j,k,t}, p_{US,k,t}, e_{j,t}\right) \quad \text{(B.3)}$$

[B1] Evidence for the endogeneity of the markup can be found in Hellerstein (2004).

Substituting Eq. B.3 into Eq. B.2.

$$p_{j,k,t} = (1+\tau_{j,k,t})\mu_{j,k,t} e_{j,t} \theta_{j,k,t}\left(\mu_{j,k,t}, p_{US,k,t}, e_{j,t}\right) \qquad \text{(B.4)}$$

Based on derivation given in Eq. B.4, the RHS of Eq. 2.10 must control for movements in the tariff/transportation costs, markup, exchange rate and the price in the U.S. market. Eq. 2.10c, reproduced below, does all of these things.

$$\begin{aligned} \ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) &= \alpha_1 + \alpha_2 t + \alpha_3 \ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right) + \gamma_j \ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right) \\ &+ \alpha_4 Vol\left(\Delta \ln money_{US,t}\right) + \alpha_5 Vol\left(\Delta \ln stcpi_{US,t}\right) + \alpha_6 ltinfav_{US,t} \qquad \text{(2.10c)} \\ &+ \alpha_7 IIT_{k,t} + \alpha_8 expshr_{j,k,t} + \alpha_9 \ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right) + \varepsilon_{k,t} \end{aligned}$$

Eq. 2.10c computes pass-through rates for each of the 57 countries, as such the distance between country *j* and the U.S. is constant; thus, if transportation costs change over time, then they are controlled by the trend. The tariff is captured by $\ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right)$. The markup is controlled by $IIT_{k,t}$ and $expshr_{j,k,t}$. Both the intra-industry trade index and exporter's market share help to approximate the degree of competition in the market for good *k*. By approximating the degree of market imperfection $IIT_{k,t}$ and $expshr_{j,k,t}$ can also approximate the markup[B2]. Finally, the exchange rate and the U.S. price are represented by $\ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right)$ and $\ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right)$ respectively.

Likewise, Eq. 2.13, reproduced below, estimates the good specific pass-through rates for 253 goods.

[B2] More detail on competition in imperfect markets can be found in Bachetta and van Wincoop (2002).

$$\ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) = \alpha_1 + \alpha_2 t + \alpha_3 \ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right) + \gamma_k \ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right) + \alpha_4 \frac{percapitaGDP_j}{percapitaGDP_{US}}$$
$$\alpha_5 expshr_{j,k,t} + \alpha_6 \ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right) + \alpha_6 dist_{j,US} + \varepsilon_{j,t} \quad (2.13)$$

Just as in Eq. 2.10c, Eq. 2.13 must control for movements in the tariff/transportation costs, markup, exchange rate and the price in the U.S. market. The effect of the tariff and transportation costs are captured by α_6 and α_7. Because Eq. 2.13 is regressed once for each good, the good component of the markup is the same for all observations. The country component of the markup is approximated by the per capita GDP of the exporting country and the exporter's market share. Finally, the exchange rate and the U.S. price are represented by $\ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right)$ and $\ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right)$ respectively.

B.2 Empirical modeling and weighting of Eq. 2.10

In order to find the country specific pass-through coefficients I experiment with three different methods outlined in this section of the appendix. The first method, exemplified in Table B.1, is to find the statistically optimal estimation method *for all countries taken together*. The second method, exemplified in Table B.2, is to find the statistically optimal estimation method *for all countries taken separately*. The last estimation method relies on the theoretical model above.

Table B.1 presents results for 5 models tested using all 96,739 observations. The Bayesian Information Criterion (BIC) is helpful in determining the optimality of certain regression models in a manner that reflects optimality for all 57 countries. With the BIC, I can test the optimality of additional variables to the simple regression, Eq. 2.10a. Because all

96,739 observations are used, the macroeconomic variables are included to control for exporting country specific effects. Because they act as control variables, I'm unable to test their usefulness. However, a "kitchen sink" approach that does make use of the macroeconomic variables tends to perform poorly relative to the other three methods (details are given below). Yet, I am able to test the importance of other variables: explicitly, the exporter's market share, the IIT index, and the three U.S. macroeconomic variables.

I turn to Taylor (2000) to provide the motivation behind the model in Table B.1. Following the staggered price setting model in Taylor (2000) let exporting firm *i* face the following demand function for its product.

$$q_{i,t} = \beta_i \left(\overline{P}_t - p_{i,t} \right) + \varepsilon_t \qquad \text{(B.5)}$$

The quantity sold by firm *i*, $q_{i,t}$, is a function of the elasticity of substitution for the firm's product, β_i, the average price level of other (differentiated) goods, $\overline{P}_t$, the price set by firm *i*, $p_{i,t}$, and a random demand parameter in the importing country, ε_t.

Firm *i* sets its price to last four periods. Firm *j*, firm *k* and firm *l* are located in the same country as firm *i* and they set their prices for four periods, except at different points in time. The average price level in the importing country is given by the four period average of the prices set by firm *i*, firm *j*, firm *k*, firm *l* and the average price of all other firms not located in the exporting country. Let the average price for all other firms not located in the some country as firms *i*, *j*, *k* and *l* be denoted by $\overline{p}_t$.

$$\overline{P}_t = (1-\alpha)\overline{p}_t + \alpha\left(p_{i,t} + p_{j,t-1} + p_{k,t-2} + p_{l.,t-3} \right)/4 \qquad \text{(B.6)}$$

The exporting country's market share in the importing country is given by α. The marginal cost of firm *i*'s production is $c_{i,t}$ and the firm pays a tariff rate of $\tau_{i,t}$. The firm's profit for the four periods in which the price is fixed can then be expressed as below[B3].

$$\sum_{s=0}^{3} E_t\left(e_{t+s} p_{i,t} q_{i,t+s}(1-\tau_{i,t}) - c_{i,t+s} q_{i,t+s}\right) \tag{B.7}$$

Because the price data in this paper is unit values we do not observe any individual exporting firm's prices. Instead, we observe the following as a unit value.

$$observed\ \ price_t = \frac{q_{i,t} p_{i,t} + q_{jt} p_{j,t-1} + q_{k,t} p_{k,t-2} + q_{l,t} p_{l,t-3}}{q_{i,t} + q_{j,t} + q_{k,t} + q_{l,t}} \tag{B.8}$$

So how would the model herein predict the results from Table B.1? We should expect to see the positive relationship between the observed price and either the exchange rate or the importing country's price (rows 1 and 2 of Table B.1).

An individual firm would react to higher transportation costs (proxied by distance in row 4 of Table B.1) by raising prices[B4]. The coefficient in Table B.1 is negative. The LHS variable is the *change* in the observed price; this suggests that transportation costs are decreasing over time. Exporting countries from greater distances are more able to pass those transportation cost savings on to their price relative to firms in exporting countries closer to the United States which may have a lower percentage of their costs determined by transportation costs.

[B3] Implicit in the formulation above is the assumption that the firm always uses Local Currency Pricing. Given that the data used in this paper is of US imports and the fact that over 90% of US imports are denominated in the dollar this is a reasonable assumption.

[B4] In order to get this result, one need only consider $\tau_{i,t}$ as a measure of transportation costs, ala the iceberg method, instead of a tariff rate.

Additionally, an individual firm would react to higher tariffs by raising prices. However, the tariff coefficient in Table B.1 is negative (row 5). This is the result of the nature of the tariff rate coefficient within the context of the unit value data. The observed tariff rate in the data is as follows:

$$observed\ tariff\ rate_t = \frac{q_{i,t} p_{i,t} \tau_{i,t} + q_{jt} p_{j,t-1} \tau_{j,t} + q_{k,t} p_{k,t-2} \tau_{k,t} + q_{l,t} p_{l,t-3} \tau_{l,t}}{q_{i,t} p_{i,t} + q_{jt} p_{j,t-1} + q_{k,t} p_{k,t-2} + q_{l,t} p_{l,t-3}} \tag{B.9}$$

The numerator of the observed price becomes the denominator of the observed tariff rate; creating a strong impetus for a negative coefficient in OLS. An alternative formulation for the tariff would be to use the observed per unit tariff given below.

$$observed\ per\ unit\ tariff_t = \frac{q_{i,t} p_{i,t} \tau_{i,t} + q_{jt} p_{j,t-1} \tau_{j,t} + q_{k,t} p_{k,t-2} \tau_{k,t} + q_{l,t} p_{l,t-3} \tau_{l,t}}{q_{i,t} + q_{jt} + q_{k,t} + q_{l,t}} \tag{B.10}$$

When the observed per unit tariff is used instead of the observed tariff rate the resulting coefficient is positive but insignificant.

The trend variable (row 6) denotes that prices for all goods and countries are tending to decrease over time as expected given decreased trade restrictions.

The macroeconomic condition of the exporting country is given in rows 7-18. An alternative setup would be to use dummy variables for each country. This however isn't required when estimating each country's pass-through rate individually.

Likewise, the dynamic macroeconomic condition in the importing country is controlled by the long-term inflation, short-term price volatility and monetary volatility (rows 21-23).

The exporting country's market share and the IIT index for industry are given in rows 19 and 20 respectively. While not explicitly modeled above in α, one way that the firms in the exporting country could increase their market share is to have lower prices; this is reflected in the negative coefficient in row 19. The coefficient in row 20 is not as the model would expect (as exporting countries with more differentiated products would likely be more able to raise prices) but it is insignificant.

So why use the results of Table B.1 to motivate the first stage regression to estimate the pass-through rate? The regressions in Table B.1 represent alternative estimation methods for the entire sample of all goods and countries. Using the Bayesian Information Criterion (BIC) I can test whether certain formulations are better for the entire sample. As the country specific pass-through rates must be compared relative to one another it is important to see what estimation formulation is optimal *for all countries when taken together*. The best BIC coefficient can be found when using Reg. 3. Reg. 3 is mirrored in the setup of Eq. 2.10b. Less optimal formulations, *for all countries taken together*, as measured by the BIC include Reg. 1 (mirrored by Eq. 2.10c), Reg. 2 (with U.S. price lagged variables), Reg. 4 (without the US macro variables) and Reg. 5 (mirrored by Eq. 2.10a). However, Eq. 2.10c is the estimation formulation most consistent with the theoretical model given above section B.1. Also, *when all countries are taken separately*, Eq. 2.10a is optimal as measured by the BIC for most of the 57 countries; this is shown below.

How much does all this matter? Probably not too much: the 2nd stage regression results in Table 4 are robust, remaining similar regardless of which estimation method is used in the 1st stage regression.

Now I turn to Table B.2 in order to see which estimation method works best *for all countries separately*. I also use the BIC for each of the 57 individual country regressions to see which of the three methods provides the “best fit”. The overwhelming favorite is the simplest regression, Eq. 2.10a.

The first method, Eq. 2.10a, is the simplest approach and is based on Reg. 5 of Table B.1. While Reg. 5 performs poorly relative to Reg. 1-3, individual countries find Eq. 2.10a optimal to all others. Out of the 57 countries, 31 countries find Eq. 2.10a superior to Eq. 2.10b, Eq. 2.10c (from the BIC). Thus, I state that there is evidence for Eq. 2.10a to be statistically superior.

The second method, Eq. 2.10b, also maintains some evidence for statistical superiority (9 of 57 countries by BIC). In Table B.1, Reg. 3 provides the best fit model from the BIC. As such Eq. 2.10b is modeled after Reg. 3 which omits the IIT index and the exporter's market share and includes the three U.S. macroeconomic variables.

The third method, Eq. 2.10c, is based on Reg. 1 from Table B.1. 17 of 57 countries are modeled best by Eq. 2.10c as determined by the BIC. I find economically compelling reasons for the use of Eq. 2.10c with this dataset. Because Eq. 2.10 is concerned with finding country specific pass-through rates, there is both a time and good component to the price data. The time component is controlled with a trend variable while Eq. 2.10c controls for some of the characteristics of the good with $IIT_{k,t}$ and $expshr_{j,k,t}$.

The pass-through estimates generated by Eq. 2.10a, Eq. 2.10b and Eq. 2.10c are presented in Table B.2. Regardless of the differences in the three methods of estimating the country specific pass-through rates, the methods produce very similar results as shown in Table 2.4. Some of the 57 pass-through estimates produce theoretically unfeasible pass-through rates (a feasible pass-through rate falls between 0 and 1). However, those countries with unfeasible pass-through rates tend to have a low weight; as such, in Eq. 2.11, the effect of those unlikely pass-through estimates is limited.

As shown in Table B.2, there are roughly 65% of the pass-through estimates from Eq. 2.10 that are not statistically different from the theoretical range of 0 and 1. While this is less than optimal, the sample size as a whole as shown in Table B.1 estimates the pass-through coefficient as .773. The price data in this paper is composed of volatile unit values rather than the price indexes studied in Yang (1997) and Campa and Goldberg (2002). As such, pass-through coefficients of the smaller samples will be more likely to exhibit extremes relative to the less volatile price index data.

85% of the coefficients on the US price variable, α_3, fall in the same theoretical range. However, for the tariff coefficient, α_4, only 60% of the pass-through estimates fall the theoretically predicted range; most of the tariff coefficients that are not theoretically as predicted are significantly negative. As noted above, this is mainly because of the construction of the tariff variable given in Eq. B.9. In an alternate formulation of the tariff variable, as given in Eq. B.10, the tariff coefficients are less likely to be below 0.

I reject the use of a "kitchen sink" approach, which makes use of macro variables from Eq. 2.11, to find the 57 country specific pass-through coefficients. When measuring the best fit model for each of the 57 countries, the "kitchen sink" model performs poorly relative to the simplest model given in Eq. 2.10a. The exporting country's macroeconomic variables do an excellent job of controlling for country specific effects in the regressions reported in Table B.1. However, Eq. 2.10 is regressed once for each of the 57 countries; there is little need to control for country specific effects. This may be due to the fact that each individual country's macroeconomic characteristics are fairly stable over the 4 year time period in the dataset. The average coefficient of variation for the additional RHS variables in the "kitchen sink" model is 16 compared to 114 in Eq. 2.11 and 56 in Eq. 2.14.

I also experimented with including lagged variables for the exchange rate, the foreign price and the U.S. price.

In order to test the usefulness of including additional lagged exchange rate variables[B5], I run the following regression for each of the 57 countries.

$$\ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) = \alpha_1 + \alpha_2 t + \alpha_3 \ln\left(\frac{p_{US,k,t}}{p_{US,k,t-1}}\right) + \alpha_4 \ln\left(\frac{(1+\tau_{j,k,t})}{(1+\tau_{j,k,t-1})}\right) + \alpha_5 Vol(\Delta \ln money_{US,t})$$
$$+ \alpha_6 Vol(\Delta \ln stcpi_{US,t}) + \alpha_7 ltinfav_{US,t} + \alpha_8 IIT_{k,t} + \alpha_9 expshr_{j,k,t} \quad \text{(B.11)}$$
$$+ \gamma_{j0} \ln\left(\frac{e_{j,t}}{e_{j,t-1}}\right) + \gamma_{j1} \ln\left(\frac{e_{j,t-1}}{e_{j,t-2}}\right) + \gamma_{j2} \ln\left(\frac{e_{j,t-2}}{e_{j,t-3}}\right) + \gamma_{j3} \ln\left(\frac{e_{j,t-3}}{e_{j,t-4}}\right) + \varepsilon_{k,t}$$

In Table B.2, the coefficient estimates for γ_{j0} are presented with the pass-through coefficients estimated for Eq. 2.10. In only 5 of the 57 countries does Eq. B.11 lead to more theoretically feasible pass-through rates (a theoretically feasible pass-through rate falls between 0 and 1). For 27 countries Eq. B.11 leads to less theoretically likely pass-through rates. Why? Most likely because of the implicit multicollinearity between the exchange rate lags and the macroeconomic variables. So long as the exchange rate itself follows an autoregressive process, there is a certain level of multicollinearity in the RHS of Eq. B.11. There is evidence for the presence of multicollinearity in Eq. B.11 as the average condition index statistic for the 57 countries is 31.1. A condition index statistic greater than 10 is an indication of instability. To contrast, the average condition index statistic for Eq. 2.10a is 1.7 and the average condition index statistic for Eq. 2.10c is 12.7[B6]. Because of the high level of

[B5] Both Campa and Golderg (2002) and Yang (1997) sum the coefficients on the four exchange rate lagged variables to determine long-run exchange rate pass-through. Short-run exchange rate pass-through is given by the coefficient on the first lagged exchange rate variable.

[B6] The low condition index statistic for Eq. 2.10a is another reason for statistical preference of pass-through coefficient estimates from that particular regression.

multicollinearity in the lagged exchange rates, the coefficient estimates of $\gamma_{j0}, \gamma_{j1}, \gamma_{j2}$ and γ_{j3} are unstable.

In order to add lagged variables of the LHS variable, $\ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right)$, I necessarily must drop all observations for which there is no record of imports of good *k* from country *j* in any of the 3 previous quarters. The result is that I must drop 19,982 of the 96,739 observations (20.6%). The remaining 76,757 observations are placed into the following regression equation:

$$\ln\left(\frac{p_{j,k,t}}{p_{j,k,t-1}}\right) = \alpha_1 + \sum_{q=1}^{3} \alpha_{q+1} \ln\left(\frac{p_{j,k,t-q}}{p_{j,k,t-1-q}}\right) + \sum_{r=0}^{3} \alpha_{r+5} \ln\left(\frac{p_{US,k,t-r}}{p_{US,k,t-1-r}}\right) + \sum_{s=0}^{3} \gamma_{js} \ln\left(\frac{e_{j,t-s}}{e_{j,t-1-s}}\right) + \varepsilon_{k,t} \qquad \text{(B.12)}$$

Because there is a strong autoregressive process in the movements of the exchange rate, I constrain $\gamma_{j1} = \gamma_{j2} = \gamma_{j3}$. As such, $\frac{\gamma_{j0}}{1 - \sum_{q}^{3} \alpha_{q+1}}$ represents the short-term pass-through rate while the long-term pass-through rate is defined as $\frac{\sum_{s}^{3} \gamma_{js}}{1 - \sum_{q}^{3} \alpha_{q+1}}$. The short-run and long-run pass-through coefficients of Eq. B.12 are reported in Figure B.1. Of all the regression equations used to determine the pass-through rate, Eq. 2.10a, 2.10b, 2.10c and Eq. B.11, Eq. B.12 provides the greatest number of pass-through estimates that fall in the theoretically feasible range between 0 and 1.

I place the short-term pass-through and long-term pass-through rate into Eq. 2.11 which is reproduced below.

$$\hat{\gamma}_j = \beta_1 + \beta_2 I_B + \beta_3 I_M + \beta_4 I_E + \beta_5 BAspread_j + \beta_6 exvol_j + \beta_7 \frac{GDP_j}{GDP_{US}}$$
$$+ \beta_8 \frac{percapitaGDP_j}{percapitaGDP_{US}} + \beta_9 ltinfav_j + \beta_{10} stcpivol_j + \beta_{11} mnyvol_j \quad \text{(B.13)}$$
$$+ \beta_{12} expshr_j + \beta_{13} sumIIT_j + \beta_{14} ImpElst_j + \beta_{15} dist_j + \beta_{16} tariffav_j + \varepsilon_j$$

The results are reported in Table B.3. Again, the theoretical work of Taylor (2000) remains valid. Long-term inflation increases the level of exchange rate pass-through while short-term price volatility decrease the level of exchange rate pass-through. The imputed elasticity variable is significant but is of the opposite sign.

Eq. 2.10a, 2.10b and 2.10c are all weighted in the same manner. Each weight is constructed to take into account both the value at time *t* and *t-1*:

$$weight_{k,j,t} = .5\left(TotalValueK_{j,t} + TotalValueK_{j,t-1}\right) \quad \text{(B.14)}$$

Eq. 2.10, Eq. 2.11, Eq. 2.13 and Eq. 2.14 are given an analytical weight (*aweight* in Stata). As there is a time, a good and a country component to the data, Eq. 2.10 and Eq. 2.13 are likely to possess heteroskedastic residuals. The use of analytical weights solves the potential problem of heteroskedasticity. In addition, because the LHS variable in Eq. 2.10 and Eq. 2.13 is a 1st moment and most of RHS variables in Eq. 2.10, Eq. 2.11, Eq. 2.13 and Eq. 2.14 are either 1st or 2nd moments I feel it is appropriate to use analytical weights. Because some observations represent a larger share of the market, Eq. 2.11, Eq. 2.13 and Eq. 2.14 make use of the weight outlined above. Thus, those observations with greater total value are given more weight.

Full results for all regressions in this paper and this paper's dataset can be found at www.unc.edu/~witte

B.3 Data Sources and Construction

This section of the appendix is designed to act as an index to the creation of variables and to designate their sources.

Both the U.S. price and foreign price data (3-digit SITC) are collected via the USITC's DataWeb. The total value of the exports and imports are also collected from DataWeb in order to aid in the construction of the IIT index and the exporter's market share. The data is collected by quantity measurement. As some goods are measured in multiple quantities, such as Grams and Kilograms, each observation is indexed by the quantity of measurement and the SITC code. For that reason, some SITC goods are observed multiple times for a single time period and a single exporting country.

There are many occasions when no observations occur in a time period because there is no record of exports from country *j* at time *t* for good *k*. Thus, for the sake of simplicity, only those observations that are ranked as being the top 200 in total export value are considered. Because each observation is weighted by the total value of the observation, the removal of those observations with little total value has a mitigated effect.

The exchange rate, including the bid and the ask price is collected on a daily basis from WM/Reuters. The exchange rate volatility is calculated as below:

$$exvol_{j,t} = StdDev\left(\ln\left(\frac{e_{j,t}}{\bar{e}_j}\right)\right) \quad \text{(B.15)}$$

$\bar{e}_j$ represents the average exchange rate over the two quarters in the observation.

The quarterly money supply, quarterly CPI and annual CPI change is compiled by the International Monetary Fund and was collected via the International Financial Statistics Browser. The measurements of GDP and per capita GDP are annually collected by the

World Bank. For Eq. 2.11 and Eq. 2.14, the RHS variables for each of the 15 time periods are averaged out for each of the 57 countries to control for the entirety of the observation window.

The DataWeb term for the total value of imports is “Customs Value” which is defined as the price paid or payable for merchandise. “Customs Value” excludes import duties, freight, insurance, and other charges. The quantity measure used to create unit values is the “First Unit of Quantity.”

The DataWeb term used for the total value of exports is the “Total FAS Export Value” which is defined as the value of exports at the U.S. port, based on the transaction price, including inland freight, insurance, and other charges incurred. The value excludes the cost of loading the merchandise and also excludes any further costs. The quantity measure used to create unit values is the “Total First Unit of Quantity.” Because the “Total FAS Export Value” includes freight and insurance the unit value constructed will likely be greater than the true unit value. However, because Eq. 2.10 and Eq. 2.13 use the differenced U.S. unit value solely as a cost control, there is a limited chance that the additional freight and insurance charges will affect the estimates of the pass-through coefficient in a meaningful way.

To find the tariff rate, I use DataWeb’s “Calculated Duties” divided by the “Customs Value”.

B.4 Non-EU Countries and Monetary Volatility

This section of the appendix is concerned with the possible bias of the coefficient on monetary volatility due to the presence of EU country observations.

Because the European Union countries all share the same currency, those countries all share the same monetary volatility. In Table B.4, I remove all EU countries from the sample and regress Eq. 2.11. Regardless of the method of estimation for the country specific pass-through rate, the volatility of money supply retains a positive, significant relationship with the pass-through rate.

Table B.1

(96739 Obs.) LHS = Change in Exporter's Price ln(pf,t/pf,t-1)	Reg. 1	Reg. 2	Reg. 3	Reg. 4	Reg. 5
Change in Exchange Rate **ln(et/et-1)**	*0.773*** (0.0307)	*0.773*** (0.0307)	*0.773*** (0.0307)	*0.792*** (0.0306)	*0.792*** (0.0306)
Change is US Price at time t **ln(pus,t/pus,t-1)**	*0.117*** (0.00626)	*0.117*** (0.00627)	*0.117*** (0.00626)	*0.120*** (0.00625)	*0.120*** (0.00625)
Change is US Price at time t-1 **ln(pus,t-1/pus,t-2)**		*0.000137* (0.000359)			
Distance	*-2.68E-06*** (1.02E-06)	*-2.68E-06*** (1.02E-06)	*3.53E-07* (6.08E-07)	*2.74E-06*** (1.02E-06)	*3.99E-07* (6.09E-07)
Tariff Rate	*-0.179*** (0.0798)	*-0.179*** (0.0798)	*-0.180*** (0.0798)	*-0.172*** (0.0799)	*-0.174*** (0.0799)
Time	*-0.00655*** (0.000769)	*-0.00655*** (0.000769)	*-0.00656*** (0.000769)	*-0.00261*** (0.000305)	*-0.00252*** (0.000304)
Banded Exchange Rate Dummy	*0.0358*** (0.0136)	*0.0358*** (0.0136)	*0.0438*** (0.0134)	*0.0365*** (0.0136)	*0.0448*** (0.0134)
Managed Float Dummy	*-0.0216*** (0.00554)	*-0.0216*** (0.00554)	*-0.0227*** (0.00553)	*-0.0231*** (0.00554)	*-0.0243*** (0.00553)
EU Dummy	-0.0224** *(0.00498)*	-0.0224** *(0.00498)*	-0.0115** *(0.00401)*	-0.0238** *(0.00498)*	-0.0125** *(0.00402)*
Bid-Ask Spread	*-1.646** (0.943)	*-1.649** (0.943)	*-1.397* (0.941)	*-2.112*** (0.942)	*-1.860*** (0.940)
Exchange Rate Volatility	*-2.458* (3.123)	*-2.454* (3.123)	*-2.094* (3.122)	*-0.583* (3.106)	*-0.240* (3.105)
GDP **(Exporting Country/U.S.)**	*0.0797*** (0.0161)	*0.0797*** (0.0161)	*0.0729*** (0.016)	*0.0809*** (0.0162)	*0.0738*** (0.016)
Per capita GDP **(Exporting Country/U.S.)**	*-0.0651*** (0.00810)	*-0.0651*** (0.00810)	*-0.0623*** (0.00806)	*-0.0702*** (0.00809)	*-0.0673*** (0.00806)
Average Annual CPI Inflation (Long-Term) **(Exporting Country)**	*-0.00081*** (0.000209)	*-0.00081*** (0.000209)	*-0.000645*** (0.000205)	*-0.000859*** (0.000209)	*-0.000689*** (0.000205)
Quarterly CPI growth volatility (Short-Term) **(Exporting Country)**	*0.746*** (0.183)	*0.746*** (0.183)	*0.694*** (0.182)	*0.790*** (0.182)	*0.739*** (0.181)
Quart. Money growth Volatility (Long-Term) **(Exporting Country)**	*-0.265*** (0.059)	*-0.265*** (0.059)	*-1.481* (0.942)	*-0.303*** (0.059)	*-0.239*** (0.057)
Exporter's Share of Market	*-0.152*** (0.041)	*-0.152*** (0.041)		*-0.157*** (0.041)	
IIT Index	*-0.000182* (0.00102)	*-0.000312* (0.00107)		*-0.000186* (0.00102)	
Average Annual CPI Inflation (Long-Term) **(US-Importing Country)**	*0.121*** (0.0216)	*0.121*** (0.0216)	*0.118*** (0.0216)		
Quarterly CPI growth volatility (Short-Term) **(US-Importing Country)**	*25.02*** (2.274)	*25.02*** (2.274)	*25.10*** (2.274)		
Quarterly Money growth Volatility **(US-Importing Country)**	*-1.576* (0.942)	*-1.577* (0.942)	*-1.481* (0.942)		
Constant	*-0.191*** (0.0504)	*-0.191*** (0.0504)	*-0.218*** (0.0499)	*0.098*** (0.0109)	*0.067*** (0.00723)
Adjusted R-squared	**0.0160**	**0.0160**	**0.0156**	**0.0142**	**0.0141**
BIC - Bayesian Information Criterion	**-1326.976**	**-1315.642**	**-1336.143**	**-1204.993**	**-1213.205**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * and ** respectively. As the regressions are weighted by the total value of each country's imports, the parameter values for significance are more strict.

Table B.2

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Australia	Passthrough Coefficient	1.411	1.337	1.310	2.197
	Standard Error	0.491	0.497	0.505	0.665
Weight	Price (US) Coefficient	0.026	0.013	0.012	0.016
1.37E+10	Standard Error	0.072	0.073	0.073	0.073
	Tariff Coefficient	-3.709	-3.721	-3.725	-3.717
	Standard Error	1.069	1.074	1.074	1.070
	Adjusted R-squared	0.0200	0.0221	0.0221	0.0260
	F-test	12.00	7.56	5.88	6.23
	BIC'	-16.58	1.86	17.30	19.10
Austria	Passthrough Coefficient	0.814	1.137	0.997	0.784
	Standard Error	0.391	0.444	0.474	0.629
Weight	Price (US) Coefficient	-0.129	-0.133	-0.130	-0.117
1.04E+10	Standard Error	0.073	0.073	0.073	0.074
	Tariff Coefficient	-5.670	-5.444	-5.415	-5.327
	Standard Error	1.832	1.836	1.836	1.837
	Adjusted R-squared	0.0666	0.0078	0.0081	0.0093
	F-test	5.29	3.59	2.87	2.49
	BIC'	11.15	31.36	46.79	67.00
Bangladesh	Passthrough Coefficient	4.077	4.728	4.334	-7.653
	Standard Error	0.613	0.689	0.655	1.545
Weight	Price (US) Coefficient	0.319	0.331	0.276	0.035
8.40E+09	Standard Error	0.052	0.057	0.054	0.055
	Tariff Coefficient	1.403	1.531	1.872	1.360
	Standard Error	0.689	0.687	0.653	0.593
	Adjusted R-squared	0.1515	0.1599	0.2556	0.3927
	F-test	28.81	17.94	23.42	34.56
	BIC'	-80.80	-70.72	-126.39	-246.07
Belgium	Passthrough Coefficient	0.482	0.356	0.303	1.789
	Standard Error	0.239	0.267	0.268	0.339
Weight	Price (US) Coefficient	-0.213	-0.221	-0.221	-0.190
3.19E+10	Standard Error	0.021	0.021	0.021	0.021
	Tariff Coefficient	-4.089	-4.549	-4.762	-4.611
	Standard Error	1.110	1.119	1.124	1.117
	Adjusted R-squared	0.0272	0.0295	0.0305	0.0466
	F-test	29.85	18.94	15.43	16.76
	BIC'	-84.56	-72.48	-62.00	-97.03

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Brazil	Passthrough Coefficient	1.161	1.145	1.257	1.431
	Standard Error	0.058	0.081	0.096	0.188
Weight	Price (US) Coefficient	0.052	0.049	0.047	0.050
5.14E+10	Standard Error	0.035	0.035	0.035	0.035
	Tariff Coefficient	-4.036	-3.995	-3.968	-3.877
	Standard Error	0.816	0.817	0.817	0.817
	Adjusted R-squared	0.0900	0.0894	0.0921	0.0907
	F-test	107.32	61.98	48.86	37.14
	BIC'	-376.34	-355.65	-344.40	-324.99
Canada	Passthrough Coefficient	0.636	0.769	0.779	0.345
	Standard Error	0.156	0.173	0.175	0.226
Weight	Price (US) Coefficient	0.075	0.081	0.081	0.085
2.51E+11	Standard Error	0.023	0.022	0.022	0.023
	Tariff Coefficient	-0.564	-0.050	-0.052	0.562
	Standard Error	2.507	2.490	2.491	2.491
	Adjusted R-squared	0.0103	0.0277	0.0270	0.0330
	F-test	8.10	12.13	9.45	8.79
	BIC'	-0.60	-28.46	-12.84	-9.00
Chile	Passthrough Coefficient	1.686	1.186	0.147	1.154
	Standard Error	0.216	0.369	0.403	0.522
Weight	Price (US) Coefficient	0.560	0.538	0.442	0.446
1.17E+10	Standard Error	0.067	0.068	0.068	0.068
	Tariff Coefficient	1.669	1.646	1.090	1.206
	Standard Error	0.571	0.581	0.578	0.576
	Adjusted R-squared	0.0923	0.0985	0.1248	0.1345
	F-test	37.42	23.36	23.71	19.71
	BIC'	-113.76	-104.79	-134.82	-133.53
Columbia	Passthrough Coefficient	1.628	1.371	1.402	2.188
	Standard Error	0.244	0.320	0.321	0.450
Weight	Price (US) Coefficient	0.162	0.148	0.150	0.190
1.87E+10	Standard Error	0.054	0.054	0.054	0.056
	Tariff Coefficient	0.154	0.187	0.133	0.769
	Standard Error	1.530	1.527	1.529	1.547
	Adjusted R-squared	0.0300	0.0322	0.0324	0.0403
	F-test	13.67	9.40	7.58	7.19
	BIC'	-24.08	-12.57	-0.02	4.86

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Croatia	Passthrough Coefficient	11.631	16.387	4.376	-36.753
	Standard Error	2.377	2.775	3.286	4.683
Weight	Price (US) Coefficient	0.055	-0.249	-0.105	0.163
4.25E+08	Standard Error	0.574	0.578	0.565	0.522
	Tariff Coefficient	-9.858	-9.066	-10.553	-13.614
	Standard Error	7.117	7.090	6.931	6.414
	Adjusted R-squared	0.0308	0.0460	0.0818	0.2184
	F-test	6.77	5.85	9.49	20.95
	BIC'	0.20	6.91	-21.51	-142.42
Cyprus	Passthrough Coefficient	6.237	6.658	6.675	3.842
	Standard Error	1.676	1.801	1.839	2.429
Weight	Price (US) Coefficient	0.428	0.251	0.251	0.368
4.24E+07	Standard Error	0.461	0.480	0.482	0.477
	Tariff Coefficient	0.014	-0.003	-0.005	0.042
	Standard Error	0.027	0.028	0.030	0.033
	Adjusted R-squared	0.0358	0.0416	0.0347	0.0675
	F-test	3.58	2.73	2.11	2.68
	BIC'	8.31	20.44	31.65	35.77
Czech Republic	Passthrough Coefficient	2.682	2.655	2.722	6.600
	Standard Error	0.426	0.452	0.454	0.789
Weight	Price (US) Coefficient	0.243	0.255	0.244	0.289
1.07E+09	Standard Error	0.150	0.150	0.151	0.149
	Tariff Coefficient	-0.999	-0.992	-0.955	-0.680
	Standard Error	0.882	0.881	0.882	0.865
	Adjusted R-squared	0.0264	0.0277	0.0279	0.0677
	F-test	10.83	6.90	5.62	9.63
	BIC'	-13.71	3.17	15.50	-24.82
Denmark	Passthrough Coefficient	1.315	1.701	1.845	2.107
	Standard Error	0.349	0.390	0.389	0.504
Weight	Price (US) Coefficient	0.331	0.293	0.294	0.295
5.30E+10	Standard Error	0.104	0.104	0.103	0.104
	Tariff Coefficient	8.211	8.200	8.403	7.962
	Standard Error	2.128	2.118	2.109	2.109
	Adjusted R-squared	0.0199	0.0310	0.0414	0.0449
	F-test	10.75	9.78	10.21	8.52
	BIC'	-12.37	-14.64	-22.16	-9.54

Table B.2 continued		**Eq. 2.10a**	**Eq. 2.10b**	**Eq. 2.10c**	**Eq. B.11**
Egypt	Passthrough Coefficient	0.512	0.557	0.607	0.622
	Standard Error	0.210	0.211	0.255	0.373
Weight	Price (US) Coefficient	0.151	0.132	0.132	0.139
2.75E+09	Standard Error	0.047	0.048	0.048	0.047
	Tariff Coefficient	4.303	4.458	4.477	4.741
	Standard Error	1.101	1.101	1.103	1.088
	Adjusted R-squared	0.0195	0.0227	0.0213	0.0499
	F-test	6.76	4.84	3.80	6.06
	BIC'	1.37	15.74	29.48	13.34
Finland	Passthrough Coefficient	0.924	0.611	0.473	0.035
	Standard Error	0.274	0.306	0.315	0.413
Weight	Price (US) Coefficient	0.063	0.023	-0.003	0.022
5.95E+09	Standard Error	0.119	0.121	0.122	0.124
	Tariff Coefficient	-6.507	-6.009	-5.971	-5.855
	Standard Error	2.182	2.173	2.173	2.175
	Adjusted R-squared	0.0129	0.0235	0.0242	0.0247
	F-test	5.93	6.19	5.17	4.19
	BIC'	5.68	8.30	19.80	37.99
France	Passthrough Coefficient	1.281	1.585	2.046	2.322
	Standard Error	0.285	0.317	0.344	0.481
Weight	Price (US) Coefficient	0.750	0.734	0.738	0.748
3.02E+10	Standard Error	0.083	0.083	0.083	0.084
	Tariff Coefficient	-2.722	-2.731	-2.452	-2.407
	Standard Error	0.947	0.947	0.948	0.951
	Adjusted R-squared	0.0413	0.0436	0.0475	0.0472
	F-test	29.41	18.17	15.61	11.87
	BIC'	-83.79	-69.46	-66.47	-44.88
Germany	Passthrough Coefficient	0.502	0.929	0.873	0.312
	Standard Error	0.196	0.217	0.218	0.324
Weight	Price (US) Coefficient	-0.105	-0.121	-0.124	-0.111
5.02E+10	Standard Error	0.054	0.054	0.054	0.054
	Tariff Coefficient	-0.643	-0.771	-0.569	-0.526
	Standard Error	0.869	0.869	0.872	0.873
	Adjusted R-squared	0.0087	0.0164	0.0181	0.0215
	F-test	6.85	7.34	6.43	5.87
	BIC'	4.23	4.15	13.49	24.77

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Ghana	Passthrough Coefficient	0.441	-0.224	-0.331	-0.162
	Standard Error	0.295	0.340	0.335	0.667
Weight	Price (US) Coefficient	2.813	2.644	2.611	2.617
4.81E+08	Standard Error	0.204	0.210	0.208	0.212
	Tariff Coefficient	-1.635	-1.755	-6.194	-8.287
	Standard Error	12.251	12.000	11.820	11.879
	Adjusted R-squared	0.3448	0.3719	0.3958	0.3963
	F-test	64.94	42.11	36.37	27.58
	BIC'	-185.17	-190.23	-198.76	-183.67
Greece	Passthrough Coefficient	2.538	2.211	2.211	2.419
	Standard Error	0.323	0.365	0.365	0.502
Weight	Price (US) Coefficient	0.241	0.257	0.256	0.255
1.56E+09	Standard Error	0.126	0.126	0.126	0.128
	Tariff Coefficient	-4.082	-3.914	-3.950	-4.032
	Standard Error	0.788	0.790	0.804	0.811
	Adjusted R-squared	0.0623	0.0680	0.0672	0.0656
	F-test	23.59	15.18	11.89	8.97
	BIC'	-62.71	-52.40	-38.83	-17.92
Hungary	Passthrough Coefficient	-12.270	-14.123	-15.046	-24.020
	Standard Error	1.069	1.324	1.480	1.833
Weight	Price (US) Coefficient	0.193	0.931	0.929	0.859
3.03E+09	Standard Error	0.406	0.419	0.419	0.388
	Tariff Coefficient	3.198	3.630	3.155	16.711
	Standard Error	2.925	2.879	2.901	2.863
	Adjusted R-squared	0.1010	0.1369	0.1369	0.2897
	F-test	34.53	28.05	22.05	41.59
	BIC'	-102.88	-133.30	-121.24	-335.88
Iceland	Passthrough Coefficient	2.113	2.316	2.163	1.756
	Standard Error	0.569	0.678	0.685	0.776
Weight	Price (US) Coefficient	-0.176	-0.168	-0.144	-0.130
7.42E+08	Standard Error	0.171	0.174	0.175	0.177
	Tariff Coefficient	25.181	25.191	25.886	26.289
	Standard Error	12.610	12.634	12.632	12.637
	Adjusted R-squared	0.0285	0.0254	0.0273	0.0276
	F-test	5.28	3.17	2.82	2.38
	BIC'	4.57	22.50	32.05	47.93

Table B.2
continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
India	Passthrough Coefficient	-12.393	-12.433	-12.515	26.308
	Standard Error	1.993	2.049	2.065	3.205
Weight	Price (US) Coefficient	0.576	0.581	0.581	0.517
2.70E+10	Standard Error	0.035	0.035	0.035	0.033
	Tariff Coefficient	2.541	3.196	3.176	-2.155
	Standard Error	2.905	2.912	2.919	2.716
	Adjusted R-squared	0.1306	0.1368	0.1362	0.2660
	F-test	91.23	55.39	43.08	73.54
	BIC'	-309.26	-306.09	-290.75	-661.73
Indonesia	Passthrough Coefficient	0.775	0.750	0.820	0.840
	Standard Error	0.070	0.072	0.082	0.102
Weight	Price (US) Coefficient	0.159	0.131	0.131	0.116
1.84E+10	Standard Error	0.033	0.033	0.033	0.033
	Tariff Coefficient	4.240	4.164	4.116	3.860
	Standard Error	0.531	0.527	0.528	0.528
	Adjusted R-squared	0.1193	0.1327	0.1333	0.1442
	F-test	62.32	40.58	31.94	26.64
	BIC'	-204.17	-212.47	-200.70	-204.28
Ireland	Passthrough Coefficient	0.935	1.199	1.725	10.112
	Standard Error	0.393	0.420	0.413	0.529
Weight	Price (US) Coefficient	0.206	0.182	0.179	-0.755
5.82E+10	Standard Error	0.087	0.087	0.085	0.095
	Tariff Coefficient	-2.596	-1.694	-1.108	4.908
	Standard Error	8.464	8.348	8.137	7.161
	Adjusted R-squared	0.0853	0.1110	0.1555	0.3481
	F-test	38.87	29.95	34.22	73.28
	BIC'	-119.34	-146.38	-217.07	-618.72
Israel	Passthrough Coefficient	1.321	2.323	2.280	2.033
	Standard Error	0.161	0.267	0.281	0.309
Weight	Price (US) Coefficient	0.038	0.051	0.051	0.060
2.89E+10	Standard Error	0.008	0.009	0.009	0.010
	Tariff Coefficient	-0.384	-0.339	-0.346	-0.368
	Standard Error	1.045	1.039	1.039	1.036
	Adjusted R-squared	0.0342	0.0460	0.0452	0.0508
	F-test	18.13	14.33	11.18	9.65
	BIC'	-41.10	-45.21	-30.44	-22.32

Table B.2 continued		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Italy	Passthrough Coefficient	1.063	0.363	0.546	0.846
	Standard Error	0.236	0.258	0.248	0.317
Weight	Price (US) Coefficient	0.030	-0.010	0.034	-0.008
2.62E+10	Standard Error	0.067	0.067	0.064	0.065
	Tariff Coefficient	-0.036	0.571	0.940	0.863
	Standard Error	1.284	1.273	1.222	1.220
	Adjusted R-squared	0.0075	0.0306	0.1085	0.1156
	F-test	5.91	12.72	36.11	29.28
	BIC'	7.88	-32.79	-236.53	-236.78
Japan	Passthrough Coefficient	0.643	0.754	0.617	1.173
	Standard Error	0.172	0.177	0.202	0.229
Weight	Price (US) Coefficient	-0.060	-0.065	-0.066	-0.081
5.95E+10	Standard Error	0.044	0.044	0.044	0.044
	Tariff Coefficient	-0.451	-0.463	-0.470	-0.477
	Standard Error	0.358	0.358	0.358	0.356
	Adjusted R-squared	0.0187	0.0202	0.0214	0.0312
	F-test	13.48	8.72	7.35	8.03
	BIC'	-21.98	-5.44	5.22	-0.64
Kazakhstan	Passthrough Coefficient	10.877	30.588	22.907	23.148
	Standard Error	9.946	12.821	12.265	22.702
Weight	Price (US) Coefficient	-0.390	-0.670	0.090	0.096
1.27E+09	Standard Error	0.663	0.654	0.640	0.645
	Tariff Coefficient	4.434	7.045	5.685	3.006
	Standard Error	7.245	7.131	6.766	6.921
	Adjusted R-squared	-0.0099	0.0346	0.1342	0.1383
	F-test	0.55	1.94	4.15	3.45
	BIC'	18.60	22.85	11.14	12.66
Kenya	Passthrough Coefficient	3.429	3.025	2.626	2.403
	Standard Error	0.899	0.935	0.927	1.383
Weight	Price (US) Coefficient	0.400	0.425	0.307	0.352
5.69E+08	Standard Error	0.142	0.157	0.157	0.165
	Tariff Coefficient	-1.651	-2.106	-2.419	-2.214
	Standard Error	1.046	1.069	1.069	1.100
	Adjusted R-squared	0.0378	0.0447	0.0701	0.0757
	F-test	6.86	4.99	6.00	5.07
	BIC'	-1.47	10.35	4.98	17.51

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Luxembourg	Passthrough Coefficient	0.332	0.537	0.613	-0.333
	Standard Error	0.708	0.785	0.824	1.084
Weight	Price (US) Coefficient	0.562	0.606	0.598	0.638
9.42E+08	Standard Error	0.274	0.278	0.281	0.283
	Tariff Coefficient	-1.460	-1.461	-1.427	-0.975
	Standard Error	1.361	1.371	1.375	1.392
	Adjusted R-squared	0.0039	0.0014	-0.0009	0.0008
	F-test	1.72	1.15	0.93	1.05
	BIC'	19.52	38.13	51.01	66.49
Mexico	Passthrough Coefficient	1.599	1.272	0.972	0.693
	Standard Error	0.111	0.118	0.120	0.151
Weight	Price (US) Coefficient	-0.046	-0.036	-0.050	-0.046
1.16E+11	Standard Error	0.018	0.018	0.018	0.018
	Tariff Coefficient	0.699	0.646	0.730	0.684
	Standard Error	0.387	0.383	0.377	0.375
	Adjusted R-squared	0.0850	0.1052	0.1322	0.1506
	F-test	63.36	46.08	46.43	40.65
	BIC'	-211.05	-250.22	-318.64	-355.52
Netherlands	Passthrough Coefficient	0.766	0.820	0.930	1.044
	Standard Error	0.284	0.316	0.344	0.460
Weight	Price (US) Coefficient	-0.025	-0.050	-0.053	-0.052
1.20E+10	Standard Error	0.087	0.087	0.087	0.087
	Tariff Coefficient	-1.361	-1.395	-1.368	-1.369
	Standard Error	0.649	0.648	0.649	0.652
	Adjusted R-squared	0.0095	0.0134	0.0129	0.0118
	F-test	6.81	5.72	4.53	3.42
	BIC'	4.04	14.72	29.59	52.61
New Zealand	Passthrough Coefficient	0.415	0.618	0.700	0.218
	Standard Error	0.176	0.201	0.204	0.273
Weight	Price (US) Coefficient	-0.020	-0.018	-0.017	-0.031
6.32E+09	Standard Error	0.060	0.060	0.060	0.061
	Tariff Coefficient	0.224	0.234	0.296	0.314
	Standard Error	0.201	0.202	0.203	0.203
	Adjusted R-squared	0.0302	0.0317	0.0339	0.0401
	F-test	13.30	8.41	7.16	6.51
	BIC'	-23.02	-6.50	2.75	11.52

Table B.2 continued		**Eq. 2.10a**	**Eq. 2.10b**	**Eq. 2.10c**	**Eq. B.11**
Nigeria	Passthrough Coefficient	0.999	0.431	0.677	-0.258
	Standard Error	0.364	0.388	0.404	0.428
Weight	Price (US) Coefficient	-0.099	-0.043	-0.024	0.123
3.22E+10	Standard Error	0.045	0.046	0.046	0.049
	Tariff Coefficient	-0.916	-19.483	-9.966	-23.865
	Standard Error	16.553	16.695	17.463	17.055
	Adjusted R-squared	0.0262	0.1182	0.1256	0.2030
	F-test	4.47	10.88	9.23	11.95
	BIC'	7.23	-28.38	-22.23	-54.51
Norway	Passthrough Coefficient	1.405	1.536	1.576	2.570
	Standard Error	0.213	0.271	0.273	0.335
Weight	Price (US) Coefficient	0.116	0.127	0.132	0.030
1.69E+10	Standard Error	0.050	0.050	0.050	0.052
	Tariff Coefficient	-2.003	-1.699	-1.560	-1.186
	Standard Error	2.386	2.373	2.376	2.334
	Adjusted R-squared	0.0305	0.0418	0.0416	0.0756
	F-test	13.85	11.19	8.88	12.14
	BIC'	-25.06	-25.09	-11.87	-51.85
Pakistan	Passthrough Coefficient	1.762	1.475	2.036	1.496
	Standard Error	0.239	0.294	0.293	0.434
Weight	Price (US) Coefficient	0.335	0.359	0.322	0.340
7.84E+09	Standard Error	0.048	0.051	0.050	0.051
	Tariff Coefficient	-3.179	-3.127	-2.062	-1.672
	Standard Error	0.894	0.892	0.876	0.881
	Adjusted R-squared	0.1186	0.1228	0.1717	0.1777
	F-test	43.29	26.13	29.95	23.64
	BIC'	-134.29	-121.85	-181.77	-172.58
Papau New Guinea	Passthrough Coefficient	1.003	0.701	0.737	1.136
	Standard Error	0.235	0.327	0.321	0.373
Weight	Price (US) Coefficient	0.677	0.649	0.558	0.607
1.39E+08	Standard Error	0.184	0.195	0.188	0.188
	Tariff Coefficient	-2.254	-2.525	-1.673	-2.722
	Standard Error	1.766	1.753	1.750	1.780
	Adjusted R-squared	0.2431	0.2598	0.3259	0.3576
	F-test	9.43	6.27	6.64	5.87
	BIC'	-14.98	-6.56	-9.34	-3.82

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Paraguay	Passthrough Coefficient	1.159	1.379	1.415	1.735
	Standard Error	0.296	0.513	0.520	0.691
Weight	Price (US) Coefficient	0.292	0.286	0.294	0.271
1.15E+08	Standard Error	0.191	0.192	0.193	0.195
	Tariff Coefficient	-1.425	-1.349	-1.447	-1.224
	Standard Error	1.064	1.099	1.111	1.119
	Adjusted R-squared	0.0470	0.0443	0.0394	0.0456
	F-test	4.65	2.96	2.35	2.18
	BIC'	4.42	19.29	30.13	42.16
Peru	Passthrough Coefficient	1.395	0.575	0.574	0.420
	Standard Error	0.578	0.635	0.636	0.768
Weight	Price (US) Coefficient	0.113	0.086	0.089	0.096
6.69E+09	Standard Error	0.060	0.061	0.062	0.062
	Tariff Coefficient	-0.060	0.188	0.095	-0.015
	Standard Error	0.660	0.665	0.682	0.695
	Adjusted R-squared	0.0089	0.0145	0.0140	0.0138
	F-test	4.10	3.91	3.18	2.61
	BIC'	12.58	23.38	36.57	55.50
Phillipines	Passthrough Coefficient	1.512	1.148	1.242	0.586
	Standard Error	0.238	0.283	0.281	0.294
Weight	Price (US) Coefficient	0.280	0.265	0.258	0.106
9.93E+09	Standard Error	0.050	0.053	0.052	0.052
	Tariff Coefficient	2.303	2.291	2.160	1.523
	Standard Error	0.259	0.260	0.258	0.257
	Adjusted R-squared	0.1035	0.1059	0.1241	0.1860
	F-test	44.11	26.25	24.50	29.43
	BIC'	-138.08	-123.03	-141.16	-231.85
Poland	Passthrough Coefficient	1.169	1.188	1.154	0.980
	Standard Error	0.350	0.364	0.395	0.519
Weight	Price (US) Coefficient	0.066	0.060	0.058	0.057
1.48E+09	Standard Error	0.107	0.108	0.108	0.110
	Tariff Coefficient	-0.806	-0.839	-0.845	-0.846
	Standard Error	0.930	0.933	0.936	0.936
	Adjusted R-squared	0.0055	0.0040	0.0028	0.0014
	F-test	3.19	1.90	1.49	1.18
	BIC'	16.70	38.18	52.85	74.11

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Portugal	Passthrough Coefficient	0.607	0.856	0.756	0.740
	Standard Error	0.193	0.214	0.215	0.275
Weight	Price (US) Coefficient	0.271	0.281	0.299	0.286
2.47E+09	Standard Error	0.036	0.037	0.037	0.037
	Tariff Coefficient	0.916	0.957	0.967	0.707
	Standard Error	0.933	0.933	0.929	0.937
	Adjusted R-squared	0.0495	0.0525	0.0602	0.0654
	F-test	18.87	11.86	10.77	8.99
	BIC'	-44.85	-30.47	-29.28	-18.16
Romania	Passthrough Coefficient	-0.994	-1.562	-1.147	-2.910
	Standard Error	1.201	1.551	1.635	1.783
Weight	Price (US) Coefficient	0.259	0.251	0.258	0.162
1.63E+09	Standard Error	0.147	0.149	0.149	0.151
	Tariff Coefficient	-3.355	-3.478	-3.488	-3.138
	Standard Error	1.370	1.378	1.378	1.401
	Adjusted R-squared	0.0140	0.0129	0.0118	0.0193
	F-test	5.53	3.37	2.70	3.09
	BIC'	6.59	26.52	40.12	48.94
Russia	Passthrough Coefficient	-1.442	-2.748	-3.705	-3.953
	Standard Error	0.649	0.925	0.956	1.539
Weight	Price (US) Coefficient	-0.094	-0.161	-0.169	-0.143
2.52E+10	Standard Error	0.047	0.048	0.048	0.048
	Tariff Coefficient	-0.817	-0.934	-0.705	-0.828
	Standard Error	1.216	1.198	1.194	1.181
	Adjusted R-squared	0.0076	0.0373	0.0461	0.0671
	F-test	4.39	10.77	10.48	11.56
	BIC'	12.37	-21.81	-25.08	-44.79
Singapore	Passthrough Coefficient	2.913	9.545	8.337	-9.529
	Standard Error	1.627	1.612	1.640	2.186
Weight	Price (US) Coefficient	-0.783	-1.007	-1.065	-1.760
7.01E+09	Standard Error	0.169	0.157	0.158	0.157
	Tariff Coefficient	-10.036	-6.526	-6.675	-7.045
	Standard Error	3.238	3.012	3.010	2.821
	Adjusted R-squared	0.0453	0.1788	0.1851	0.2882
	F-test	20.33	51.64	42.09	55.93
	BIC'	-50.02	-276.16	-275.90	-477.06

Table B.2
continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Slovenia	Passthrough Coefficient	2.736	2.586	2.394	2.413
	Standard Error	0.525	0.584	0.586	0.737
Weight	Price (US) Coefficient	-0.265	-0.261	-0.252	-0.238
9.14E+08	Standard Error	0.121	0.121	0.121	0.122
	Tariff Coefficient	0.618	0.549	0.115	0.225
	Standard Error	2.175	2.210	2.216	2.213
	Adjusted R-squared	0.0245	0.0229	0.0282	0.0340
	F-test	9.20	5.36	5.20	4.83
	BIC'	-7.75	13.00	18.24	28.87
South Africa	Passthrough Coefficient	2.340	2.407	3.518	5.141
	Standard Error	0.333	0.428	0.468	0.514
Weight	Price (US) Coefficient	0.621	0.599	0.605	0.811
1.28E+10	Standard Error	0.057	0.061	0.060	0.059
	Tariff Coefficient	-0.435	-0.452	0.284	-0.087
	Standard Error	2.113	2.114	2.104	2.000
	Adjusted R-squared	0.0817	0.0813	0.0951	0.1860
	F-test	44.39	25.67	23.79	38.16
	BIC'	-140.07	-119.53	-135.99	-322.98
South Korea	Passthrough Coefficient	0.199	-0.040	0.127	0.074
	Standard Error	0.152	0.161	0.191	0.204
Weight	Price (US) Coefficient	0.241	0.219	0.221	0.208
2.32E+10	Standard Error	0.045	0.046	0.046	0.047
	Tariff Coefficient	-0.727	-0.670	-0.706	-0.712
	Standard Error	0.327	0.327	0.327	0.330
	Adjusted R-squared	0.0149	0.0230	0.0237	0.0269
	F-test	10.25	9.22	7.60	6.64
	BIC'	-9.53	-9.28	2.47	14.81
Spain	Passthrough Coefficient	1.763	2.302	2.330	2.578
	Standard Error	0.237	0.263	0.263	0.340
Weight	Price (US) Coefficient	0.209	0.174	0.180	0.183
9.13E+09	Standard Error	0.067	0.067	0.067	0.068
	Tariff Coefficient	-7.103	-7.092	-7.290	-7.074
	Standard Error	0.856	0.853	0.856	0.862
	Adjusted R-squared	0.0576	0.0702	0.0720	0.0726
	F-test	37.08	26.47	21.34	16.41
	BIC'	-113.09	-124.59	-115.53	-96.90

Table B.2 continued		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Sri Lanka	Passthrough Coefficient	-1.229	-1.668	-1.765	-1.098
	Standard Error	0.699	0.707	0.707	0.748
Weight	Price (US) Coefficient	0.219	0.170	0.176	0.156
6.83E+09	Standard Error	0.051	0.053	0.053	0.054
	Tariff Coefficient	0.942	0.723	0.271	0.466
	Standard Error	0.967	0.968	0.980	0.980
	Adjusted R-squared	0.0258	0.0354	0.0403	0.0585
	F-test	7.71	6.31	5.74	6.25
	BIC'	-2.85	4.89	11.46	9.80
Sweden	Passthrough Coefficient	0.817	1.344	1.593	1.464
	Standard Error	0.276	0.289	0.289	0.395
Weight	Price (US) Coefficient	0.357	0.327	0.277	0.340
9.65E+09	Standard Error	0.077	0.076	0.076	0.078
	Tariff Coefficient	-0.680	-1.129	-1.163	-1.091
	Standard Error	1.016	1.011	1.003	1.004
	Adjusted R-squared	0.0148	0.0315	0.0475	0.0606
	F-test	9.07	10.96	12.90	12.54
	BIC'	-5.37	-21.95	-44.51	-54.20
Switzerland	Passthrough Coefficient	0.014	0.040	1.722	3.386
	Standard Error	0.491	0.547	0.567	0.841
Weight	Price (US) Coefficient	-0.022	-0.040	-0.038	-0.016
1.32E+10	Standard Error	0.083	0.083	0.082	0.083
	Tariff Coefficient	-20.543	-20.125	-19.435	-20.702
	Standard Error	2.955	2.965	2.910	2.915
	Adjusted R-squared	0.0192	0.0204	0.0568	0.0649
	F-test	12.13	7.79	16.25	14.16
	BIC'	-17.18	0.06	-72.73	-72.05
Taiwan	Passthrough Coefficient	0.500	0.363	1.093	0.943
	Standard Error	0.271	0.298	0.313	0.352
Weight	Price (US) Coefficient	0.117	0.097	0.081	0.084
2.23E+10	Standard Error	0.037	0.037	0.037	0.037
	Tariff Coefficient	-0.050	-0.038	-0.225	-0.311
	Standard Error	0.389	0.388	0.385	0.387
	Adjusted R-squared	0.0055	0.0109	0.0297	0.0313
	F-test	4.48	4.98	9.62	7.82
	BIC'	13.44	20.17	-14.92	1.47

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Thailand	Passthrough Coefficient	2.573	2.269	2.195	1.769
	Standard Error	0.226	0.258	0.257	0.256
Weight	Price (US) Coefficient	0.168	0.166	0.178	0.117
2.09E+10	Standard Error	0.026	0.026	0.026	0.026
	Tariff Coefficient	-2.746	-2.706	-2.499	-3.083
	Standard Error	0.631	0.634	0.632	0.626
	Adjusted R-squared	0.0979	0.1029	0.1123	0.1509
	F-test	59.60	36.39	31.37	32.98
	BIC'	-195.94	-187.92	-197.41	-273.34
Turkey	Passthrough Coefficient	1.063	0.988	0.925	0.707
	Standard Error	0.138	0.168	0.169	0.304
Weight	Price (US) Coefficient	-0.187	-0.214	-0.158	-0.149
8.30E+09	Standard Error	0.131	0.136	0.137	0.137
	Tariff Coefficient	3.015	3.110	3.070	2.754
	Standard Error	1.904	1.903	1.899	1.920
	Adjusted R-squared	0.0379	0.0401	0.0448	0.0462
	F-test	16.93	10.63	9.43	7.52
	BIC'	-36.97	-21.41	-16.70	0.15
United Kingdom	Passthrough Coefficient	0.160	0.405	0.136	1.041
	Standard Error	0.529	0.617	0.617	0.737
Weight	Price (US) Coefficient	0.688	0.689	0.695	0.675
5.85E+10	Standard Error	0.063	0.064	0.063	0.064
	Tariff Coefficient	-4.757	-4.787	-4.897	-4.829
	Standard Error	1.942	1.944	1.935	1.939
	Adjusted R-squared	0.0448	0.0442	0.0530	0.0540
	F-test	32.01	18.44	17.44	13.56
	BIC'	-93.75	-71.22	-82.12	-64.13
Uruguay	Passthrough Coefficient	1.052	1.014	1.178	1.280
	Standard Error	0.158	0.204	0.226	0.267
Weight	Price (US) Coefficient	0.050	0.075	0.067	0.080
6.79E+08	Standard Error	0.103	0.113	0.113	0.113
	Tariff Coefficient	-0.001	-0.006	0.011	-0.004
	Standard Error	0.281	0.282	0.282	0.281
	Adjusted R-squared	0.0489	0.0457	0.0469	0.0642
	F-test	11.31	6.48	5.38	5.59
	BIC'	-17.51	2.24	12.56	14.83

Table B.2 continued

		Eq. 2.10a	Eq. 2.10b	Eq. 2.10c	Eq. B.11
Vietnam	Passthrough Coefficient	-3.606	0.808	2.489	1.691
	Standard Error	1.301	1.420	1.471	1.785
Weight	Price (US) Coefficient	0.116	0.099	0.088	0.092
6.84E+09	Standard Error	0.033	0.034	0.034	0.034
	Tariff Coefficient	-2.196	-2.238	-2.288	-2.093
	Standard Error	0.334	0.331	0.330	0.330
	Adjusted R-squared	0.0644	0.1067	0.1172	0.1386
	F-test	22.78	22.58	19.67	17.96
	BIC'	-59.74	-99.85	-102.61	-115.19

Table B.3

Equation B.13 - (57 Obs.) **Pass-through estimates are generated by Eq. B.12**	**LHS is short-term pass-through estimate from Eq. B.6**	**LHS is long-term pass-through estimate from Eq. B.6**
Banded Exchange Rate Dummy	*-1.963** (1.09)	*-1.918* (1.66)
Managed Float Dummy	*-0.316* (0.496)	*-1.293** (0.755)
EU Dummy	*-0.085* (0.412)	*-0.211* (0.628)
Distance	*0.0000505* (0.0000872)	*0.0000148* (0.0001329)
Tariff Rate	*0.877* (6.228)	*8.398* (9.487)
Bid-Ask Spread	*-2.62* (94.63)	*-141.39* (144.15)
Exchange Rate Volatility	*39.8* (759.0)	*-425.7* (1156.0)
GDP **(Exporting Country/U.S.)**	*-0.566* (1.378)	*0.247* (2.099)
Per capita GDP **(Exporting Country/U.S.)**	*0.112* (0.708)	*-0.599* (1.078)
Average Annual CPI Inflation (Long-Term) **(Exporting Country)**	*0.0584*** (0.0227)	*0.0694** (0.0346)
Quarterly CPI growth volatility (Short-Term) **(Exporting Country)**	*-98.15*** (30.78)	*-92.70** (46.89)
Quarterly Money growth Volatility (Long-Term) **(Exporting Country)**	*3.699* (5.142)	*1.095* (7.832)
Exporter's Share of Market	*2.621* (3.197)	*0.654* (4.87)
Cumulative IIT Index	*-0.235* (1.228)	*0.528* (1.871)
Imputed Elasticity **(Cumulative good specific pass-through)**	*-0.994*** (0.405)	*-0.389* (0.617)
Constant	*1.314* (1.038)	*1.216* (1.582)
Adjusted R-squared	**0.3083**	**0.2394**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * and ** respectively. As the regressions are weighted by the total value of each country's imports, the parameter values for significance are more strict.

Table B.4

Equation 2.11 - (45 Obs.) LHS = Country specific pass-through estimate	LHS generated by Eq. 2.10a	LHS generated by Eq. 2.10b	LHS generated by Eq. 2.10c
Banded Exchange Rate Dummy	*-2.598* (3.476)	*-2.205* (3.864)	*-2.155* (3.538)
Managed Float Dummy	*-0.367* (1.577)	*0.536* (1.753)	*0.164* (1.605)
Distance	*0.00014* (0.00028)	*0.00031* (0.00031)	*0.00034* (0.00028)
Tariff Rate	*-4.554* (19.689)	*-5.041* (21.886)	*-1.117* (20.042)
Bid-Ask Spread	*581.3** (302.4)	*491.7* (336.1)	*508.4* (307.8)
Exchange Rate Volatility	*1628.3* (2472.4)	*2786.8* (2748.4)	*3513.4* (2516.8)
GDP (Exporting Country/U.S.)	*-4.692* (4.524)	*-7.019* (5.029)	*-8.238** (4.605)
Per capita GDP (Exporting Country/U.S.)	*5.099*** (2.362)	*7.082*** (2.626)	*7.434*** (2.405)
Average Annual CPI Inflation (Long-Term) (Exporting Country)	*0.037* (0.077)	*0.0228* (0.085)	*0.0047* (0.078)
Quarterly CPI growth volatility (Short-Term) (Exporting Country)	*-138.6* (100.7)	*-166.3* (111.9)	*-154.9* (102.5)
Quarterly Money growth Volatility (Long-Term) (Exporting Country)	*51.02*** (17.87)	*64.34*** (19.86)	*62.96*** (18.19)
Exporter's Share of Market	*14.44* (10.74)	*21.48** (11.94)	*22.16** (10.93)
Cumulative IIT Index	*-6.65* (4.783)	*-10.5** (5.317)	*-11.19*** (4.869)
Imputed Elasticity (Cumulative good specific pass-through)	*-7.246* (3.543)	*-10.617* (3.939)	*-10.568* (3.607)
Constant	*3.699*** (4.531)	*6.051*** (5.037)	*6.061*** (4.612)
Adjusted R-squared	**0.2223**	**0.2662**	**0.3547**

Note: Robust standard errors are in parenthesis. Significance at the 10% and 5% level is denoted by * and ** respectively. As the regressions are weighted by the total value of each country's imports, the parameter values for significance are more strict.

Figure B.1 **Pass-through rates from Eq. B.12**

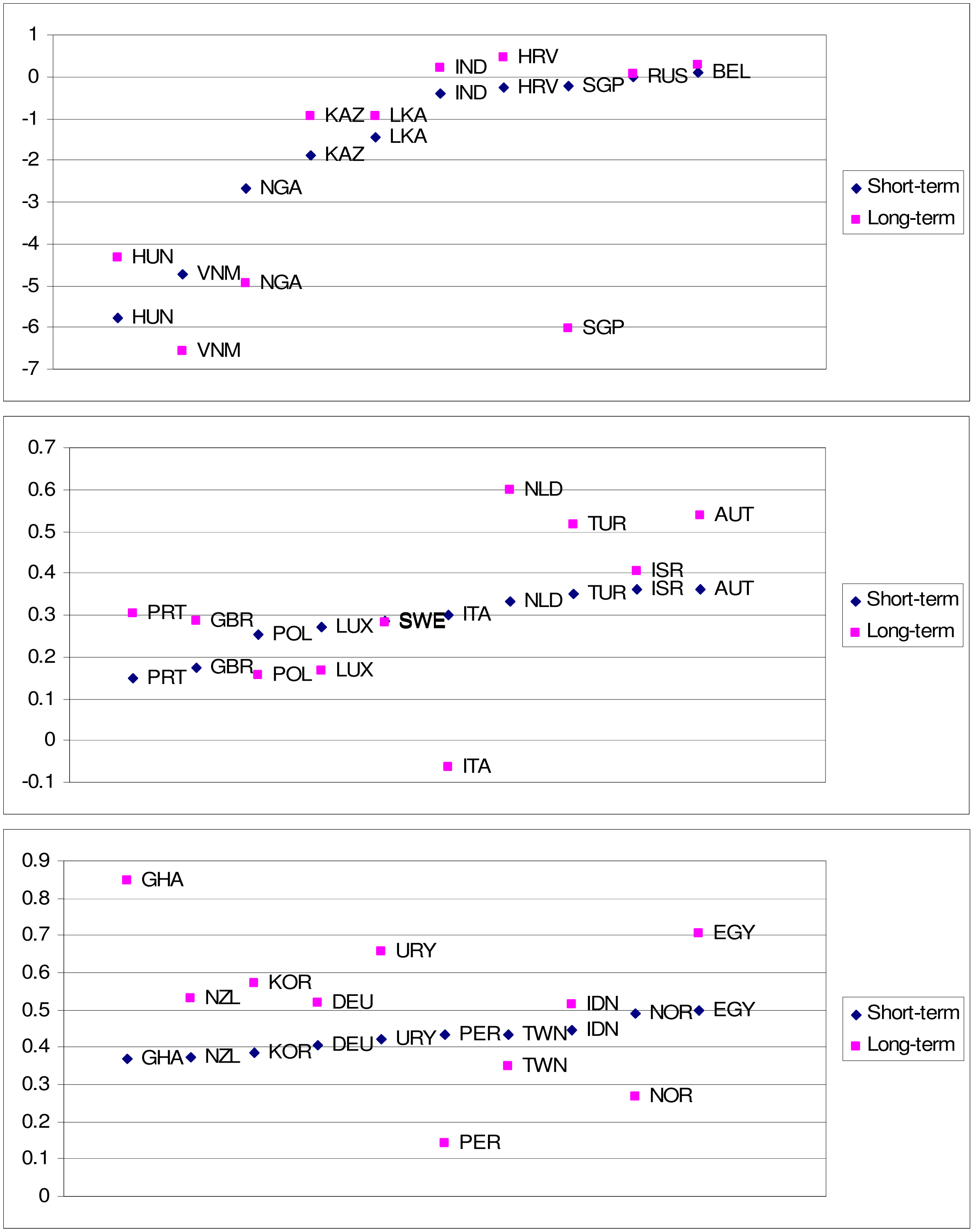
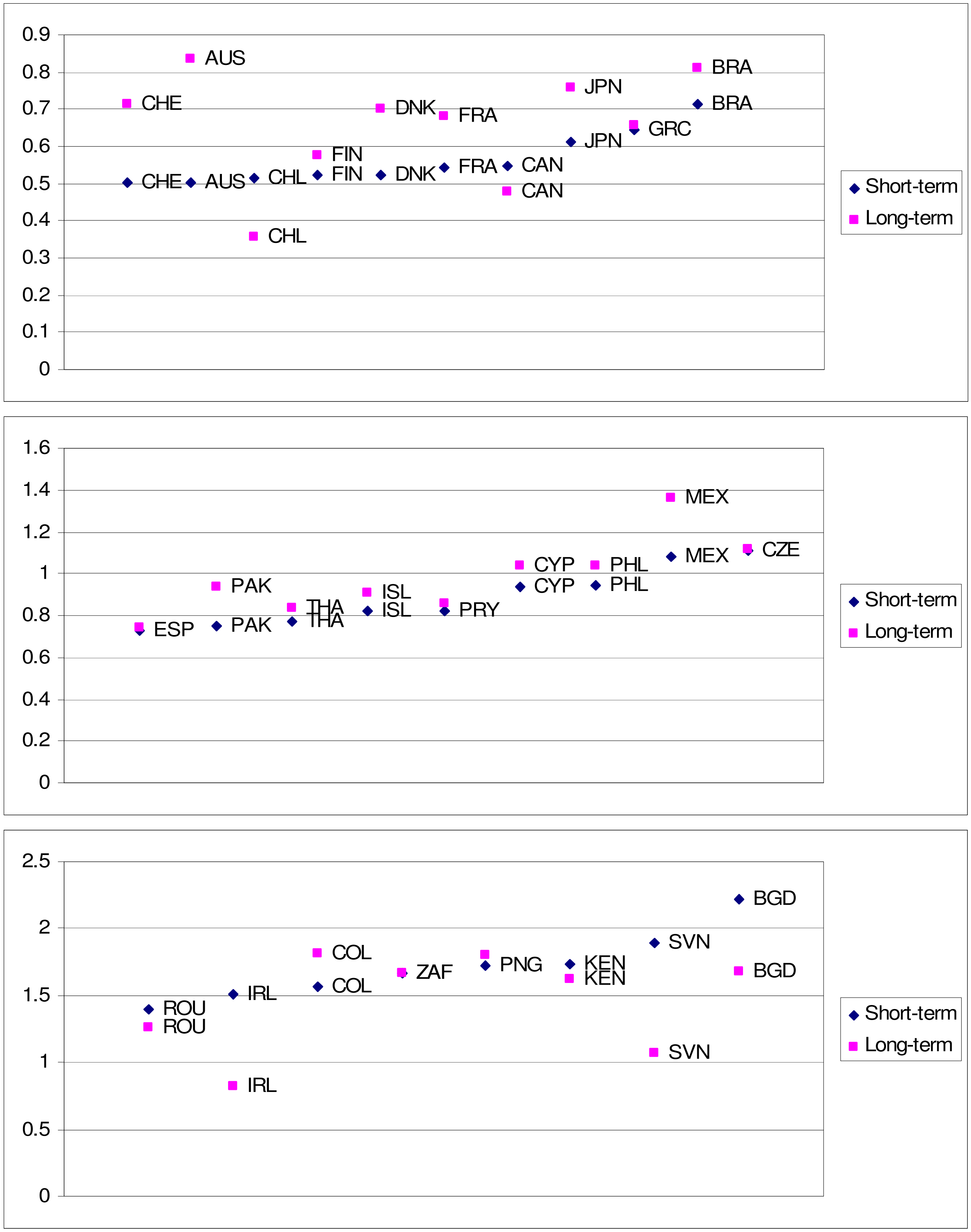


Figure B.1 **Pass-through rates from Eq. B.12**



Appendix C

The dynamic model is calibrated so that each period represents one month. As such, I allow the firm to choose a frequency of price adjustment from $K = 1\ldots23$. When $K = 23$, the firm's price remains unchanged for 2 years. The menu cost parameter, F, is .04 (the same as Devereux and Yetman (2005)). The discount factor is consistent with monthly time periods, $\beta = .99$.

First, I generate three exchange rates according to the following process designed to imitate a random walk:

$$\begin{aligned} \ln(e_{jk,t}) &= \ln(e_{jk,t-1}) + \mu_{jk,t} \\ \ln(e_{ik,t}) &= \ln(e_{ik,t-1}) + \mu_{ik,t} \\ \ln(e_{ij,t}) &= \ln(e_{ik,t}) - \ln(e_{jk,t}) - \tau_{ij} - \tau_{ik} - \tau_{jk} \end{aligned} \tag{C.1}$$

The construction of $\ln(e_{ij,t})$ is designed to fulfill a "no arbitrage" condition. The variances of the error terms, $\mu_{ik,t}$ and $\mu_{jk,t}$, are modeled in part after the variances of the US/Canada, US/Mexico and Mexico/Canada exchange rates as reported by International Financial Statistics. Just as in Friberg (1998), I allow forward currency markets to be efficient so that the forward currency rate is equal to the expected value of the exchange rate one period forward. In both Friberg's paper and in this paper the effect of forward currency contracts is pronounced (as shown in Figure C.1). Without forward currency contracts firms are much less likely to use LCP.

The exporter's wage, $w_{j,t}$, is based on inflation, but will tend to be sticky depending on movements in the shadow wage $\ddot{w}_{j,t}$[C1]. The shadow wage is based on the randomly determined inflation rate in country j, π_t^j. The inflation rate is based on individual country

[C1] Choudhri, Faruqee and Hakura (2005) convinced me of the necessity of sticky wages.

data from International Financial Statistics and is modeled as a random walk. The process for generating the wage is as follows:

$$\ddot{w}_{j,t} = \pi^{j}_{t-1}\ddot{w}_{j,t-1}$$

$$\text{if } \ddot{w}_{j,t} > 1.05 w_{j,t-1} \quad \text{then } w_{j,t} = \ddot{w}_{j,t} \tag{C.2}$$

$$\text{else } w_{j,t} = w_{j,t-1}$$

The parameter 1.05 demands that any increase in the wage be at least 5%. The targeted price index in the importing country, P^i_t, is determined by Eq. 3.5 which is reproduced below.

$$\ln(P^i_t) = \ln(P^i_{t-1}) + \delta_{ij}\ln\left(\frac{e_{ij,t}}{e_{ij,t-1}}\right) + \delta_{ik}\ln\left(\frac{e_{ik,t}}{e_{ik,t-1}}\right) + v_t \tag{3.5}$$

The variance of v_t is calibrated to the variance of several U.S. price indexes which display a random walk.

The firm's profit and price are calculated as given in Eq. 3.4 and Eq. 3.5. I average the exporting firm's profit over three trials to find the final results.

In the baseline model, the values of α are .2, .4, .6, .8 and 1. Values of λ are 1.1, 3.5, 5, 6.5 and 8. Meanwhile the values given to $\frac{\tau_{ik}}{\tau_{ij}} = \frac{\tau_{jk}}{\tau_{ij}}$ are .05, .1 and .2. The initial wage, $w_{j,0}$, takes the values of 10, 50 and 250. δ_{ij} and δ_{ik} each take the values of 0, .25, .5, .75 and 1. With these values there are a total of $5\times5\times3\times3\times5\times5 = 5{,}625$ possible combinations and as a result the model tests 5,625 hypothetical industries.

For the high importer/exporter exchange rate volatility model, the exogenous variables are the same as the baseline model. However Eq. C.1 is changed to include a normally distributed random variable as shown below:

$$\begin{aligned}
\ln(e_{jk,t}) &= \ln(e_{jk,t-1}) + \mu_{jk,t} \\
\ln(e_{ik,t}) &= \ln(e_{ik,t-1}) + \mu_{ik,t} \\
\ln(e_{ij,t}) &= \ln(e_{ik,t}) - \ln(e_{jk,t}) - \tau_{ij} - \tau_{ik} - \tau_{jk} + \varepsilon_t
\end{aligned} \tag{C.4}$$

The variance of ε_t is set to .6: making the variance of $\ln\left(\frac{e_{ij,t}}{e_{ij,t-1}}\right)$ roughly four times greater then the average variance of $\ln\left(\frac{e_{ik,t}}{e_{ik,t-1}}\right)$ and $\ln\left(\frac{e_{jk,t}}{e_{jk,t-1}}\right)$.

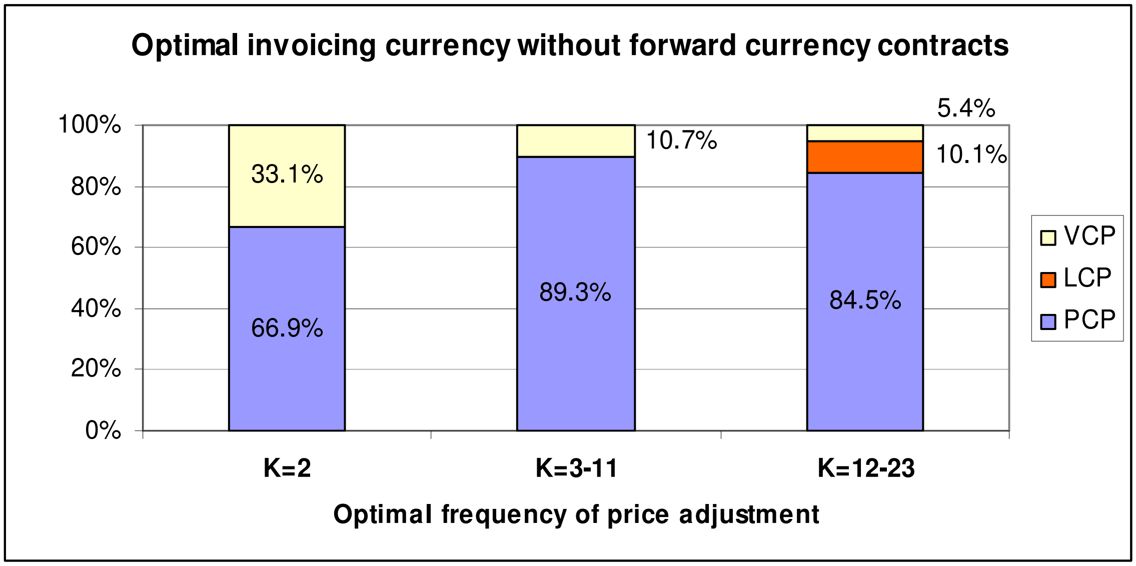
The high vehicle/exporter exchange rate volatility model also has the same set values of the exogenous variables from the baseline model. Eq. C.4 is changed so that the third equation generates $\ln(e_{jk,t})$ instead of $\ln(e_{ij,t})$. The variance of ε_t is set to .16: making the variance of $\ln\left(\frac{e_{jk,t}}{e_{jk,t-1}}\right)$ roughly four times greater than the average variance of $\ln\left(\frac{e_{ik,t}}{e_{ik,t-1}}\right)$ and $\ln\left(\frac{e_{ij,t}}{e_{ij,t-1}}\right)$.

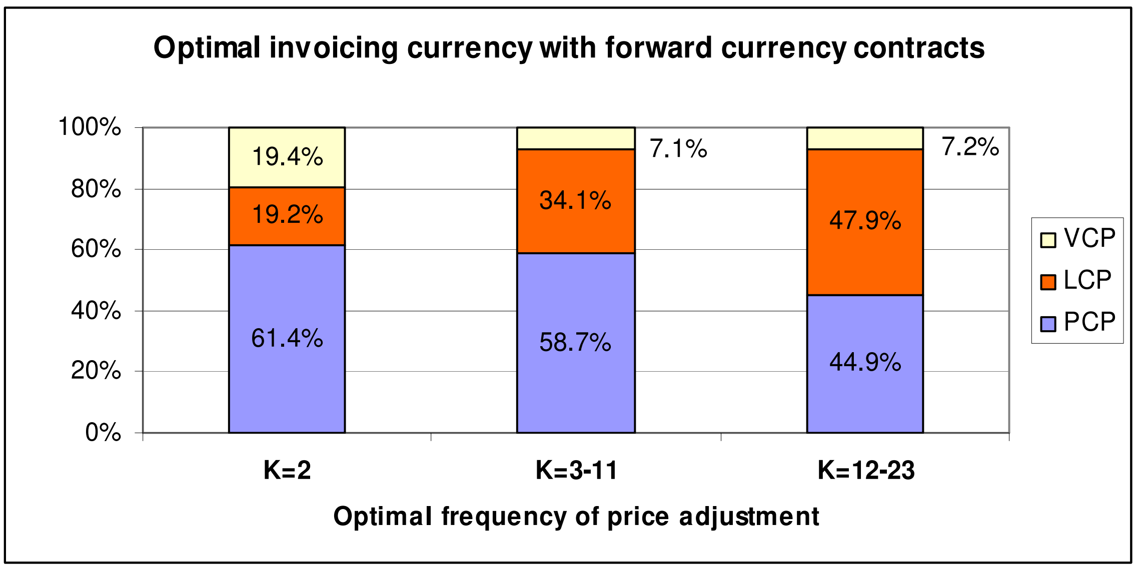
The full MATLAB model used in this paper may be found at www.unc.edu/~witte

Table C.1
Variables in the model and their descriptions

Variable Symbol	Variable Name	Variable Type
$q_{ij,t}$	Quantity sold of a good by a firm	Endogenous
$p^i_{ij,t}$	Price of good produced by a firm, denominated in currency *i*	Endogenous
P^i_t	Price index in country *i*	Exogenous-dynamic
$e_{ij,t}$	Exchange rate, currency of country *i* per one unit of currency *j*	Exogenous-dynamic
$f_{jk,t}$	Forward rate, currency of country *j* per one unit of currency *k*	Exogenous-dynamic
λ	Elasticity of substitution for the firm's good	Exogenous-static
τ_{ij}	Transaction cost for exchanging currency *i* for currency *j*, or vice versa	Exogenous-static
α	Returns to scale for the firm's production technology	Exogenous-static
L_t	Labor input	Endogenous
$w_{j,t}$	Wage in country *j*	Exogenous-dynamic
K_{Le}	Optimal Frequency of price adjustment, (in this case for LCP and no forward contracts)	Endogenous
I_{PCP}	Indicator variable, denotes that the firm is using PCP	Endogenous
I_F	Indicator variable, denotes that the firm is using forward currency contracts	Endogenous
π^{kf}_t	Maximum profit from using VCP (denominating in currency *k*) and using forward contracts	Endogenous
F	Menu cost	Exogenous-static
β	Discount factor	Exogenous-static
δ_{ij}	Pass-through rate of currency *j* to the price index in country *i*	Exogenous-static

Figure C.1
Effect of forward currency contracts on optimal invoicing currency





Note: In the top graph representative firms are not allowed to engage in forward currency contracts. In the lower graph firms can choose whether or not to use forward currency contracts.

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