Exchange Rate Pass-Through, Currency Invoicing and Trade Partners

Preliminary and Incomplete Draft

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Abstract

This paper investigates the pass-through from changes in exchange rates to import prices using a new and unique micro data set on Canadian imports over a six-year time span. The paper focuses on apparel imports and we begin by studying the relationship between exchange rate pass-through and the currency of invoicing of the imported good. Our preliminary findings support the theoretical literature indicating that the invoicing currency has a large impact on exchange rate pass-through. Pass-through is significantly higher for U.S. dollar invoiced goods than for Canadian dollar invoiced goods. In general, we find large estimates of exchange rate pass-through into import prices over this period. In addition, we find that in estimating pass-through rates, it is important to distinguish between the exporting country and the country of origin of imports. For imports denominated in U.S. dollars, exchange rate pass-through is significantly higher when the good is exported directly from the country of origin than if it is shipped indirectly through the U.S.

JEL Classification: F3, F4

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1. Introduction

The relationship between exchange rates and goods prices has been one of the most discussed and studied areas in international economics. A large part of the core theory of international trade and macroeconomics depends on assumptions about how prices, both at the retail level and 'at the dock' (at both the aggregate and individual firm levels), respond to changes in exchange rates. One central concept in both the theory and empirical work on this topic is that of 'exchange rate pass-through'. This pertains to the question of how much of an exchange rate change is reflected in domestic currency goods prices (when various controls are applied). There is a very large literature on exchange rate pass-through, both at the level of the individual firm, and at a more aggregate level of imports (see Knetter, 1989, Campa and Goldberg, 2005, and Burstein and Gopinath, 2013).

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It is an almost universally recognized fact that at all levels of aggregation, pass-through of exchange rate changes to prices is less than full. Early studies by Krugman (1987) and Froot and Klemperer (1989) suggested this was due to the presence of strategic forces leading firms to engage in 'pricing-to-market'. Later literature proposed that slow nominal price adjustment and local currency pricing (Devereux, Engel and Storgaard, 2003) may be responsible for partial pass-through both at the import price level and the level of retail prices. These two explanations are not at all exhaustive, however. Other theories of low exchange rate pass-through stress the role of distribution costs, or composition effects (Burstein, Neves and Rebelo, 2003, Nakamura and Zerom, 2010). Nor are the theories mutually exclusive—Engel (2006) and Gopinath et al. (2010) argue that the decision to engage in local currency pricing, which implies low short run pass-through, may coincide with the motivation for pricing to market, which, in turn, implies less than complete long run pass-through.

Progress in this literature has always been constrained by data availability. Recently, many studies of exchange rate pass-through have availed of more detailed micro data sets of goods prices (e.g. Gopianath et al., 2011). But it has been difficult to obtain comprehensive matched data on currency of invoicing and goods prices. The papers by Gopinath and Rigibon (2008) and Gopinath et al. (2010) focus on U.S. export and import price data. But it is widely accepted that the U.S. may be quite a special case (albeit an important one) due to the central nature of the U.S. dollar in international trade settlement and invoicing (Golberg and Tille, 2008).

This paper adds to the literature on exchange rate pass-through by focusing specifically on the relationship between pass-through to import prices and currency of invoicing. We exploit access to a new and extremely large data-set on Canadian import prices at a highly disaggregated level. The data includes the universe of Canadian import prices over a six-year period from 2002-2008. The rich nature of the data allows us to investigate how exchange rate pass-through differs for different categories of imports, for different currencies of invoicing, by country of origin and currency of export, and a series of other features of import prices.

To guide our empirical analysis, we develop a theoretical framework of monopolistic competition. Specifically, we first present a flexible price model to explore the determinants of exchange rate pass-through into import prices, then add sticky prices to emphasize the critical role of currency of pricing. Moreover, making an important distinction between country of export and country of origin suggests a higher rate of exchange rate pass-through for direct to market rather than round-about export goods.

In this paper, we report some preliminary findings from the data, focused only on import prices in the apparel sector. While in this sector, China has grown considerably in importance both as a direct exporter and as a country of origin of exports, the share of the U.S. dollar as an invoicing currency in weighted imports has remained constant over the whole data set at 85 percent, with a 10 percent share for Canadian dollars. Our initial focus then is to distinguish pass through rates between those goods invoiced in U.S. dollars relative to goods invoiced in Canadian dollars. Our notion of pass-through studied is intermediate between 'short-run' and 'long-run' pass-through measures used in the

literature.[4]

As in earlier literature, we find that pass-through is incomplete, but significantly higher than that found in previous papers, and much higher and more significant than pass-through found at retail levels. In addition, the empirical findings strongly support the theories of pass-through where currency of invoicing represents an important element in the size of pass-through. Specifically, we find that exchange rate pass-through is much higher for goods that are invoiced in U.S. dollars than goods invoiced in Canadian dollars, irrespective of exporting country. We also find that exchange rate pass-through differs significantly by both the exporting country and the country of origin of the imported good. Specifically, pass-through for goods invoiced in U.S. dollars but exported through the U.S. is significantly lower than for the same goods directly exported from the source country. We show that this holds particularly for apparel imports from China and India.

The paper proceeds as follows. Section 2 presents the theoretical discussion. Section 3 describes the data. Section 4 presents the empirical findings. Finally, Section 5 concludes.

2. Theoretical Discussion

In this section we explore the determinants of exchange rate pass-through into import prices in a simple model of monopolistic competition. This will help to frame the empirical analysis of the following sections. For the most part, the discussion borrows from previous literature, especially Burstein and Gopinath (2013), Amiti et al. (2012), Gopinath et al. (2010), and Hong and Li (2013).

Take a firm i exporting to a 'home' market within a sector k. The firm is assumed to have the CES demand schedule given by:

$$x_{ik} = {p_{ik}}^{-\rho} {p_k}^{\rho-\eta} X \tag{2.1}$$

where p_{ik} is the firm's price evaluated in home currency, and p_k is the sectoral price (also in home currency). We assume there is a finite number of firms in the sector, N, where N is small enough that firm i takes into account the impact of its pricing decision on the sectoral price index. The sectoral price index is defined as:

$$p_k = \left[\sum_{i=1}^{N} p_{ik}^{1-\rho} \right]^{(\frac{1}{1-\rho})} \tag{2.2}$$

The total demand for sector k goods is defined as:

$$x_k = {p_k}^{-\eta} X \tag{2.3}$$

As is usual, we assume that $\rho > \eta$, so that the elasticity of demand for individual goods is greater than the elasticity of demand for the sectoral composite good.

[4] While not exactly what Burstein and Gopinath (2013) refer to a medium-run pass-through, our concept of pass-through is similar.

Firm i's production technology combines local (foreign country) labour, some distribution services from the importing (home) economy, and possibly intermediate imports for a third country. We assume constant returns to scale in production. Firm i then has the technology given by:

$$x = \left[a^{\frac{1}{\gamma}} F_x^{1-\frac{1}{\gamma}} + (1-a)^{\frac{1}{\gamma}} N_x^{1-\frac{1}{\gamma}} \right] \tag{2.4}$$

where F_x represents domestic production of the foreign exporter, and N_x represents local (home country) content, such as distribution services, etc. In turn, we define domestic production as being determined by a combination of domestic labour and imported intermediate inputs:

$$F_x = L_x^{\alpha} I_x^{1-\alpha} \tag{2.5}$$

To simplify notation and discussion, assume that the both the price of imported intermediate inputs and the price of local distribution services in the home country is set equal to unity. Then the firm's cost function is then defined as:

$$c(w, s_f, s, x) = \left[a w^{\alpha} (\frac{1}{s_f})^{1-\alpha} + (1-a)\frac{1}{s} \right] x \tag{2.6}$$

where w is the nominal wage in the exporters currency, s_f is the exchange rate between the exporter's currency and the imported intermediate currency (intermediate firm's country currency price of exporter currency), and s is the exchange rate between the home currency and the exporter currency (home cost of exporter currency).

2.1. Exchange Rate Pass-Through with Flexible Nominal Prices

If prices are fully flexible, the currency in which the firm sets its price is irrelevant. Thus, without loss of generality, say the firm sets its price in home currency (local currency).

Evaluated in home currency, the exporters profit is defined as:

$$p_{ik} x_{ik} - s c(w, s_f, s, x) \tag{2.7}$$

If the exporter sets its price freely, its profit maximizing price is given by:

$$p_{ik} = \frac{\epsilon_{ik}}{\epsilon_{ik} - 1} s \left[a w^{\alpha} s_f^{1-\alpha} + (1-a)\frac{1}{s} \right], \tag{2.8}$$

where ϵ is defined as the firms demand elasticity, given by

$$\epsilon = -\frac{d \log(x_{ik})}{d \log(p_{ik})} = \rho - (\rho - \eta) \left[\frac{p_{ik}}{p_k} \right]^{1-\rho} \tag{2.9}$$

Now the market share of firm i in sector k sales is defined as:

$$\left[\frac{p_{ik}}{p_k}\right]^{1-\rho} = \frac{p_{ik}x_{ik}}{\sum_{i=1}^{N} p_{ik}x_{ik}} \equiv \theta_{ik} \tag{2.10}$$

So the firm's elasticity is

$$\epsilon(\theta_{ik}) = \rho - (\rho - \eta)\theta_{ik}. \tag{2.11}$$

If the firm's price is fully flexible, we can obtain the implied pass-through from the exchange rate to its price as follows. Take a log approximation around an initial equilibrium where $w^{\alpha}(\frac{1}{s_f})^{1-\alpha} = \frac{1}{s}$. We obtain the expression

$$\frac{d\log p_{ik}}{d\log s} = \frac{a}{1+\omega} + \frac{\omega}{(1+\omega)(1-\theta_{ik})}\sum_{j\neq i}\theta_{jk}\frac{d\log p_{jk}}{d\log s} + \frac{a}{1+\omega}\left[\alpha\frac{d\log w}{d\log s} - (1-\alpha)\frac{d\log s_f}{d\log s}\right] \tag{2.12}$$

where $\omega = -\frac{d\log(\mu)}{d\log(p_{ik})}$ is the elasticity of the markup to the firm's price. We can calculate this elasticity as follows[5]:

$$\omega = \frac{(\rho-\eta)(\rho-1)\theta_{ik}(1-\theta_{ik})}{\epsilon(\theta_{ik})(\epsilon(\theta_{ik})-1)}. \tag{2.13}$$

The expression (2.12) contains a number of separate determinants of exchange rate pass-through to the individual firm's price that can help guide our approach to the data. The first term on the right hand side of (2.12) captures the direct effect of the exchange rate on home currency denominated costs, adjusted for the local content used in production, and taking account of the impact of the price on the firm's markup through the change in its market share. The second term captures the indirect effect of the exchange rate change on the firm's markup through the degree to which all other firms in the sector adjust their price to the exchange rate. The third and fourth terms represent the proportional impact of the exchange rate change on the firm's domestic costs, and the degree to which the firm's cost of imported intermediate inputs is correlated with changes in the home country exchange rate.

To see this in more detail, assume that $\frac{d\log p_{jk}}{d\log s} = 0$ for all $j \neq i$, $\frac{d\log w}{d\log s} = 0$, and $\frac{d\log s_f}{d\log s} = 0$. Then pass-through equals the first term on the right hand side, $\frac{a}{1+\omega}$. Even if there was no local content, so that $a = 1$, pass-through would be less than unity because a rise in the firms price reduces its market share, and for $\rho > \eta$, this reduces its optimal markup. When $a < 1$, this further reduces pass-through because some of the firm's costs are home-currency denominated.

While endogenous markups will lower pass-through in this fashion, the effect of the firm's market share itself on this pass-through term is ambiguous. This is because ω is non-monotonic in θ_{ik}. To see this, note that

$$\frac{d\omega}{d\theta_{ik}} = \frac{\eta(\eta-1)\theta_{ik}^2 - \rho(\rho-1)(1-\theta_{ik})^2}{\epsilon(s_{ik})^2(\epsilon(\theta_{ik})-1)^2}. \tag{2.14}$$

[5]Note, this is the 'full' elasticity, which takes into account the effect of the change in the firm's price on the sectoral price index. In Amiti et al. (2013), they derive a 'partial elasticity' which involves taking p_k as given in deriving the elasticity.

For θ_{ik} close to zero, this is negative, while for θ_{ik} close to unity, it is positive. Intuitively, for θ_{ik} equal to zero or unity, the firm is either infinitesimal relative to the market, or is a monopoly firm in the sector, and the markup is a constant, determined only by elasticities. In between these two extremes, the firm's markup is endogenous, and increasing in θ_{ik}. But exchange rate pass-through depends not on the markup itself, but on the elasticity of the markup ω. For very low θ_{ik}, this elasticity is increasing in θ_{ik}, and pass-through is declining in θ_{ik}. But as θ_{ik} approaches one, the elasticity is decreasing in θ_{ik}, and pass-through is increasing in θ_{ik}. In the empirical analysis below, we use a number of alternative proxies for θ_{ik}. Our results seem to indicate that exchange rate pass-through is increasing in θ_{ik}.

Note that the second term in (2.12) indicates that an individual firm's exchange rate pass-through response cannot be divorced from the overall sectoral response. If for instance, all firms are of identical size, so that $\theta_{ik} = \frac{1}{N}$, then in an industry equilibrium pass-through will be independent of variations in markup and depend only on cost factors. This is because, using the second expression in (2.12), given that $\frac{d \log p_{ik}}{d \log s}$ is the same for all $i = 1..N$, the terms involving markup elasticities cancel out.

Finally, (2.12) makes clear that the presence of imported intermediate inputs for the foreign exporter, combined with correlated exchange rate movements, so that $\frac{d \log s_f}{d \log s} > 0$, reduces pass-through by reducing the fraction of the exporters costs that are affected by exchange rates. In this way, imported intermediate inputs act in the same way as local content in production, reducing pass-through both at the firm level and at the sectoral level.

2.2. Sticky Prices and the Choice of Invoicing Currency

If firms cannot freely adjust their prices, then exchange rate pass-through may differ substantially from that described in the last subsection. A large literature has linked exchange rate pass-through to price stickiness of various kinds.[6] One of the key determinants of exchange rate pass-through under sticky prices is the currency in which prices are set (e.g. Devereux and Engel, 2003.). If prices are set in producers currency (PCP), then pass-through is high, since final-goods prices in the importing country will adjust one-for-one with exchange rates. But if prices are set in the consumer's currency (LCP), the pass-through is much lower.

Empirical evidence on invoicing currency practices (see Cook and Devereux, 2006, Goldberg and Tille, 2009, Gopinath and Rigobon, 2008), suggest that there is a range of outcomes varying between LCP and PCP, although evidence on very low pass-through to consumer good prices (Engel, 1999) suggest significant LCP at the retail level. Since the choice of price-setting currency is of critical importance, an obvious question is: what factors should lead a firm to choose one currency over another in setting nominal prices for export?[7] Bachetta and Van Wincoop (2003), Devereux, Engel and Storgaard (2004) and Engel (2007) develop models of endogenous currency of pricing, in which firms must set a price in advance and can choose between LCP and PCP. Engel (2007) shows an intimate relationship

[6] See Engel (2008) and Devereux and Yetman (2009), for instance.

[7] Corsetti and Pesenti (2005) allow for the possibility that firms set prices somewhere 'in between' LCP and PCP, through the choice of an exchange rate indexing parameter which allows the selling price to adjust partially to ex-post exchange rate movements. Empirically, however, this practice does not seem to be observed.

between the determinants of pass-through for the firm with flexible prices, and the choice of currency of price-setting for the sticky price firm. In particular, he shows that a firm that would desire a large exchange rate pass-through elasticity under flexible prices is more likely to choose PCP if it must set the nominal price in advance. Gopinath et al. (2010) extend Engel's result to a model of Calvo staggered pricing. They show that the critical determinant of the currency of pricing is what they define as 'medium run pass-through', which measures the pass-through of exchange rate changes to a firm's price after it has an opportunity to adjust its price. In the empirical analysis below, we focus on a similar measure of exchange rate pass-through.

Adapting the results of Gopinath et al. (2008) to our model, assume that the firm can re-set prices only at random intervals according to the Calvo price adjustment process, where κ represents the probability that the firm's price is constant from one period to the next. Let $\tilde{p}_t$ be the firm's desired price in the home currency, as defined in the previous subsection[8]. Then $\tilde{p}_t^* = \tilde{p}_t - s_t$ is the desired price in the foreign currency. Assuming a discount factor β, up to a first order approximation in the Calvo model, the optimal price in local (i.e. home) currency for a firm which re-sets its price is given by:

$$p_t^{LCP} = (1 - \beta\kappa)E_t \sum_{j=0}^{\infty} (\beta\kappa)^j \tilde{p}_{t+j} \tag{2.15}$$

With producer currency pricing, the optimal price is:

$$p_t^{PCP} = (1 - \beta\kappa)E_t \sum_{j=0}^{\infty} (\beta\kappa)^j (\tilde{p}_{t+j}^*) = (1 - \beta\kappa)E_t \sum_{j=0}^{\infty} (\beta\kappa)^j (\tilde{p}_{t+j} - s_{t+j}) \tag{2.16}$$

If the exchange rate is a random walk then it follows that $p_t^{LCP} = p_t^{PCP} + s_t$. In this case, if the currency of price setting was assigned exogenously, independent of firm characteristics, then it would have no consequences for exchange rate pass-through, after the time of first price setting. But the key message of Gopinath et al. (2008) is that firms will self-select into LCP or PCP pricing decisions based on the exchange rate pass-through characteristics of their desired price. In particular, firms that wish to have a high medium run pass-through from the exchange rate to the local currency price will choose to set prices in the producer currency, otherwise they will choose local currency. The implication is exchange rate pass-through is higher for PCP firms, not because of price stickiness per-se, but because PCP firm's are those which desire to have a higher pass-through from unanticipated exchange rate shocks to local currency prices.

In the empirical analysis below, we will investigate the implications of this theory by asking whether exchange rate pass-through, conditional on a price change, is systematically different between goods which are invoiced in Canadian dollars relative to goods invoiced in U.S. dollars or other currencies.

More generally, this theory also has testable implications governing the determinants of currency invoicing. In particular it implies the the factors which *reduce* exchange rate pass-through, such as a high level of local content in production, imported intermediate goods, and a variable markup, should

[8]For notational simplicity, we drop the firm-sector notation here.

also lead to a greater tendency towards invoicing in Canadian dollars relative to other currencies[9].

2.3. Indirect Trade and Exchange Rate Pass-through

In a large fraction of our data on imported goods, there is a distinction between country of origin and country of export. For instance, in the apparel industry in 2008, 33 percent of imports by shipments came from China, but only 10 percent of shipments were directly exported by China; the rest were exported to Canada through the U.S., Hong Kong, or other countries. What implications does this have for exchange rate pass-through? In our model in the previous subsections, there was no difference between country of export or country or origin.

At least two factors suggest that exchange rate pass-through will be smaller in the case where country of origin and country of export differ. The first is the presence of value added generated by the country of export. This will reduce pass-through of exchange rate changes in the currency of the country of origin, unless the exchange rates of both countries are perfectly correlated. The second is the presence of double marginalization in pricing. With strategic price setting, Hong and Li (2013) show that fractionalization in the supply chain leads to a reduction in the pass-through of cost changes to final goods prices. Take the case where there is an original supplier of a good in a country of origin, and an import-export firm in the country of export. Then an exchange rate shock to the country of origin will have a lower pass-through to the final goods price when there is a separation between the pricing decision of the supplier and the import-export firm, and both behave strategically. The intuition is that original suppliers take account of not just of the impact of their own price changes on market share, but also the downstream effect of the price change on the import-export firm's market share. If both firms were merged into one exporter, then this double marginalization disappears, and exchange rate pass-through is higher.

The empirical implications of this theory are immediate. Conditional on price change, we should see a higher rate of exchange rate pass-through for goods in which the country of origin is the same as the country of export.

3. Data

We use data from the Canadian Border Services Agency (CBSA) customs database. The data set contains information on every single import/shipment into Canada from July 2002 to August 2008, and is organized at the 10-digit Harmonized System (HS) code level.[10] Our analysis in this paper focuses on the knitted and non-knitted apparel categories (the 2-digit HS codes 61 and 62). In the data, we observe to total value of each shipment, as well as the number of units in the shipment.[11] With this, we

[9] Goldberg and Tille (2008) also explore an empirical and theoretical model of currency invoicing. Our results are complementary to theirs.

[10] This data set is similar to the Argentine customs data used in Gopinath and Neiman (2013).

[11] For textiles, possible reported units are "numbers", "kilograms", and "parcels". We keep only transactions reported in "numbers" (note that observations reported in "numbers" make up 93 percent of the observations in HS 61 and 62).

use unit prices as a proxy for prices, defined as total shipment value divided by the number of units.[12] We also have information on the origin of the good (where it was produced), the exporting country (if this is different from the origin country), the purchasing company in Canada[13] and the currency in which the shipment was invoiced. If the shipment is invoiced in a currency other than Canadian dollars, the total value of the shipment in both Canadian dollars and the currency of invoice are reported, which allows us to back out an implied exchange rate. Finally, we know whether the reported transaction is trade among affiliated companies—we drop all of these imports as we want to focus on inter-firm, rather than intra-firm, trade prices.[14] With this, we are left with roughly 6.7 million price observations.

3.1. Summary Statistics on Imports

In this section, we provide some summary statistics on imports. We document the patterns of Canadian imports, both from the point of view of transactions count (shipments) and the point of view of transaction value (shipments weighted by shipment value). Our focus will be on documenting facts by country of export and country of origin,[15] as well as the currency of invoice, which are dimensions of the data that we explore further in the empirical work in this paper.

In Table 1, we report the percentage of shipments from a number of export countries (Canada's six biggest trade partners), as a percentage of total shipments and total value. In Table 2, we provide similar numbers to Table 1, but for country of origin, rather than country of export.

Although the U.S. remains Canada's major trading partner in terms of percentage of shipments, China has surpassed it to become Canada's biggest trading partner in the apparel sector in terms of percentage of import value. The European Union accounts for a significant percentage of Canadian apparel imports, though its share as country of origin is declining across time, similar to the U.S. Hong Kong, India and Bangladesh also show up on the radar and account for single digit shares of apparel shipments. It is important to distinguish between the country of export and country of origin. That the

Therefore our unit price is price per individual good, and the prices represent the price of a good that is part of single shipment into Canada.

[12]There are several issues that arise from using unit values as a proxy for prices, such as the fact that even though 10-digit HS codes are quite fine, there may still be more than one distinct product in each code, and therefore observed prices changes may be due to compositional changes within the 10-digit HS code, rather than changes in the true, underlying prices of individual goods. Moreover, there may be measurement errors in the number of units. These issues are raised in Berman, Martin and Mayer (2012) and Amiti, Itskhoki and Konings (2012) who use similar data. In section 3, we provide a very specific definition of a product that can be tracked over time that addresses these issues, to some extent, but the empirical results that we present must be interpreted with the understanding of this data limitation.

[13]The actual business number is scrambled, but we are able to identify a single buyer over time.

[14]See Neiman (2010) for an analysis of pass-though and intra-firm trade.

[15]To understand why the country of origin may differ from the country of export in our data, it helps to divide trade into to groups: direct and indirect trade. Direct trade is when a good is shipped directly from the producing country to the final destination country, or is transshipped via another country. In these cases, the country of origin will be the same as the country of export. Indirect trade is when a good is shipped from the country of origin to the final destination country, via an intermediary country and the good enters the economy of the intermediary country in the shipment process. This may, for example, occur through the use of a customs broker located in the intermediary country or extended warehousing in the intermediary country. It may also be considered indirect trade if there is value added to the good in the intermediary country. In the case of indirect trade, the intermediary may be listed as the country of export, which is different from the country of origin (in the case of value added to the product, the country of origin and export will be determined by the Rules of Origin).

Table 1: Country of Export

	Percentage of shipments							Percentage of value						
	U.S.	China	HK	E.U.	India	BD	Other	U.S.	China	HK	E.U.	India	BD	Other
2002	47	6	8	20	4	1	14	16	21	17	7	6	2	30
2003	47	7	7	21	4	2	13	16	22	14	7	7	6	28
2004	47	8	7	20	4	2	12	16	25	13	6	7	8	24
2005	45	10	7	20	4	2	11	17	31	15	6	6	7	19
2006	48	10	7	21	3	2	9	18	33	14	6	5	7	17
2007	50	11	6	20	3	2	8	16	36	14	6	7	6	16
2008	54	10	5	18	3	2	8	19	34	12	6	5	7	16

Table 2: Country of Origin

	Percentage of shipments							Percentage of value						
	U.S.	China	HK	E.U.	India	BD	Other	U.S.	China	HK	E.U.	India	BD	Other
2002	25	15	5	16	5	1	32	10	30	7	6	6	2	38
2003	23	15	4	15	5	2	34	10	30	6	5	7	6	36
2004	22	18	4	14	5	3	35	9	33	5	5	7	8	33
2005	17	26	2	12	6	3	34	7	45	2	4	7	7	28
2006	13	29	2	10	7	3	37	6	50	1	4	6	7	26
2007	12	33	2	9	5	3	36	5	53	1	4	5	7	25
2008	12	33	2	8	6	3	37	6	50	1	4	6	8	25

U.S. accounts for a much larger share as the country of export compared to country of origin suggests that there is a significant amount of indirect trade via the U.S. to Canada. Similarly, Hong Kong's share both in terms of shipment and value is higher as the country of export than country of origin may reflect its role as a trade intermediary re-exporting Chinese products.[16]

Finally, in Table 3, we present the percentages of shipments and imports, respectively, set in the major currencies. The share of U.S. dollar as an invoicing currency in weighted imports remained quite stable over the sample period of time at about 85%, followed by the Canadian dollar and the Euro.

4. Empirical Analysis

4.1. Panel Design: Defining Good Prices

Given that these prices represent transaction prices, but not necessarily unit prices that we can track over time, we combine price observations in order to define a good price that is importing firm

[16]Research on the nature of China's trade with Hong Kong has revealed that a large fraction of Hong Kong's exports originate from China, and these Hong Kong exporters are often intermediaries (Feenstra and Hanson, 2004).

Table 3: Currency of invoice

	Percentage of shipments						Percentage of value					
	USD	CAD	EUR	HKD	GBP	Other	USD	CAD	EUR	HKD	GBP	Other
2002	62	22	11	2	2	1	85	10	4	1	0	0
2003	63	22	11	2	2	1	84	11	3	1	0	0
2004	68	17	11	2	2	1	84	11	4	1	0	0
2005	67	17	11	2	2	1	85	11	3	1	0	0
2006	66	18	11	1	3	1	85	10	3	1	0	0
2007	67	19	11	1	2	1	85	10	4	1	0	0
2008	70	18	9	1	1	1	85	10	4	1	0	0

(f), HS10 product (p), country of origin (o), country of export (e), currency (c) and time (t) specific. For clarity of exposition, let $s = \{f, p, o, e, c\}$ in the subscripts. The price of a good can be defined as:

$$P_{st} = \Sigma_{i=1}^{n}(\alpha_{ist} \cdot P_{ist}) \tag{4.1}$$

where i is an individual transaction and α_{ist} is a weight, defined as the relative shipment size to total shipments of the $fpoec$ good. That is:

$$\alpha_{ist} = \frac{Shipment_{ist}}{\Sigma_{i=1}^{n} Shipment_{ist}} \tag{4.2}$$

where $Shipment_{ist}$ is the number of units in each shipment.

In addition, since we have a transaction-specific exchange rate for those goods priced in currencies other than the Canadian dollar (the exchange rate can vary depending on what day of the month a good crosses the border), we can create a $fpoect$-specific exchange rate, in a manner similar to the way we created a $fpoect$-specific price. For those goods priced in Canada dollars, there is no implied exchange rate in the data. We therefore match these observations with the monthly bilateral exchange rate between the Canadian dollar and the currency of the exporting country. With this definition of a $fpoect$-specific price, we now have a "collapsed" or "condensed" data set that is 66 percent smaller than the full data set for apparel imports.

4.2. Empirical Model

To examine the extent of exchange rate pass-through to import prices in Canada, we start with the following micro-price pass-through regression:

$$\triangle_{\tau} p_{st} = \beta \triangle_{\tau} e_{st} + Z'_{st}\gamma + \epsilon_{st} \tag{4.3}$$

where $\triangle_\tau p_{st} = ln(P_{st}) - ln(P_{s\tau})$ expressed in Canadian dollars and τ represents the last period in which this price is observed.[17] $\triangle_\tau e_{st}$ is the cumulative change in the log of the nominal exchange rate over the duration for which the previous price was in effect. Z_{st} are controls that include the cumulative change in the foreign consumer price level, export country market share, a dummy for large importers and product fixed effects (at the HS10 level). The CPIs of the country of origin are included as a proxy for production costs. Export country market share and the large importer dummy capture the strategic considerations in the markup decision. Export country market share is computed as the market share of exporters from country e in all Canadian imports in product p at the HS6 level, at each month t. It proxies the bargaining power of exporters. The large importer dummy variable takes a value of 1 if the particular transaction falls in the top 5th percentile of transactions for any HS4 product at time t and zero otherwise. Similar to Goldberg and Tille (2010), while a large transaction can reflect a large importer or exporter, we take this measure as a proxy for the size and bargaining power of the importer. In our benchmark specification, we take exporting country CPIs as the proxy for production costs because they are available for a broad group of countries. As alternatives, our robustness tests will consider U.S. PPI, U.S. nominal GDP and wage rates as cost measurements.[18]

Table 4: Exchange rate pass-through conditional on price adjustment

	(1)		(2)		(3)		(4)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
$\triangle_\tau e_{st}$	0.531	0.010	0.524	0.011	0.547	0.010	0.589	0.027
$\triangle_\tau CPI_{st}$	-0.149	0.024						
$\triangle_\tau PPI_{st}$			-0.026	0.022				
$\triangle_\tau GDP_{st}$					0.033	0.018		
$\triangle_\tau W_{st}$							0.902	0.079
$\triangle_\tau Exportershare_{st}$	0.024	0.000	0.023	0.000	0.023	0.000	0.026	0.001
$Largestimporter_{st}$	-0.004	0.001	-0.004	0.001	-0.004	0.001	-0.008	0.004
Constant	0.005	0.001	0.003	0.001	0.002	0.001	0.002	0.001
Obs.	2,080,350		2,138,512		2,163,178		400,430	

Table 4 presents the results for overall pass-through based on four regression specifications (note these regression are unweighted, i.e. they are not weighted by shipment value). We start with the country of origin CPI being the cost measurement variable in column (1), then change to U.S. PPI, U.S. nominal GDP and country of origin wage rates in column (2), (3) and (4). Overall, the coefficient estimates for the price sensitivity to exchange rates are quite robust across different specifications. The average price elasticity with respect to the exchange rate is around 0.55. At the macro level, empirical estimates of exchange rate pass-through to Canadian import prices are about 65 percent in the short run (Bailliu and Bouakez, 2004)—however, it has long been known that these macro estimates of pass-

[17] We have a very specific definition of a good price, and a good will not necessarily be imported every period.

[18] It is not possible to find monthly PPI and nominal GDP for many countries outside the U.S., so we use U.S. PPI and nominal GDP as rough proxies for production costs in all countries. For wages, we use a smaller sub-sample in which we are able to match a small number of countries to their wage rates.

through for Canada are likely to be biased upward because a number of Canadian import prices are constructed by multiplying the foreign-currency price by the nominal exchange rate.

Changes in export country market share are positively associated with price changes so that exporting firms with increasing market shares have larger Canadian dollar price adjustment. On the other hand, the coefficient on largest importer is negative, implying that larger import bargaining power leads to smaller price adjustment. Although the choice of production cost proxies does not seem to matter for the rest of the coefficient estimates, their own estimates differ quite a bit. In general, wage rates seem to provide a better proxy for the cost term as the coefficient estimate is positive and significant. But the sample size in regression (4) is also dramatically reduced due to data availability. Since the monthly CPI series are available for a broad set of countries and the exchange rate pass-through coefficient is quite robust to the choice of cost proxies, we use the specification in regression (1) as the baseline specification in the follow-up analysis.

In Table 5, we present the same set of regression results as in Table 4 for the sub-sample where the country of origin and export is the U.S. as a cross check. In this sub-group, we are not subject to data availability constraint, and by using U.S. CPI, PPI, nominal GDP and wages, we have an exact match to the production cost proxy of the goods produced in the U.S. These regression results suggest that all cost proxies have significant and positive coefficient estimates. In addition, the rest of the estimates are generally robust to the choice of cost proxy.

Table 5: Exchange rate pass-through conditional on price adjustment: country of origin being U.S.

	(1)		(2)		(3)		(4)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
$\triangle_\tau e_{st}$	0.646	0.032	0.634	0.033	0.771	0.035	0.718	0.032
$\triangle_\tau CPI_{st}$	0.860	0.095						
$\triangle_\tau PPI_{st}$			0.555	0.072				
$\triangle_\tau GDP_{st}$					0.745	0.059		
$\triangle_\tau W_{st}$							1.161	0.092
$\triangle_\tau Exportershare_{st}$	0.010	0.002	0.010	0.002	0.012	0.002	0.011	0.002
$Largestimporter_{st}$	-0.007	0.005	-0.007	0.005	-0.006	0.005	-0.006	0.005
Constant	0.002	0.002	0.003	0.002	0.000	0.002	0.000	0.001
Obs.	339,881		335,323		339,881		339,881	

Next, we present the results for pass-through by country of export, origin or currency of invoicing in Table 6, where only exchange rate pass through coefficients are reported. There is a large degree of heterogeneity across exporting countries. Both in terms of country of export and origin, India has the highest exchange rate pass-through to the Canadian dollar import prices, while the EU has the lowest. Except for Bangladesh, all other major trading countries have somewhat different degree of exchange rate pass-through depending on whether they are the country of origin or export. This suggests that it is important to make a distinction between the country of export and origin when examining pass-through. For example, the U.S. produced goods have a higher pass-through than the U.S. exported

goods, indicating that there are significant amounts of products with lower pass-through that are exported from the U.S. but not produced there. In terms of invoicing currency, our findings support the theoretical and empirical literature (Gopinath et al., 2010, and Fitzgerald and Haller, 2013) in that pass-through is significantly higher for U.S. dollar invoiced goods than for Canadian dollar invoiced goods. Pass-through is also low for Euro invoiced goods.

Table 6: Exchange rate pass-through: by country of export, origin or currency of invoice

Country of export			Country of origin			Currency of invoice		
Country of export	β	s.e.	Country of origin	β	s.e.	Currency of invoice	β	s.e.
US	0.524	0.020	US	0.644	0.032	USD	0.554	0.012
China	0.706	0.028	China	0.655	0.019	CAD	0.270	0.035
EU	0.226	0.022	EU	0.162	0.027	EUR	0.242	0.025
Hong Kong	0.761	0.027	Hong Kong	0.581	0.053	Other	0.598	0.152
India	0.797	0.054	India	0.682	0.045			
Bangladesh	0.344	0.098	Bangladesh	0.335	0.079			
Other	0.416	0.027	Other	0.526	0.017			

To further look into how pass-through could differ for direct trade versus indirect trade, in Table 7 we present the results for some cross-combinations for country of origin, export, and currency of invoice.

Table 7: Exchange rate pass-through: by country of origin, export and currency of invoicing

Country of origin	Country of export	Currency of invoice	β	s.e.	Obs.
US	US	USD	0.677	0.033	315,996
US	US	CAD	0.046	0.162	23,849
EU	EU	USD	0.544	0.162	15,089
EU	EU	CAD	-0.176	0.070	53,980
EU	EU	EUR	0.248	0.033	203,717
China	China	USD	0.674	0.028	256,929
China	China	CAD	1.670	0.223	8,354
China	Hong Kong	USD	0.754	0.032	117,614
China	Hong Kong	CAD	0.123	0.204	8,184
China	US	USD	0.370	0.052	136,861
China	US	CAD	-0.448	0.228	7,615
Hong Kong	Hong Kong	USD	0.649	0.057	25,552
Hong Kong	Hong Kong	CAD	0.151	0.391	1,996
Hong Kong	US	USD	0.642	0.143	15,685
Hong Kong	US	CAD	0.106	0.585	1,089
India	India	USD	0.858	0.061	72,858
India	India	CAD	0.908	0.128	26,337
India	US	USD	0.559	0.137	19,597
India	US	CAD	-0.283	0.393	1,313

Note that not all coefficients are significant and meaningful given the rather small sample sizes in

some cases (usually the Canadian dollar invoiced transactions). Focusing on the U.S. dollar invoiced transactions, the pass-through for products made in China but exported through the U.S. (around 0.4) is much lower than for the goods made in China and directly exported from China or via Hong Kong (around 0.7). Similarly, pass-through for products invoiced in U.S. dollars and made in India but exported through the U.S. (around 0.6) is also lower than for the goods made in India and directly exported from India (around 0.9). In order to see if the goods that are exported from the country of origin directly are any different than those shipped indirectly through the U.S., we look at a breakdown of the type of products (at the 3-digit HS level) by country of export and origin in Table 8 and 9. At the HS level, there does not appear to be a significant difference in the types of goods imported from each country.

For what seem to be similar products, why are some of them shipped directly from the country of origin to Canada, while others shipped indirectly through the U.S.? It may have something to do with the role of intermediary firms in facilitating trade across borders. For example, a Canadian firm that does not have direct links to Chinese exporters has to rely on U.S. intermediary companies to bring the goods to North America before bringing them into Canada. In this case, the goods are shipped from China to the U.S., where the customs details and/or extended warehousing and/or (in some cases) transportation to Canada are taken care of by the U.S. intermediary company. For those Canadian companies that have direct trade links with Chinese exporters, the goods are more likely to be shipped directly to Canada. Based on discussions with officials at the Canadian Border Services Agency, this may be linked to firm size and export experience, as larger, more experienced firms are more likely to have contacts (i.e. customs brokers and others to handle logistics) in China that can organize direct shipment (or transshipment) of goods to Canada, whereas smaller importers are more likely to rely on U.S. customs brokers and distributors. We are continuing to look into the connection between firm characteristics and imports in the Canadian apparel industry.

Table 8: Type of products by country of export

	Percentage of shipments							Percentage of value						
HS3	U.S.	China	HK	E.U.	India	BD	Other	U.S.	China	HK	E.U.	India	BD	Other
610	46	9	7	14	5	3	16	15	24	12	3	11	9	25
611	35	14	12	17	3	2	16	10	32	23	4	5	5	21
620	38	12	9	21	4	2	13	12	34	14	7	5	7	22
621	51	11	5	14	5	1	13	17	33	12	7	5	4	22

Finally, we include interaction terms between changes in exchange rate and export country market share and the large importer dummy in the baseline framework and run the following regression:

$$\triangle_\tau p_{st} = \beta_1 \triangle_\tau e_{st} + Z'_{st}\gamma + \beta_e(\triangle_\tau e_{st} \cdot \triangle_\tau Exportershare_{st}) + \beta_i(\triangle_\tau e_{st} \cdot Largestimporter_{st}) + \epsilon_{st} \quad (4.4)$$

Table 9: Type of products by country of origin

	Percentage of shipments							Percentage of value						
HS3	U.S.	China	HK	E.U.	India	BD	Other	U.S.	China	HK	E.U.	India	BD	Other
610	19	21	2	10	7	4	38	7	35	2	2	11	10	32
611	13	33	5	12	5	3	31	6	50	6	3	5	5	26
620	14	29	3	15	6	3	30	5	46	3	5	6	7	29
621	22	28	1	11	7	1	29	9	48	1	6	5	4	28

The regression results are reported in Table 10. In column (5), only the interaction term with exporter market share change is included. In column (6), only the interaction term with importer bargaining power is included. In column (7), both interaction terms are included. The positive and significant estimates of α_e and α_i suggest that exporting firms with increasing shares in the Canadian market have higher exchange rate pass-through to their CAD invoiced prices. On the other hand, the Canadian importing firms with bigger size or bargaining power also have larger price elasticity to exchange rate movements.

Table 10: Exchange rate pass-through and exporter/importer market share

	(5)		(6)		(7)	
	Coeff.	s.e.	Coeff.	s.e.	Coeff.	s.e.
$\triangle_\tau e_{st}$	0.526	0.010	0.510	0.011	0.505	0.011
$\triangle_\tau CPI_{st}$	-0.143	0.024	-0.146	0.024	-0.139	0.024
$\triangle_\tau Exportershare_{st}$	0.026	0.000	0.024	0.000	0.026	0.000
$Largestimporter_{st}$	-0.004	0.001	-0.001	0.001	-0.001	0.001
$\triangle_\tau e_{st} \cdot \triangle_\tau Exportershare_{st}$	0.069	0.006			0.070	0.006
$\triangle_\tau e_{st} \cdot Largestimporter_{st}$			0.189	0.028	0.195	0.028
Constant	0.004	0.001	0.004	0.001	0.004	0.001
Obs.	2,080,350		2,080,350		2,080,350	

5. Conclusion

To be added..

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