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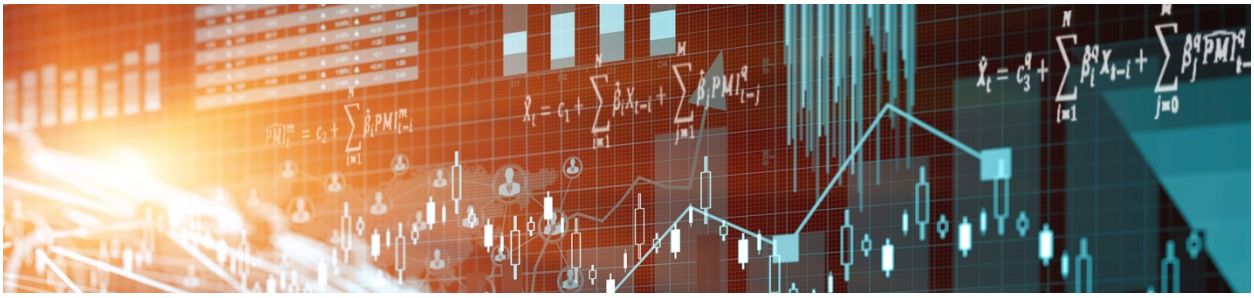

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Trade Flows and Exchange Rates: Importers, Exporters and Products

by

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Abstract

Using highly disaggregated transaction-level trade data, we document the importance of new firm-level trade partner relationships and the addition of new products to existing relationships in driving aggregate trade flows. Moreover, we find that these margins are sensitive to movements in the exchange rate and that this relationship is stronger for larger firms. These findings are then rationalized in a model of international trade with endogenous matching between heterogeneous importers and exporters. Simulations of the model highlight: (1) a new channel through which exchange rates influence short-run trade flows; and (2) the importance of firm heterogeneity—on both sides of trade transactions—in the adjustment process.

Bank topics: International topics; Exchange rates; Firm dynamics
JEL codes: F1, F4

Résumé

À partir de données fortement désagrégées relatives aux transactions commerciales, nous rendons compte de l'importance d'établir de nouvelles relations entre les partenaires commerciaux à l'échelle des entreprises et d'ajouter des produits dans le cadre des relations existantes comme moteurs des flux commerciaux agrégés. De plus, nous constatons que ces marges sont sensibles aux mouvements du taux de change et que cette corrélation est plus forte pour les grandes entreprises. Nous expliquons ensuite ces résultats à l'aide d'un modèle de commerce international avec appariement endogène entre importateurs et exportateurs hétérogènes. Les simulations du modèle font ressortir : 1) un nouveau canal par lequel les mouvements de taux de change agissent sur les flux commerciaux à court terme; et 2) l'importance de l'hétérogénéité des entreprises – des deux côtés des transactions – dans le processus d'ajustement.

Sujets : Questions internationales; Taux de change; Dynamique des entreprises
JEL codes : F1, F4

Non-technical Summary

Motivation and question

At the most fundamental level, international trade takes places between an exporting firm and an importing firm for a given product. Focusing on the importer-exporter-product triplet allows us to rethink the traditional intensive and extensive margin dichotomy of international trade, the role of these margins in determining trade flows and the role of aggregate shocks in shaping these flows. We explore the role of relationship formation and evolution—in terms of the products traded within relationships—in import flows, and then we examine how exchange rate shocks affect trade flows by influencing these margins. We also emphasize the role of importer and exporter heterogeneity in aggregate trade flows and the response to exchange rates.

Methodology

Using highly disaggregated data on Canadian imports, where the domestic importer, foreign exporter and product are known, we document several facts pertaining to market concentration and buyer-seller-product relationships. We then empirically examine the relationship between exchange rate shocks and importer adjustment in terms of trade partners and products. Finally, we develop a model of international trade with endogenous matching between heterogeneous importers and exporters, where the exporters produce multiple products and the range of products traded within relationships is also determined endogenously. Both the establishment of new relationships and the addition of new products to existing buyer-seller relationships involve fixed costs, and the model generates a set of cut-off points for the number of buyer-seller relationships and the number of products traded.

Key results and contributions

We document that the Canadian import market is dominated by a relatively small number of foreign exporters and domestic importers—the top 1 percent of importers account for roughly 62 percent of imports in 2007, while the top 1 percent of exporters account for roughly 52 percent. We also show that while new buyer-seller relationships and the addition of new products to existing relationships account for only a small portion of short-run import flows, they dominate longer-run flows, accounting for a combined 53 percent of imports over a four-year horizon. Regression results also suggest that these margins are sensitive to movements in exchange rates and that aggregate responses are driven by large firms.

The stylized model with a simple calibration fits the data well and is used to explore the effects of exchange rate shocks. We show that an appreciation of the destination-market currency leads to an increase in the number of buyer-seller relationships and the range of products within existing relationship. With the existence of fixed costs and firm heterogeneity, this suggests that exchange rate shocks can influence short-run trade flows.

1. Introduction

At the most fundamental level, international trade takes place between an exporting firm and an importing firm for a given product. While this is a truism, developing a better understanding of this tripartite relationship may be key for understanding trade flows. Indeed, a long-standing literature has explored the effects of trade shocks on the intensive and extensive margins of trade in terms of firms and products traded (Krugman, 1979; Baldwin, 1988; Baldwin and Krugman, 1989; Dixit, 1989; and Melitz, 2003), highlighting persistent effects stemming from the entry and exit of firms and products in international markets. However, when considering the full buyer-seller-product relationship in a trade setting, there are a number of other margins—such as the establishment of new relationships between importers and exporters and adjustments along the product margin within relationships—that have heretofore received little attention.

In this paper, we examine the role of new buyer-seller relationships and changes in the set of products within relationships in driving aggregate trade flows, and we explore how the trade partner and products margins adjust to trade shocks such as exchange rate fluctuations. To do so, we make use of highly disaggregated customs data on Canadian imports that identify both the importer and the foreign exporter in any trade transaction. We first document a number of stylized facts on market concentration, the number of trade partners and products firms deal with, and the role of new firm-level relationships and the addition of new products to established relationships in driving trade flows. We then show empirically that movements in exchange rates have a significant effect on the formation and destruction of new relationships, as well as the range of products traded within a buyer-seller relationships. Moreover, the response of large firms to exchange rate shocks is stronger than that of small firms.

We rationalize these empirical findings in a model of international trade with endogenous matching between heterogeneous importers and exporters. Exporters in the model produce multiple products, which allows for adjustments along the product dimension within trade relationships. As in Arkolakis, Ganapati and Muendler (2019), there is a higher production cost for products further from a firm's core competency. With an empirically reasonable calibration, the model replicates the key features of the data, capturing the granularity in individual buyer-seller-product relationships. More specifically, it predicts that a significant share of trade transactions are accounted for by new firm-level relationships and new products being added to existing relationships. Isolating the exchange rate in the model shows that a destination-currency appreciation triggers a significant increase in firm-to-firm matches and the number of products traded within relationships, and that this is driven mainly by the adjustments of larger importing firms. Taken together, the model and data findings highlight a new channel through which exchange rates influence short-run trade flows.

The customs data we use cover the universe of Canadian commercial imports from September

2002 to June 2008. In the paper we use a subset of nine broad product categories that have complete information on quantities shipped and the total value of the shipment, along with some other vital information. These account for roughly 40 percent of the value of Canadian imports in any given year.[1] A key feature of this data set is that it allows for the identification of the importer and foreign exporter involved in each transaction, along with a narrow product identifier. With this, we begin by measuring the degree of concentration in the Canadian import market. We find that the top 1 percent of foreign exporters account for over 50 percent of imports into Canada. At the same time, the top 1 percent of Canadian importers account for over 60 percent of the import market. Larger firms also have more trade partners than smaller firms, with exporters in the top quintile of sales to Canada having three times more trade partners than those in the bottom quintile, and large importers having over 14 times more partners. In addition, large firms trade more products overall and more products per trade partner.

A unique finding of this paper is the importance of new relationships and the addition of new products to existing relationships in driving total import flows. In terms of transactions, the relationship and product extensive margins account for over 40 percent of quarterly import flows. In terms of value, the number is smaller at 12 percent, since continual relationships tend to be among large buyers and sellers, and also that newly formed relationships start small. We then take all of the relationships in 2007 (the last full year in our sample) and look back to see whether they existed in 2003 (the first full year in our sample). Decomposing this way, we find that the relationship and product extensive margins account for a combined 70 percent of transactions and over 50 percent of the value of imports. Although not all newly formed relationships survive and grow, it appears that the accumulation of these new buyer-seller-product relationships is an important driver of trade flows in the longer term.

Another key finding of this paper is that trade shocks, such as exchange rate shocks, can affect the dynamics of relationship formation and adjustment (in terms of the products traded). Empirically, we find that appreciations of the Canadian dollar (CAD) are associated with an increase in the number of trade partners for importers, as well as the number of products, and products per buyer-seller relationship. Evidence of this is found in several different econometric frameworks. Moreover, we find substantial heterogeneity among firms in the response to exchange rate shocks—in particular, larger firms (where firm size is measured in several different ways) are substantially more responsive to exchange rate shocks in both the trade partner and product dimensions.

These findings guide the development of a parsimonious model of the imported goods market with endogenous buyer-seller matching and product choice. In the model, sellers choose the

[1] These data were previously used in Devereux, Dong and Tomlin (2017). See that paper for more details on the data.

measure of buyers with whom they interact, the measure of product varieties to offer to each of these buyers, and the price for each variety sold to a given buyer. Both buyers and sellers differ in terms of their productivity, and low cost sellers tend to match with low cost sellers, on average. Buyers combine the endogenously determined range of intermediate inputs into a unique final good, which they sell to domestic consumers. Both the establishment of relationships and the addition of products to relationships involve fixed costs. Given heterogeneous productivity among buyers and sellers, this generates a set of cut-off points for the addition of new trade relationships and products within relationships. In equilibrium, the import market is dominated by a small number of large exporters and importers, and larger firms have more trade partners and products per partner, as in the data.

We use the model to explore the response to shocks to the exchange rate. As in the data, adjustments within continuous buyer-seller-product relationships dominate the response in terms of import value, but, with multi-product exporters and endogenous matching, firms in the model also respond by adding new trade partners and products within existing relationships. This shows up in significantly larger shares of these margins in total buyer-seller-product transactions. Moreover, when looking across the distribution of importers, the model implies that aggregate responses to exchange rate movements are driven primarily by larger firms, which is also in accordance with our empirical findings.

Aside from the impact of an exchange rate shock itself, we show that the volatility of exchange rate variation is critical for the measurement of the different margins of adjustment. Increasing the volatility of exchange rate shocks has little impact on the value shares since new relationships and new products tend to already have a low value relative to the core continuous relationships and products. In terms of transaction shares, however, the extensive margin of adjustment both in terms of new buyer-seller relationships and new products within relationships, are extremely sensitive to the size of exchange rate volatility, with higher volatility substantially increasing the role of these margins of adjustment.

Our paper builds on the literature that examines the extensive margin of trade in terms of the countries (Helpman, Melitz and Rubenstein, 2008) and firms involved in trade (Melitz, 2003; Eaton, Kortum and Kramarz, 2011), as well as the products being traded (Broda and Weinstein, 2006; Chaney, 2008). It diverges from these papers by focusing not on new firms or products in a given country, but rather on firm-level relationships, where, within the traditional intensive margin (continuing firms or products within a country), there are relationship-extensive margins (the establishment of new relationships and adjustments in the products traded within relationships). Our decomposition of the Canadian import data suggests that these margins are non-negligible and sensitive to exchange rates.

Increasing availability of firm-level trade data sets where firms on both sides of transactions

can be identified in some way has led to a burgeoning literature on firm-to-firm relationships and the importance of the relationships in driving trade. Bernard, Moxnes and Ulltveit-Moe (2018) use Norwegian export data to document several facts about buyers and sellers across markets. They develop a model to explore the implications of importer and exporter heterogeneity on export growth. Eaton et al. (2016) develop a two-sided search and match model of trade and fit it to Colombian import data to study how entry of exporters and reductions in search costs affect import flows. Kramarz, Martin and Mejean (2016) use French export data to show how network structure and granularity magnify aggregate fluctuations, while Martin, Mejean and Parenti (2020) highlight the role of relationship stickiness in firm-level responses to uncertainty. Blum, Claro and Horstmann (2010) establish a number of facts about trade between firms in Argentina and Chile. Monarch and Schmidt-Eisenlohr (2017) quantify the value of trade relationships in U.S. import data and then explore the aggregate implications of the relationships. Heise (2018) also makes use of the U.S. import data to explore the relationship between exchange rate pass-through and the length of buyer-seller relationships, providing evidence that pass-through increases as relationships age. Like these papers, we use highly disaggregated data where the identity of the firms on both sides of transactions is known. Where this paper differs is that we use the data to highlight a new mechanism in the adjustment to exchange rate shocks.

Finally, the findings in this paper may apply more broadly to the disconnect between exchange rates and real trade variables. Firms pricing behavior has been extensively studied in the literature to understand the phenomenon of incomplete exchange rate pass-through observed in the data (see for example, Campa and Goldberg, 2005; and Burstein and Gopinath, 2014). Sticky prices, strategic complementarities, and imported intermediates can reduce the price response and are necessary to match international micro price data (see for example, Gopinath and Rigobon, 2008; Gopinath and Itskhoki, 2010; and Amiti, Itskhoki and Konings, 2014). On top of these, a low (implied) value of the trade elasticity is often needed to provide a better fit of the disconnect between international prices and real variables (examples include Backus, Kehoe and Kydland, 1995; Chari, Kehoe and McGrattan, 2002; and Corsetti, Dedola, and Leduc, 2005), despite that the empirical literature provides a wide range of estimates for trade elasticities at the aggregate level.[2] Our findings suggest that simply assuming a low trade elasticity may overlook important dynamics. In our model, exchange rate shocks may have small impacts on the short-run value shares but significant impacts on the transaction shares of new relationship formation and on the set of goods traded within relationships.

The remainder of the paper proceeds as follows. Section 2 describes the data used and highlights some important stylized facts that are used to develop our theoretical model. Section

[2]While it is common in many applied macroeconomic models to choose values of the elasticity of substitution between 1 and 1.5, micro studies tend to find much higher estimates in the range of 5 to 6 (examples include Lai and Trefler, 2002, and Broda and Weinstein, 2006).

3 details the key empirical findings relating to importer, exporter and product relationships and the exchange rate. The model is presented in section 4, along with a detailed exploration of its properties. Section 5 explores the response of the model to exchange rate shocks. Section 6 concludes.

2. Data and Stylized Facts on International Trade

2.1. Transaction-level import data

We begin by documenting a number of facts about international trade between importers, exporters and products. In order to do so, we use data from the Canadian Border Services Agency (CBSA) that contain information on every commercial import/shipment into Canada from September 2002 to June 2008. The data, collected by the CBSA and housed at Statistics Canada, contain information on the total value of each shipment (in the currency in which it was paid for as well as the Canadian-dollar value), the number of units shipped, the 10-digit Harmonized Commodity Description and Coding System (HS) product code for the good, the country from which the good originated (the country of origin) and the country from which the good was finally exported directly to Canada.

Critically for our analysis, the data set also has an importing firm identifier *and* an exporting firm/vendor identifier. As a result, we know, for each transaction, the quantity and value of the imported good as well as the identity of the exporting and importing firms. The scrambled (for confidentiality) importing firm identifier allows us to track a single Canadian buyer over time and is associated with the province in which the buyer is located. On the exporter side, the identifier is built from the company name provided in the customs sheet, which is linked in the cross-section and over time based on a name-matching algorithm developed by researchers at Statistics Canada.

While the data are reported at the individual transaction level, most statistics reported in this paper are at a monthly, quarterly or annual frequency. In each case, the unit of observation is a buyer-seller-product relationship, where a product is defined at the six-digit HS (HS6) code level. As a result, when we refer to products entering and exiting buyer-seller relationship, it is clearly a new type of product rather than a variation on an existing product, which could be the case if we defined a product at the eight- or ten-digit HS code level.

As in Devereux, Dong and Tomlin (2017), we use a segment of the data that comprises nine broad product categories representing a wide range of goods and accounting for approximately 40 percent of Canadian imports in any given quarter. The nine product groupings or sectors are presented in Table 1 along with the number of observations at the transaction level. Overall, there are about 68 million transaction-level observations, just over 71,000 unique importers

Table 1: Product Categories

	HS Code	# of Observations
Vegetable products	07–14	6,401,302
Food and beverage	16–22	3,363,866
Chemical products	28–35	4,793,851
Textiles	50–60	8,397,023
Apparel	61–62	6,162,182
Footwear	64	906,285
Metal products	72–81	20,354,196
Industrial machinery	84	12,054,290
Consumer electronics	85	5,494,637
Total		67,927,538

Note: HS Code refers to the range of two-digit Harmonized Commodity Description and Coding System products included in the broad product category. The # of Observations is the number of buyer-seller-product transactions in the data, and this can include multiple buyer-seller-product transactions in a given month.

and 297,100 unique exporters. In any given year in the data, there are approximately 40,000 importers and 121,00 exporters.

The data contain a variable that identifies whether the two firms involved in a transaction are affiliated (intra-firm trade). For the findings below, we do not eliminate these observations. In some cases, it is more informative to keep these observations—when, for example, examining overall market share and concentration levels. In fact, the results differ little with and without these observations. Therefore we opt to preserve them in order to provide a clearer picture of the aggregate outcomes.

2.2. Findings on buyer-seller-product relationships

In this subsection, we describe a number of facts relating to buyer-seller-product relationships in the Canadian import market. We begin by looking at the degree of market concentration, then further explore the trade networks and relationships between buyer and sellers.

2.2.1. The import market is dominated by a small number of importers and exporters

A key characteristic of the Canadian import market is that it is dominated by a relatively small number of foreign exporters and domestic importers. The top 1 percent of importers (in terms of value of imports in 2007)—approximately 400 importing firms—account for almost 62 percent of the value of all imports within the nine product categories, and the top 10 percent account for 92 percent of imports. On the other side, the top 1 percent of exporters—approximately

1,200 firms—account for 52 percent of Canadian imports and the top 10 percent account for 87 percent of the import market.

In addition, import flows are largely determined by importers and exporters that have many trade partners. Using Norwegian export data, Bernard, Moxnes and Ulltveit-Moe (2018) find that trade flows are dominated by transactions involving exporters that are matching with many trade partners and that exports by exporters with only one foreign trade partner make up a small portion of trade flows. We replicate the Bernard, Moxnes and Ulltveit-Moe (2018) exercise for our data and present the results in Table 2. Trade relationships where the importer and foreign exporter only trade with each other within the Canadian import market (one-to-one matches) account for just 1.68 percent of all importer-exporter connections in 2007, and only 0.25 percent of the value of trade. Similarly, many-to-one matches—where the exporter has many Canadian trade partners, but the importer only trades with that one exporter—account for only a small percentage of matches (3.90 percent) and value (0.68 percent). The majority of trade is accounted for by one-to-many matches—where the importer is a multi-trade-partner firm, but the exporter only trades with one importer in the Canadian market—and many-to-many matches—where both the importer and exporter have multiple trade partners. Together, these types of interactions account for 94.42 percent of importer-exporter matches and 99.07 percent of the value of trade in 2007.

Table 2: Types of Matches Between Importers and Exporters

	One-to-One	Many-to-One	One-to-Many	Many-to-Many
Share of total number of matches (%)	1.68	3.90	36.04	58.38
Share of total trade value (%)	0.25	0.68	32.97	66.10

Note: The calculations in this table are analogous to Table 8 in Bernard et al. (2018). The results are for 2007 data. One-to-one matches are where the importer and exporter are trading only with each other. Many-to-one matches are where the exporter has many Canadian trade partners, but the importer has only the one exporter match. One-to-many is when the importer is importing from many exporters, but the exporter is trading only with that importer. Many-to-many matches are where both the importer and the exporter have many trade partners.

These results highlight the difference in using exporter-based data, as in Bernard, Moxnes and Ulltveit-Moe (2018), relative to importer-based data, as we do. While both data sets suggest that trade is dominated by exporters and importers that have many trade partners (many-to-many transactions), the exporter-based data of Bernard, Moxnes and Ulltveit-Moe (2018) suggest that many-to-one matches also play an important role in trade flows (and one-to-one and one-to-many matches make up a small portion of trade). In our importer-based data, many-to-one matches play a small role in Canadian imports, but one-to-many are an important component of trade. The difference in results is likely because, using the exporter-based data, Bernard, Moxnes and Ulltveit-Moe (2018) observe the full set of trade partners of the exporter, but not

of the foreign importer. Conversely, we observe the full set of trade partners of the importer, but not of the foreign exporter.

2.2.2. Larger firms have more trade partners, products, and products per trade partner

This set of facts builds on what is described above, but shows that larger firms (in terms of the value of imports/exports to Canada) have more trade partners, import/export more products, and trade more products per trade partner than smaller firms. Table 3 reports that an importer in the first quintile of the of the import-value distribution trades with an average of 1.2 exporters, whereas an importer in the top quintile has an average of 17.2 trade partners. On the exporter side, an average firm in the first quintile has 1.1 trade partners, and one in the fifth quintile has 3.6 Canadian trade partners.

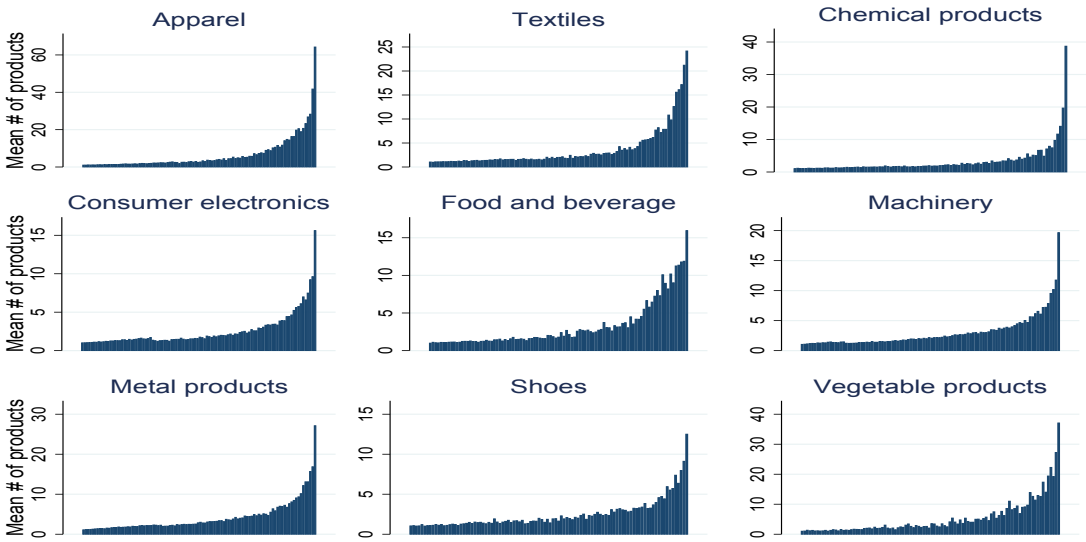
Table 3: Number of Trade Partners by Quintile of Import Market Share (2007)

	Importers		Exporters	
Quintile	Mean # of Trade Partners	S.D.	Mean # of Trade Partners	S.D.
1	1.2	0.7	1.1	0.4
2	1.7	1.3	1.2	0.7
3	2.6	2.5	1.5	1.1
4	4.5	4.5	1.9	2.1
5	17.2	61.4	3.6	6.3

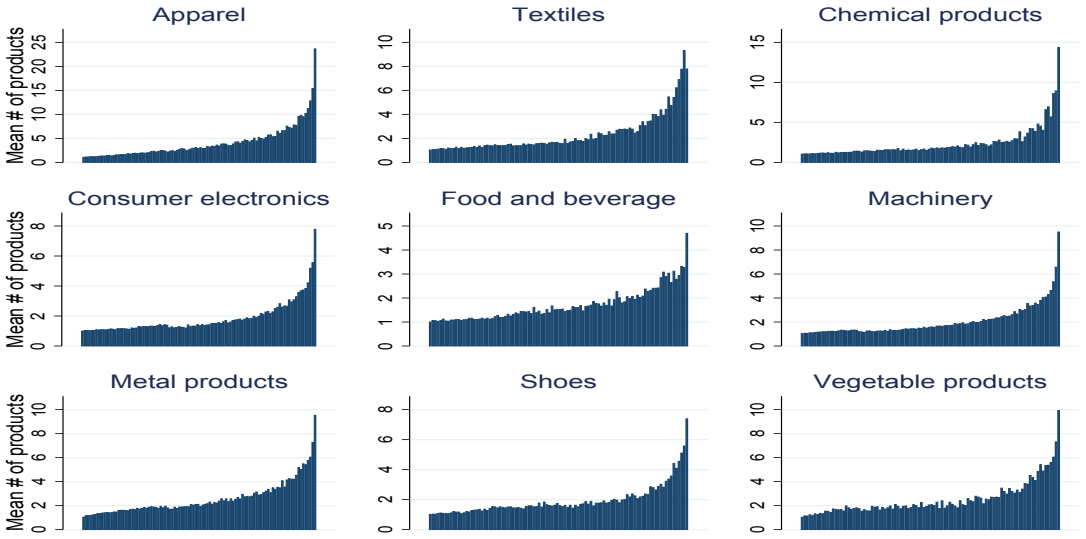
Figure 1 presents the average numbers of products per importer and exporter by market share percentile for each of the nine product categories. A clear pattern emerges: the larger the importing (exporting) firm, in terms of the value of trade, the more unique HS6 products it imports (exports). While the majority of importers import one or two products regardless of the sector, a significant amount of heterogeneity exists across sectors at the top end of the distribution. For example, importers in the top percentile in the apparel sector import an average of 62 unique HS6 products, whereas those in the food and beverage sector import about 16 products. Similarly for exporters, those in the top percentile of the apparel sector export an average of 24 products to Canada, while those in the food and beverage sector export about 5 products.

Finally, Figure 2 shows that larger firms import/export more products per trade partner. For example, importers at the lower end of the distribution in the apparel sector import, on average, one product per trade partner. Those firms at the top end of the distribution purchase almost eight products from each trade partner. For firms exporting apparel items to Canada, those in the bottom end of the distribution sell on average 1 product to each trade partner, and those at the top end of the distribution export about 12 products per trade partner. A

Figure 1: Number of Products by Market Share Percentiles, 2007



(a) Importers



(b) Exporters

Note: Panel (a) presents the average number of products imported by importers within percentile bins based on the total value of imports in 2007. Panel (b) presents the average number of products exported to Canada by exporters within percentile bins based on the total value Canadian imports in 2007.

similar pattern is observed in all the other product categories.[3] Since firms may be involved in

[3]The results in Figure 2 understate the true degree of heterogeneity in the number of products per trade partner, especially at the top end of the market share distribution, where large firms often have a few trade partners with whom they trade many products and many firms with whom they trade only a few (or even one) products. When constructing Figure 2, we first take the mean number of trade partners per relationship for each

multiple product markets at the same time, the product and products-per-trade-partner counts in Figures 1 and 2 may understate the actual firm-level counts. Calculations similar to Table 3 but for products and products-per-partner show that the positive relationship between market share products and products-per-trade partner hold when not conditioning on product category.

2.2.3. New buyer-seller matches and the introduction of new products into existing buyer-seller relationships are important contributors to import flows

Each period, trade flows evolve along a number of margins in the buyer-seller-product space. Traditionally, trade flows are divided into intensive and extensive margins of trade, where these margins are defined at the firm or product level (see, for example, Eaton, Kortum and Kramarz, 2004, Bernard et al., 2009, and Bernard, Redding and Schott, 2011). That is, the introduction of a new firm or product into international trade markets constitutes the extensive margins, whereas the continued involvement of a firm or trading of a product contributes to the intensive margin. In line with the former definition, we begin by defining what we call the *importer extensive margin*, which refers to import flows coming from firms importing for the first time. The remainder is the importer intensive margin and in line with previous research.[4]

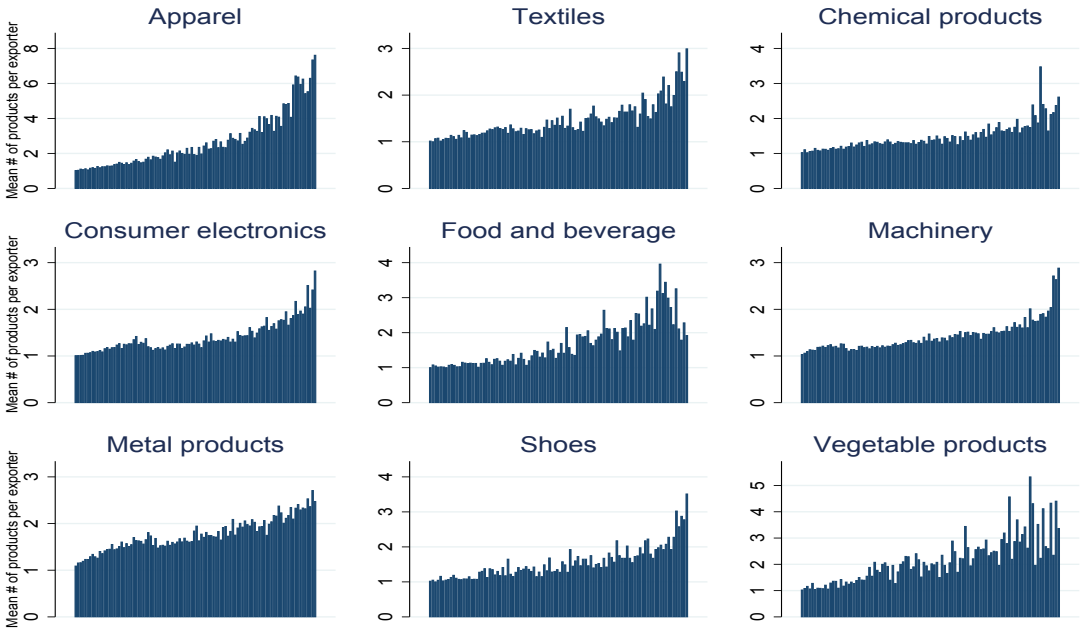
We divide the importer intensive margin into three further margins that dissect the buyer-seller-product relationship. Each of these margins is conditional on the buyer being already active. The first we call the *buyer-seller extensive margin*, which refers to imports coming from a new match between a Canadian importer and foreign exporter. The second is the *product extensive margin*, which refers to the introduction of a new product into an existing buyer-seller relationship. Finally, there is the *pure intensive margin*, which is continuous trade between a buyer and seller for a given product (that is, the buyer-seller-product relationship observed at a point in time existed previously). The first two sub-margins offer added insight into the evolution of trade flows beyond the traditional extensive and intensive margins of trade.

We begin by looking at the contribution of these different margins to quarterly import flows. In order to do this, we identify the margins by tracking buyer-seller-product relationships in a given quarter over the previous year. That is, a quarterly buyer-seller-product transaction is flagged as being part of the importer extensive margin if that importer did not import any product (from any exporter) in the previous four quarters. If the importer/buyer imported at

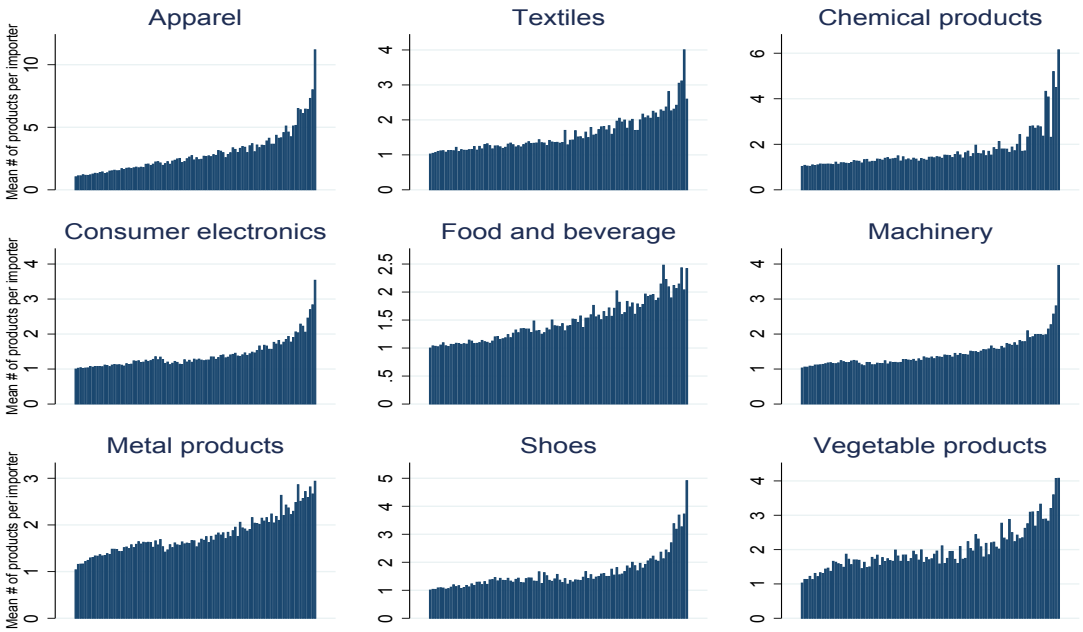
firm and then take the mean within each percentile of the market share distribution. This process can mask the fact that there are many large firms that have relationships with many products and therefore the necessary conditions for the within-relationship product margin to matter in the aggregate, which is relevant to what we explore below.

[4]Our focus on the importer for defining the extensive margin is based on the fact that we observe the full set of trade operations for that importer, so we can clearly identify when they have become active as an importer. For exporters, we only observe the exporting activities to Canada and therefore cannot identify when they became exporters. For this reason, our decompositions are based on the importer.

Figure 2: Number of Products per Trade Partner by Market Share Percentiles, 2007



(a) Importers



(b) Exporters

Note: Panel (a) presents the average number of products imported per trade partner by importers within percentile bins based on the total value of imports in 2007. Panel (b) presents the average number of products exported to each trade partner in Canada by exporters within percentile bins based on the total value Canadian imports to Canada in 2007.

Table 4: Contributions of Buyer-Seller-Product Margins to Import Flows

Panel A: Quarterly Contributions (quarterly, 2003:3–2008:2)

		Importer intensive		
	Importer extensive	Buyer-seller extensive	Product extensive	Pure intensive
Share of total trade transactions (%)	2.7	24.6	15.9	56.8
Share of total trade value (%)	0.7	8.1	3.4	87.9

Panel B: 2007-over-2003 Contributions (annual, 2007 compared with 2003)

		Importer intensive		
	Importer extensive	Buyer-seller extensive	Product extensive	Pure intensive
Share of total trade transactions (%)	15.5	41.0	29.4	14.1
Share of total trade value (%)	7.7	31.1	22.6	38.6

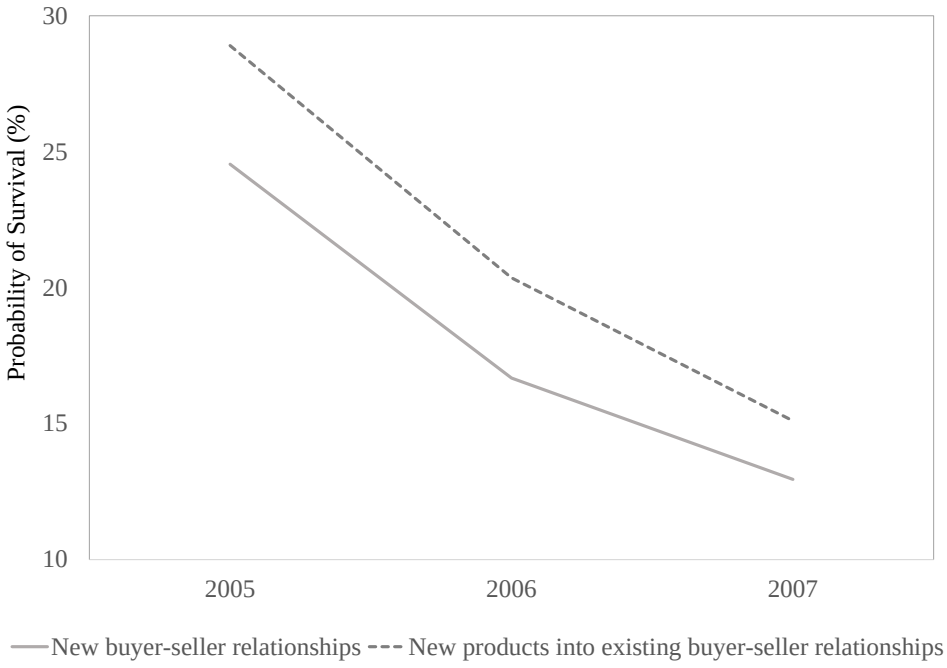
Note: To calculate the quarterly contributions in Panel A, we identify the contribution of each margin to quarter t import flows by looking back over the previous four quarters. For example, if an importer did not import in the previous four quarters, its quarter t imports are assigned to the importer extensive margin. In Panel B, the margins are identified for 2007 only, by looking back to 2003. For example, if a firm imports in 2007, but did not import in 2003, its 2007 imports are assigned to the importer extensive margin. When a buyer-seller relationship is formed after 2003, all products traded within that relationship in the year it is formed are assigned to the buyer-seller extensive margin. Products added to the relationship after the year it was formed are assigned to the product extensive margin.

some point over the last four quarters, but the buyer-seller match is new in the current quarter, the import flows associated with this buyer-seller match are assigned to the buyer-seller extensive margin. When a new product is introduced into a buyer-seller match that already existed some time in the previous four quarters, these buyer-seller-product import flows are assigned to the product extensive margin. Lastly, when a buyer-seller-product relationship existed at some point in the previous four quarters, the current quarter flows are assigned to the pure intensive margin.

Panel A of Table 4 reports the contributions of the different margins to quarterly trade in terms of the share of buyer-seller-product transactions and share of the value of import flows. The calculations are done for each quarter and then averaged over all quarters. The importer extensive margin plays a small role in determining quarterly import flows, accounting for less than 3 percent of transactions and less than 1 percent of value. The buyer-seller and product extensive margins are more important in terms of transactions—accounting for roughly 25 and 16 percent of transactions, respectively—but their share of total value is much smaller (both are below 10 percent). This indicates that, while there are many of these interactions, their average value is relatively small. Finally, the pure intensive margin accounts for the majority of quarterly import transactions and value, at roughly 57 and 88 percent, respectively.

These newly formed relationships start small in value and many of them do not survive. We next convert the data into annual buyer-seller-product transactions and compute the attrition rates. Figure 3 shows that only 25 percent of the new buyer-seller relationships established in 2004 survive in to 2005, and, by 2007, only 13 percent remain active. Similarly for new products added to existing relationships in 2004, 29 percent are still traded within these relationships in 2005, and only 15 percent remain in 2007.

Figure 3: Survival Probability of Buyer-Seller and Product Relationships Established in 2004

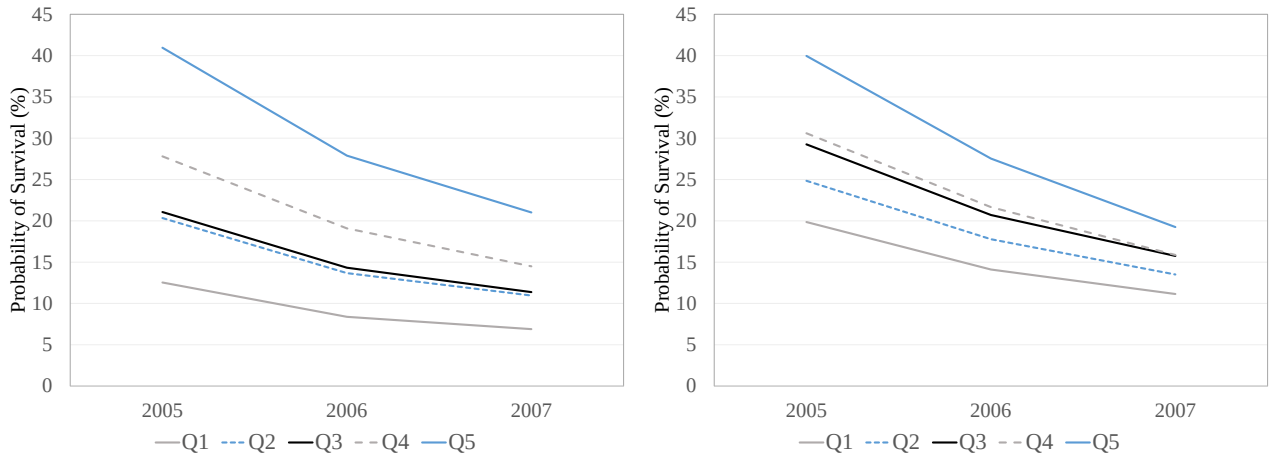


Note: This figure is constructed by first taking the total number of new relationships and new products added to existing relationship in 2004 and then dividing the surviving buyer-seller and product relationships in each subsequent year by the total number of new relationships and new products in 2004.

Growth rates of different relationships are difficult to calculate for a number of reasons (including attrition within the sample and partial-year effects), but Figure 4 shows that larger new relationships are more likely to survive into subsequent years. A newly formed relationship in the top quintile of the 2004 new-relationship value distribution (see Panel a), has a 41 percent chance of surviving in to 2005 and 21 percent change of surviving until at least 2007. A new relationship in the bottom quintile only has a 12 and 6 percent chance of surviving to 2005 and 2007, respectively. Similarly for new products introduced into existing relationships (see Panel b), where new products in the top quintile of the new-product-into-existing-relationships value distribution have a higher chance of surviving than those in the lower quintiles. Moreover, a simple regression of the log of the initial relationship size (total value) on the log of the previous period import market share of the importer (measured as its market share within its primary

HS2 category) returns a statistically significant coefficient of 0.1, indicating that larger firms have larger new relationships.

Figure 4: Survival Probability of New Buyer-Seller and Product Relationships by Initial Size Quintile



(a) Buyer-seller relationships

(b) New products into existing relationships

Note: Panel (a) presents the probability that a new buyer-seller relationship formed in 2004 survives into subsequent years by quintiles of the 2004 new relationship value distribution. Panel (b) presents the probability that a new product added to an existing relationship in 2004 is traded between the importer and exporter in subsequent years, by quintiles of the 2004 new product-relationship value distribution.

Over time, these newly established relationships (in terms of trade partners or products within existing relationships) that survive may grow and play a more important role. We take all of the relationships in 2007 and look back to see whether they existed in 2003. If the importer was operating in 2007, but not in 2003, all of the importer's 2007 transactions are assigned to the importer extensive margin. For importers that were importing the same HS6 product from the same partner in 2003 and 2007, their 2007 transactions are allocated to the pure intensive margin. The remainder is accounted for by the buyer-seller and product margins. To split them, we track the buyer-seller-product relationship over the post-2003 period. When a new relationship is formed in the 2004–2007 period, we assign the products traded at the time the relationship is formed to the buyer-seller extensive margin. When a new product is added to an old relationship sometime over this period—and this includes relationships that may have been formed post-2003 but before the new product is added—we attribute this to the product extensive margin.

Panel B in Table 4 presents the results from this decomposition. Interestingly, after four years, the buyer-seller and product extensive margins become dominant, accounting for a combined 70 percent of transactions and over 50 percent of the value of imports. Individually, the buyer-seller extensive margin accounts for 41 percent of annual transactions and 31 percent of

import value, while the product extensive margin accounts for 29 and 23 percent of transactions and value, respectively.[5] While the pure intensive margin is still the biggest individual category, its share of imports (both in transaction and value) has declined significantly from its quarterly shares.

To explore this further, we calculate the contributions to total 2007 import value coming from adjustments along these margins in each year. Figure 5 shows that the relationships formed in 2004 account for roughly 6 percent of imports in 2007, while those formed in 2005, 2006 and 2007 account for approximately 6, 8 and 10 percent of 2007 imports by value, respectively. For the product extensive margin, the contribution of new products added to existing relationships in 2004 to the value of imports is about 2 percent; it is 3, 4 and 14 percent for those added in 2005, 2006 and 2007, respectively. Older cohorts appear to play less of a role in determining current flows than later cohorts but nevertheless contribute to current flows through the accumulation of past cohorts.

3. Empirical Results on the Effects of Exchange Rate Shocks

3.1. The formation of new buyer-seller matches and the introduction of new products into existing relationships are sensitive to movements in the exchange rate

It is possible that trade shocks, such as movements in the value of the exchange rate, will affect the formation of buyer-seller matches as well as the set of products traded within buyer-seller relationships. An appreciation of the destination-market currency can act as a negative cost shock for the exporter, allowing the exporter the possibility of overcoming fixed costs associated with adding a marginal trade partner, and fixed costs associated with adding a marginal product within an existing buyer-seller relationship. This will result in a positive relationship between the exchange rate (defined as exporter currency per destination-market currency) and the establishment of new buyer-seller matches, as well as the exchange rate and the addition of new products to existing relationships.

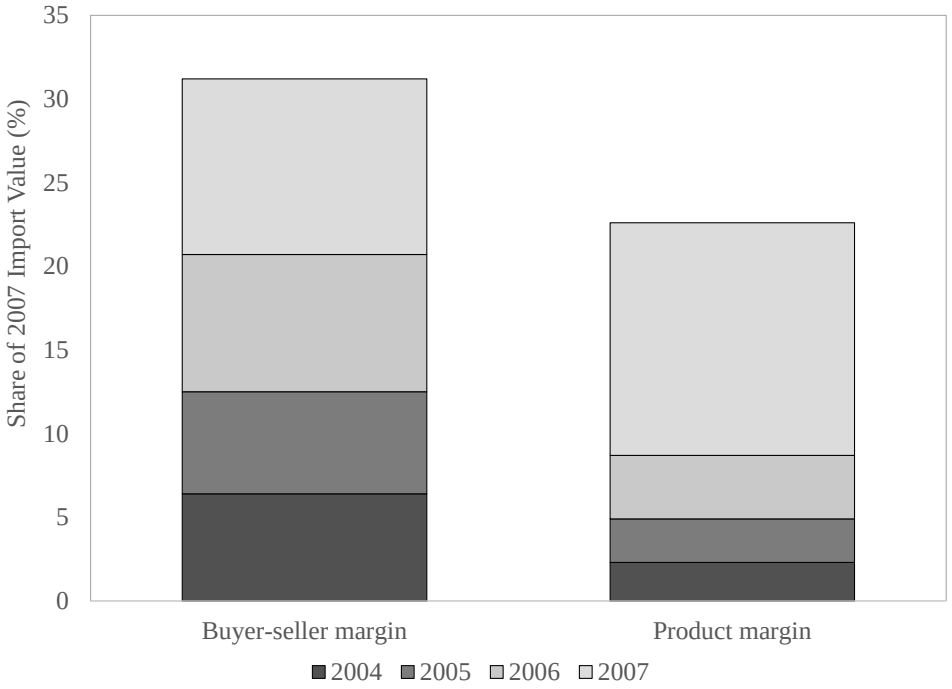
To explore these relationships in the data, we start by running the following regression:

$$\Delta y_{it} = c + \beta \Delta ex_t + Z_t'\gamma + \sigma time + \alpha_i + \theta_q + \epsilon_{it}, \tag{3.1}$$

where Δy_{it} can be the quarter-over-quarter change (log difference) at time t in the number of

[5]The buyer-seller and product extensive margins could be split a number of ways. If the products traded at the time a buyer-seller relationship is formed, and all subsequent products added to the relationship, are allocated to the buyer-seller extensive margins, the contribution of the buyer-seller extensive margin to 2007 import value is closer to 40 percent, and the product extensive margin is closer to 15 percent. We chose the decomposition presented above to highlight the role of the product extensive margin, but some of this could easily be attributed to the buyer-seller extensive margin.

Figure 5: Contribution of the Buyer-Seller and Product Extensive Margins by Year



Note: The total of each bar is equal to the values for the buyer-seller and product extensive margins in Panel B of Table 4. This figure shows the contribution of the relationships formed (counting only products traded in that year of formation) in each year to 2007 import values as well as the contribution of new products added to existing relationships to the value of imports in 2007.

importer i trade partners, products or products per relationship. Δex_t is the quarterly log difference of the Canada–U.S. exchange rate (defined as USD per CAD), Z_t is a control variable for aggregate demand shocks, *time* is a linear time trend, α_i is an importer-specific fixed effect, θ_q is a quarterly seasonal fixed effect, and ϵ_{it} is an error term. Although importers may form relationships or adjust relationships (in terms products) in many different countries, we use the Canada–U.S. bilateral exchange rate as a proxy for the relevant exchange rate. Over the sample period, 86 percent of transactions and 88 percent of the value of Canadian imports are invoiced in U.S. dollars, making the Canada–U.S. bilateral exchange rate the most relevant exchange for adjustments.

Table 5 presents the results of these regressions. Columns I and II show that an exchange rate appreciation is associated with an increase in the number of the importer's trade partners. In column II, where we include Canadian GDP growth as a control for demand shocks, we see that a 1 percent appreciation is a associated with a 0.146 percent increase in the number of trade partners. Columns III and IV show a similar positive relationship between the exchange rate and the number of products per importer, with column IV showing that a 1 percent appreciation is associated with a 0.138 percent increase in the number of products for importers. Finally,

Table 5: Regression Results for the Change in the Number of Partners and Products

	Importer Partners		Importer Products		Relationship Products	
	I	II	III	IV	V	VI
Exchange rate (Δex_t)	0.153***	0.146***	0.150***	0.138***	0.060***	0.053***
	(0.028)	(0.028)	(0.031)	(0.032)	(0.015)	(0.015)
Canadian GDP growth		0.695**		1.316***		0.930***
		(0.286)		(0.321)		(0.153)
Time trend	-0.003***	-0.003***	-0.004***	-0.003***	-0.004***	-0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.048***	0.039***	0.047***	0.031***	0.049***	0.038***
	(0.003)	(0.004)	(0.003)	(0.005)	(0.002)	(0.022)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter/Seasonal FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	688,152	668,152	668,152	668,152	2,252,656	2,252,656

Note: Results based on estimates of equation (3.1), where the dependent variable Δy_{it} is the quarter-over-quarter log change in the number of trade partners per importer (columns I and II), the change in the number of products per importer (columns III and IV), or change in the number of products within importer-exporter relationships (columns V and VI) at time t. The increase in the number of observations in columns V and VI reflects the fact that the unit of observation in these regressions is the buyer-seller relationship. For columns I to IV, the unit of observation is the importer.

columns V and VI show that an increase in the exchange is associated with an increase in the number of products per trade partner for importers, with the estimated elasticity being 0.053 in column VI.

While these results are informative and suggest that firms adjust their set and constitution of relationships in response to exchange rate shocks, the dependent variables are not entirely analogous to the decomposition presented in Table 4. For example, if Δy_{it} is the change in the number of trade partners, an increase in Δy_{it} could reflect a more complicated process of adding and dropping trade partners that, on net, results in an increase in Δy_{it}—not just simply the addition of new trade partners. To better approximate how these margins react to exchange rate shocks, in Appendix A, we explore logit regressions where the dependent variable is the probability of adding a new trade partner or adding a new product into an existing relationship and find that an appreciation of the CAD does increase the probability of adding a partner or product.

3.2. Large firms respond more to exchange rate movements in terms of adjusting trade partners and the scope of products traded

The findings in section 2.2 suggests significant heterogeneity in terms of the number of trade partners and products depending on the size of the firms involved in trade transactions. This

suggests that there may be heterogeneous responses to exchange rate shocks. To explore this further we run similar regressions to (3.1) but now consider the role of firm size in responses to exchange rate shocks. To begin with, we include a lagged variable for firm size and interact it with the exchange rate variable:

$$\Delta y_{it} = c + \alpha_0 MS_{i,t-1} + \beta_0 \Delta ex_t + \sum_{j=1}^{2} \left(\beta_j \left[\Delta ex_t \cdot MS_{i,t-1}^{j}\right]\right) + Z_t'\gamma + \sigma time + \alpha_i + \theta_q + \epsilon_{it}, \quad (3.2)$$

where $MS_{i,t-1}$ is firm i's market share—within a quarter in its primary HS6 product category—in the previous period. An importing firm's primary HS6 product category is defined as the HS6 category for which it has the most imports in terms of value over the sample. Its market share is then defined as its share of imports in a quarter within the HS6 product category.[6] We allow for the possibility of a squared market share interaction term (hence the j superscript) to better capture non-linearities in the market share and exchange rate relationship, and the β coefficients can then be used to map out the relationship.

Table 6 presents the regression results for the market-share regressions.[7] Columns I, III and V present the results with only the single interaction term between market share and the exchange rate. For the number of importer partners (column I) and products (column III), the coefficient on the interaction term is positive but insignificant, while for the number of products per relationship (column V), the estimate is positive and significant, providing some evidence that larger firms are more likely to adjust their relationships along the product margin in response to exchange rates. In general, the results in Table 6 provide mixed evidence when it comes to the role of market share.

However, with the squared market-share interaction term, the results suggest that there is important curvature not captured with the single linear interaction term. Columns II and IV show that the estimates for both partners and products on the linear interaction is negative and significant, while the estimate on the squared interaction term is positive and significant. Plotting this out implies that the response to exchange rate movements could be negative for firms in the middle of the market-share distribution, but for large market share firms the response is

[6] We experimented with a number of other measures of firm size and found that the results were similar. In Appendix B, we present results where the measure of firm size is simply $y_{i,t-1}$. For example, if Δy_{it} is the log change in the number of trade partners, then the measure of firm size (that replaces $MS_{i,t-1}$) is the number of trade partners for firm i in the previous period. The message from these results is qualitatively the same as described below. We also explored different measures of market share, such as HS2 and HS4 market shares. Again, the results differed little from what is presented below.

[7] Note that the number of observations in the market-share regressions are slightly lower that in the baseline results presented in Table 5. This is due to the fact that some outliers are excluded from the market-share results—we dropped observations where the adjustment in the number of trade partners from period $t-1$ to t was greater that 100 in absolute value. Keeping the observations in the baseline estimates had little effect on the baseline results.

Table 6: Regression Results with Market-Share Interaction Term

	Importer Partners		Importer Products		Relationship Products	
	I	II	III	IV	V	VI
Exchange rate (Δex_t)	0.140***	0.223***	0.131***	0.218***	0.021	0.023
	(0.029)	(0.030)	(0.033)	(0.033)	(0.015)	(0.015)
Firm size ($MS_{i,t-1}$)	-0.361***	-0.375***	-0.413***	-0.427***	-0.034***	-0.038***
	(0.012)	(0.012)	(0.013)	(0.013)	(0.003)	(0.003)
$\Delta ex_t \cdot MS_{i,t-1}$	0.072	-6.023***	0.053	-6.318***	0.127***	0.128***
	(0.206)	(0.527)	(0.231)	(0.592)	(0.041)	(0.041)
$\Delta ex_t \cdot MS^2_{i,t-1}$		8.786***		9.185***		0.025***
		(0.699)		(0.786)		(0.003)
Canadian GDP growth	0.695**	0.695**	1.326***	1.326***	0.973***	0.962***
	(0.286)	(0.286)	(0.321)	(0.321)	(0.132)	(0.132)
Time trend	-0.003***	-0.003	-0.003	-0.003	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.047***	0.047***	0.048***	0.049***	0.010***	0.008***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter/Seasonal FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	672,401	672,401	672,401	672,401	2,239,572	2,239,572

Note: Results based on estimates of equation (3.2), where the dependent variable Δy_{it} is the quarter-over-quarter log change in the number of trade partners per importer (columns I and II), the change in the number of products per importer (columns III and IV), or change in the number of products within importer-exporter relationships (columns V and VI) at time t.

positive. Take, for example, a firm with eighty percent market share. A one percent appreciation of the exchange rate is associated with a 1.027 percent increase in the number of trade partners and a 1.042 percent increase in the number of products per importing firm. For the number of products per relationship, the estimates in column VI suggest a non-negative relationship for the exchange rate all along the market share distribution, with very small firms having essentially no relationship, while for a firm with eighty percent market share, a one percent increase in the exchange rate is associated with a 0.141 percent increase in the number of products per trade partner for importers.

Two difficulties arise when interpreting these results. The first is that the dependent variable in regression (3.2) may not be well suited for studying the role of firm size in the relationship between the exchange and partner and product margins. The second is how to interpret results where the coefficient on the linear interaction term is negative, while that on the squared interaction term in positive. We address each of these issues in turn below.

First, it is possible that the definition of Δy_{it} in the previous regressions understates the relationship between margin adjustment, the exchange rate and firms size as the use of Δy_{it} is

highly dependent on the initial number of trade partners or products. For example, for firms with only one trade partner (a significant portion of the sample), any additional partners will imply a $\geq$100% change, whereas for larger firms, even if they were to add many new partners in response to an exchange rate shock, it is likely the adjustment will be significantly less than 100%. This could obscure the role of firm size in margin adjustment. To address this issue, we run the following regression:

$$Y_{it} - Y_{it} = c + \alpha_0 MS_{i,t-1} + \beta_0 \Delta ex_t + \sum_{j=1}^{2} \left(\beta_j \left[\Delta ex_t \cdot MS_{i,t-1}^{j}\right]\right) + Z_t'\gamma + \sigma time + \alpha_i + \theta_q + \epsilon_{it}, \quad (3.3)$$

where the dependent variable is simply the change in the number of trade partners, products or product per partners, and the right-hand-side is the same as it was in (3.2).

The results are presented in Table 7. For the number of importer partners, the coefficient on the linear interaction term in column I is positive but insignificant. When we include the squared interaction term, we again find that the coefficient on the linear term is negative and significant, while that on the squared term is positive and significant. As before, this suggests that the effect of market share is negative for firms in the middle range of the market-share distribution. For a firm with eighty percent market share, a one percent appreciation of the Canadian dollar is associated with a net increase of nearly 6 trade partners. This degree of curvature suggests that the positive coefficients results in columns I and II in Table 5 can be driven by adjustments of large firms. It is also possible that the negative coefficient on the linear action terms is the result of using a simple non-linear term to fit what is a highly-skewed firm-size effect.

The positive relationship between the number of importer products, the exchange rate and market share is clearer, as column III reports a positive and significant coefficient on the linear interaction term. It implies that for a firm with ten percent market share, a one percent appreciation of the Canadian dollar is associated with an increase of 1.288 products. When the non-linear term is included, we again see a U-shaped relationship for market share. As with the number of partners, the interpretation of this is not entirely clear and we explore it further below. Finally, all of the interaction terms in the regressions for the number of products per relationship for importers (columns V and VI) are positive and significant.

Next, because there are issues with the interpretation of the interaction terms in the regressions above, we present the results from an alternative methodology. We run regression (3.3)—but without the market-share terms—on different sub-samples based on the distribution of firm size. That is, we divide the data up by market-share quintiles and run the regression on each sub-sample in order to get a better sense of the full relationship between margin adjustments, exchange rates and firm size. The results for the number of partners and products reported in Figure 6 support the findings above and suggest that the response of large firms is

Table 7: Regression Results with Level Difference for Dependent Variable

	Importer Partners		Importer Products		Relationship Products	
	I	II	III	IV	V	VI
Exchange rate (Δex_t)	1.006***	1.498***	0.579**	1.168***	-0.042	-0.038
	(0.197)	(0.202)	(0.229)	(0.235)	(0.065)	(0.065)
Firm size ($MS_{i,t-1}$)	-2.363***	-2.442***	-3.526***	-3.621***	-0.155***	-0.171***
	(0.081)	(0.081)	(0.094)	(0.095)	(0.014)	(0.014)
$\Delta ex_t \cdot MS_{i,t-1}$	0.054	-36.189***	7.087***	-36.376***	0.855***	0.856***
	(1.399)	(3.580)	(1.626)	(4.163)	(0.182)	(0.182)
$\Delta ex_t \cdot MS^2_{i,t-1}$		52.250***		62.659***		0.095***
		(4.751)		(5.524)		(0.013)
Canadian GDP growth	2.587	2.585	8.393***	8.391***	2.731***	2.688***
	(1.939)	(1.940)	(2.255)	(2.255)	(0.587)	(0.587)
Time trend	-0.018***	-0.018***	-0.021***	-0.021	-0.004***	-0.004***
	(0.001)	(0.001)	(0.001)	(0.000)	(0.000)	(0.000)
Constant	0.281***	0.284***	0.337***	0.341***	0.053***	0.046***
	(0.027)	(0.027)	(0.032)	(0.032)	(0.009)	(0.009)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter/Seasonal FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	672,401	672,401	672,401	672,401	2,239,572	2,239,572

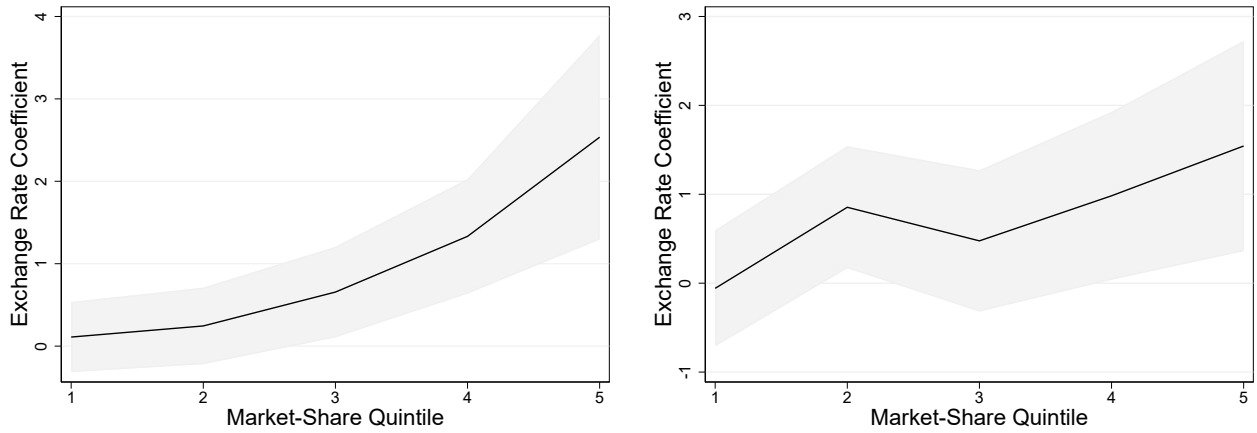
Note: Results based on estimates of equation (3.3), where the dependent variable $Y_{it} - Y_{i,t-1}$ is the quarter-over-quarter level change in the number of trade partners per importer (columns I and II), the change in the number of products per importer (columns III and IV), or change in the number of products within importer-exporter relationships (columns V and VI) at time t.

stronger than that of smaller firms.[8]

Specifically, panel (a) shows that the response of the number of trade partners to an exchange rate shock is much stronger for firms in the top quintile that it is for firms at the lower end of the distribution. The results for the number of products in panel (b) are less skewed towards very large firms than for the number of partners, but they nevertheless suggest that larger firms react more to exchange rate shocks, with the point estimate for firms in the bottom quintile being essentially zero, while the estimate at the top quintile suggest a one percent appreciation is associated with an increase of 1.543 products. Taken together, these results suggest that firm size plays an important role in the adjustment of different margins to exchange rate shocks.

[8]We do not conduct this exercise for the number of products per partner for importers as the results in Tables 6 and 7 are clear enough and this exercise offered little further insight.

Figure 6: Exchange-Rate Coefficient by Market-Share Quintile



(a) Number of Partners

(b) Number of Products

Note: The solid line connects the point estimates on the exchange rate from estimates of equation (3.3)—excluding the market-share terms—run on market-share quintile sub-samples. The shaded area is the 95% confidence interval.

4. A Model of Multi-Product Exporters and Endogenous Matching

A simple partial equilibrium model of the import market can provide theoretical insights into the empirical results outlined above, and in particular can be used to explore the margins of adjustment to an exchange rate shock. The market for imports is characterized by the interaction of exporters/sellers and importers/buyers.[9] Sellers are exporters who produce with a range of different productivity levels, and sell a range of different products. Buyers are importers who purchase exported intermediate goods from a range of sellers and then produce for final sales to domestic consumers. Buyers also differ in their productivity for producing final goods. A relationship between a buyer and seller involves at least one unique product, but may involve multiple products produced by the seller. Fixed costs of entering a relationship as well as fixed costs of adding products to a relationship determine the density of buyer seller relationships as well as the number of goods transacted within each relationship.

Specifically, we allow for a measure B of buyer firms who are purchasing goods from a measure S of sellers. Both buyers and sellers are arranged in inverse order of productivity, so that buyer b is more productive (as described fully below) than b' if $b < b'$, and similarly seller s is more productive that s' if $s < s'$. The total number of active buyer firms is denoted $\tilde{B} \leq B$ and the total number of active sellers is $\tilde{S} \leq S$. An active buyer is one that has an endogenously

[9]The model is similar to Bernard et al. (2018). It is a partial equilibrium framework. But more importantly, we model both a relation-specific fixed cost and a product-specific fixed cost to capture the extensive margins on both fronts.

determined relationship with at least one seller. Each active buyer imports an endogenous range of intermediate inputs from each seller it interacts with, which it then combines into a composite good, and then combines all composite goods into a unique final good that is sold to domestic consumers. The buyer firms are monopolistic competitors and set a price markup over their marginal cost. Sellers choose the measure of buyers to whom they offer their intermediate goods and, in addition, choose the measure of product varieties to offer to each of these buyers. Finally, for each variety sold to a given buyer, sellers set their price as a markup over marginal cost.

4.1. Utility and production

The domestic consumer in the importing country has preferences over final import goods given by

$$C = \left(\int_0^{\tilde{B}} C(b)^{(1-\frac{1}{\rho})} db \right)^{\frac{1}{1-\frac{1}{\rho}}},$$

where $C(b)$ is the purchase of the brand of the final good produced by buyer b. We assume that there is an outside good consumed by the domestic consumer. We take the price of this outside good as given, and assume that that the demand for the final imported good, relative to the outside good can be written as

$$C = P^{-\gamma} Y,$$

where P is the price index for the final imported good, γ is the substitution elasticity between the final import good and the outside good, and Y is total domestic demand.

The buyer firm b produces using a range S_b of intermediate goods according to the production technology

$$C(b) = \left(Z(b) \int_0^{\tilde{S}(b)} x(b,s)^{(1-\frac{1}{\eta})} ds \right)^{\frac{1}{1-\frac{1}{\eta}}}.$$

Here, $Z(b)$ is the exogenous productivity of the buyer firm, and $x(b,s)$ represents the composite basket that is purchased by buyer b from seller s. As noted above, we assume that $Z(b)$ is ordered so that $Z(b) \geq Z(b')$ when $b < b'$.

The composite goods basket offered by each seller is in turn produced by combining individual varieties $x(b,s,g)$ according to the aggregator

$$x(b,s) = \left(\int_0^{G(b,s)} x(b,s,g)^{(1-\frac{1}{\sigma})} dg \right)^{\frac{1}{1-\frac{1}{\sigma}}},$$

where $G(b,s)$ represents the measure of varieties of the seller s offered to buyer b.

The seller produces each variety g for buyer firm b according to the linear technology

$$x(b,s,g) = \frac{z(s)}{h(s,g)}\ell(s,g),$$

where $\frac{z(s)}{h(s,g)}$ is the productivity of firm s in producing variety g, where we assume that $h_g(s,g) > 0$, so that the firm becomes less productive as it departs from its "core competence."[10] $\ell(s,g)$ is the firm's input (which can be thought of as labour), which has a price $w(s)$. In what follows, we interpret a uniform fall in $w(s)$ across all exporters s as an appreciation of the importer's currency.

The selling firm incurs two types of fixed costs. There is a fixed cost $f(b,s)$ of selling to buyer b (i.e. entering a relationship), and there is a fixed cost of each additional variety it offers to each buyer, given by $f(b,s,g)$. These fixed costs will play an important role in the determination of buyer-seller relationships because the profits associated with the combined productivities of the buyer and seller will have to be high enough to overcome these fixed costs in order to establish a relationship.

4.2. Final demand and importer price setting

Domestic demand for the importer b's final product (or brand) is determined by

$$C(b) = \left(\frac{p(b)}{P}\right)^{-\rho} C,$$

where $p(b)$ is the price set by the importer for their product and

$$P = \left(\int_0^{\tilde{B}} p(b)^{(1-\rho)} db\right)^{\frac{1}{1-\rho}}$$

is the price index over all final imported goods.

Given this, profit maximization by active an buyer b is as follows. Profits are defined as

$$\Pi(b) = \Big(p(b) - q(b)\Big)C(b),$$

where

$$q(b) = \left(Z(b)^{\eta} \int_0^{S(b)} q(b,s)^{1-\eta} ds\right)^{\frac{1}{1-\eta}}$$

is the unit cost for the buyer, $q(b,s)$ is cost of an individual composite good purchased from seller s, and $S(b)$ is the total measure of sellers that sell to buyer b. In turn, we can define the

[10] We model core competency similar to Eckel and Neary (2010) and Arkolakis, Ganapati and Muendler (2019).

cost of the composite good $q(b,s)$ as an aggregate over the prices of the individual varieties g produced by seller s for sale to buyer b, $q(b,s,g)$. That is,

$$q(b,s) = \left(\int_0^{G(b,s)} q(b,s,g)^{1-\sigma} dg \right)^{\frac{1}{1-\sigma}}.$$

The optimal retail price for buyer b is a markup over the marginal cost of the composite good

$$p(b) = \hat{\rho} q(b)$$

where $\hat{\rho} \equiv \frac{\rho}{\rho - 1}$.[11] When all buyers use the same markup rule, the total sales for buyer b are

$$\left(\frac{\hat{\rho} q(b)}{P} \right)^{-\rho} P^{-\gamma} Y = q(b)^{-\rho} \left(\int_0^{\tilde{B}} q(b)^{(1-\rho)} db \right)^{\frac{\rho-\gamma}{1-\rho}} \hat{\rho}^{-\gamma} Y,$$

and total revenue is

$$\hat{\rho}^{1-\gamma} q(b)^{1-\rho} \left(\frac{\hat{\rho} q(b)}{P} \right)^{-\rho} P^{-\gamma} Y = \hat{\rho}^{1-\gamma} q(b)^{1-\rho} \left(\int_0^{B} q(b')^{(1-\rho)} db' \right)^{\frac{\rho-\gamma}{1-\rho}} Y.$$

4.3. The seller's problem

Each exporter s has three decisions to make. First, it must choose a price $q(b,s,g)$ for each product variety g that it is offering to buyer b. Secondly, for each buyer, it will choose the measure of varieties to sell $G(b,s)$. Finally, it has to choose the measure (or number) of buyers to trade with. For the latter two choices, we use a cut-off rule, assuming that there is a maximum measure of varieties $G(b,s)$ for each buyer b that the seller can profitably supply and there is a maximum measure of buyers $B(s) \leq B$ that the seller can supply to and make a profit. In each case, these must be functions of the buyer's productivity and the seller's productivity. But before we make this relationship explicit, we can start by stating the optimality conditions for the seller.

Buyer b's demand for seller s's product variety g is

$$x(b,s,g) = \left(\frac{q(b,s,g)}{q(b,s)} \right)^{-\sigma} x(b,s),$$

[11] We assume that in setting retail prices, buyers behave as monopolistic competitors. This differs from the assumptions we make about sellers. Allowing buyers to price strategically would complicate the analysis without changing the predictions of the model. Since we do not have data on retail prices, we cannot assess to whether an assumption of variable retail markups are supported empirically. A number of papers provide support for variable exporter markups, including with the data set used in this papers (see Devereux, Dong and Tomlin, 2017).

where $x(b,s)$ is s's demand for the total product line of seller s

$$x(b,s) = \frac{Z(b)^{\eta} q(b,s)^{-\eta}}{q(b)^{-\eta}} C(b).$$

Finally, overall demand for buyer b's product line is (as defined above)

$$Y(b) = q(b)^{-\rho} \left(\int_0^{\tilde{B}} q(b')^{(1-\rho)} db' \right)^{\frac{\rho-\gamma}{1-\rho}} \hat{\rho}^{-\gamma} Y.$$

Sellers are multi-product monopolistic competitors. They choose the range of prices for their own goods, taking into account an elasticity σ for each variety of the good and an elasticity η for their own product line relative to other sellers. Since $Z(b') \leq Z(b)$ for $b' \geq b$, in choosing buying firms to trade with, the seller will first sell to buyer firms with higher productivity.

We can then describe the sellers profit maximization problem as the joint maximization associated with the three decisions described above. That is, they must choose (i) the price, $q(b,s,g)$, of their varieties, (ii) the range of varieties, $G(b,s)$, to sell within each relationship, and (iii) the total number of relationships, $B(s)$, to maximize profits, defined as

$$\int_0^{B(s)} \int_0^{G(b,s)} \left(q(b,s,g) - \frac{h(s,g)w(s)}{z(s)} \right) x(b,s,g) dg db - \int_0^{B(s)} \int_0^{G(b,s)} f(b,s,g) dg db - \int_0^{B(s)} f(b,s) db,$$

where $w(s)$ is the per unit input cost for the firm. As discussed above and below, movements in $w(s)$ can be thought of as movements in the exchange rate. Also, $f(b,s,g)$ is the fixed cost of adding variety g to the relationship between b and s, and $f(b,s)$ is the fixed cost of establishing a relationship between b and s

(i) Optimal pricing: The optimal price for the seller is

$$q(b,s,g) = \mu(b,s) \frac{w(s)h(s,g)}{z(s)}.$$

The seller is a multi-product firm and uses the "outer" price elasticity to determine the markup, $\mu(b,s)$, over marginal cost. In light of the extreme granularity of the import market, as documented in Section 2.2, we allow for sellers to internalize the impact that their pricing decisions have on the market price. Therefore, in choosing $q(b,s)$, seller s will take account of its affect on $q(b) = \left(Z(b)^{\eta} \int_0^{S(b)} q(b,s)^{1-\eta} ds \right)^{\frac{1}{1-\eta}}$. The optimal markup for firm s is then

$$\mu(b,s) = \frac{\eta + (\rho - \eta) \left(\frac{q(b,s)}{q(b)} \right)^{1-\eta}}{\eta + (\rho - \eta) \left(\frac{q(b,s)}{q(b)} \right)^{1-\eta} - 1}.$$

The expression $\left(\frac{q(b,s)}{q(b)}\right)^{1-\eta}$ is a measure of the market share of seller s in all sales to buyer b. A reasonable assumption is that the "within" buyer elasticity of substitution η exceeds the "across" buyers' elasticity of substitution ρ. This implies the familiar result that the seller markup is declining in market share. As shown in Devereux, Dong and Tomlin (2017), this leads to the implication that exchange rate pass-through is lower for firms with a larger market share.[12]

(ii) Range of varieties: For each b, the seller determines the extent of product variety to offer. This is represented by the condition that at $G(b,s)$ the seller makes zero net profit, given the fixed cost already paid for selling to b. Thus, the cut-off condition is

$$\left(q\left(b,s,G(b,s)\right)-\frac{w(s)h(b,s,G(b,s))}{z(s)}\right)x(b,s,G(b,s))-f\left(b,s,G(b,s)\right)=0.$$

Note that there is one of these conditions for each buyer.

(iii) Determination of the measure of buyers: The number of buyers to which an exporter sells is determined by the condition that at the marginal buyer, denoted $B(s)$, the exporter makes zero net profit. That is, at $B(s)$, we have

$$\int_0^{G(B(s),s)}\left(q(B(s),s,g)-\frac{w(s)h(B(s),s,g)}{z(s)}\right)x(B(s),s,g)dg-\int_0^{G(B(s),s)}f\left(B(s),s,g\right)dg-f(B(s))=0.$$

Writing out the full expression for $x(b,s,g)$

$$x(b,s,g)=\left(\frac{q(b,s,g)}{q(b,s)}\right)^{-\sigma}\frac{Z^{\eta}q(b,s)^{-\eta}}{q(b)^{-\eta}}\frac{q(b)^{-\rho}}{\left(\int_0^B q(b')^{(1-\rho)}db'\right)^{\frac{\gamma-\rho}{1-\rho}}}Y.$$

Substituting into the two conditions for optimal b and G, using the markup condition gives us

$$\frac{\mu(b,s)^{-\sigma}}{\mu(b,s)-1}\left(\frac{w(s)h(b,s,G(b,s))}{z(s)}\right)^{1-\sigma}q(b,s)^{\sigma-\eta}Z(b)^{\eta}q(b)^{\eta-\rho}\left(\int_0^{\tilde{B}}q(b')^{(1-\rho)}db'\right)^{\frac{\rho-\gamma}{1-\rho}}\hat{\rho}^{-\gamma}Y$$

$$-f(b,s,G(b,s))=0$$

and

$$\int_0^{G(B(s),s)}\left[\frac{\mu(B(s),s)^{-\sigma}}{\mu(B(s),s)-1}\left(\frac{w(s)h(B(s),s,g)}{z(s)}\right)^{1-\sigma}q(B(s),s)^{\sigma-\eta}Z^{\eta}q(B(s))^{\eta-\rho}\right.$$

[12]Other papers that show the negative relationships between exchange rate pass-through and exporter size include Berman, Martin and Mayer (2012) and Amiti, Itskhoki and Konings (2014) who show that exchange rate pass-through decreases monotonically in exporter market share. Feenstra, Gagnon and Knetter (1996), Garetto (2016) and Auer and Schoenle (2016) emphasize a U-shaped relationship between exporter market share and pass-through.

$$\times \left(\int_0^{\tilde{B}} q(b')^{(1-\rho)} db' \right)^{\frac{\rho-\gamma}{1-\rho}} \hat{\rho}^{-\gamma} Y \Bigg] dg$$

$$- \int_0^{G(B(s),s,g)} f(B(s), s, g) dg - f(B(s)) = 0.$$

4.4. Calibration

Next, we explore the characteristics of the model and how well it can explain the findings detailed in section 2.2. In order to to this, we need to calibrate the model parameters and numerically solve for the equilibrium. We start by transforming the continuous measures of buyers, sellers and goods into discrete measures. We assume there is a maximum of 32 buyers and 100 sellers, which roughly matches the ratio of buyers to sellers in the data. We assume there is a maximum of 8 separate products that each seller can offer to any buyer, which again is close to the maximum observed for the separate product categories in Figure 2. In most circumstances, not all matches between buyers and sellers will be achieved because the lowest productivity buyers and sellers will seldom trade with each other, and the goods farthest from a seller's core competency will seldom be produced.

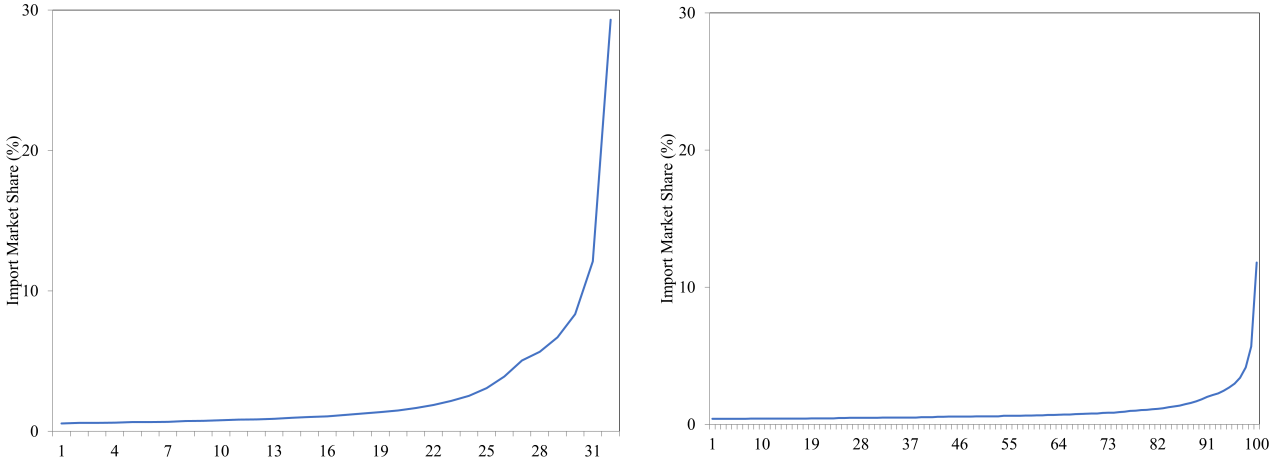
For the calibration of the model's parameters, we turn to the existing literature. Using U.S. data, Feenstra et al. (2018) estimate the microelasticity across individual industries (the substitution elasticity between alternative foreign import sources) to be around 3 to 4—depending on the empirical method used—and the macroelasticities (the substitution elasticity between domestic and foreign import sources) to be lower. We follow their findings, setting η and ρ at 3.5 and 3.25 respectively, and set γ somewhat smaller, at 3.

The productivity of sellers and buyers follows a Pareto distribution in the form of $F(z) = kz^{-(k+1)}$, where k is the shape parameter.[13] Calibrated to the U.S. data, Melitz and Redding (2015) set the Pareto shape parameter for firm productivity to be 4.25, and Bernard, Redding and Schott (2009) set it equal to 4. Estimating using French firm level data, Nigai (2017) found that a Pareto shape parameter would take a value of 1.9 (lower values of k correspond to greater firm heterogeneity). We set $k = 3$ in our simulation—a number roughly in the middle of this set of estimates.

There are three remaining parameters for which we have little guidance in terms of reasonable values. First, we assume that additional products farther away from a seller's core competency incur higher unit costs. To model this, we assume that $h(g) = (1 + h)^g$ where h

[13]The Pareto distribution has been the common choice for approximating the shape of firm productivity distribution, though the Pareto assumption is sometimes challenged when Log-normal provides a closer fit to the left tail of distribution. See also Fernandes et al. (2018).

Figure 7: Importer and Exporter Share of the Import Market (model)



(a) Importers (b) Exporters

Note: Panel (a) presents the model results for the share of import value accounted for by importing firms (there are 32 importing firms). Panel (b) presents the share of imports accounted for by each exporting firm (there are 100 exporting firms).

is the unobserved parameter that governs the shape of the core competency function. We use a method of simulated moments (MSM) to estimate h. More specifically, we estimate the parameter h which mostly closely fits the quarterly decomposition of import transactions into the importer intensive margins describe in section 2.2. With this, the estimated value for h is 0.05.[14]

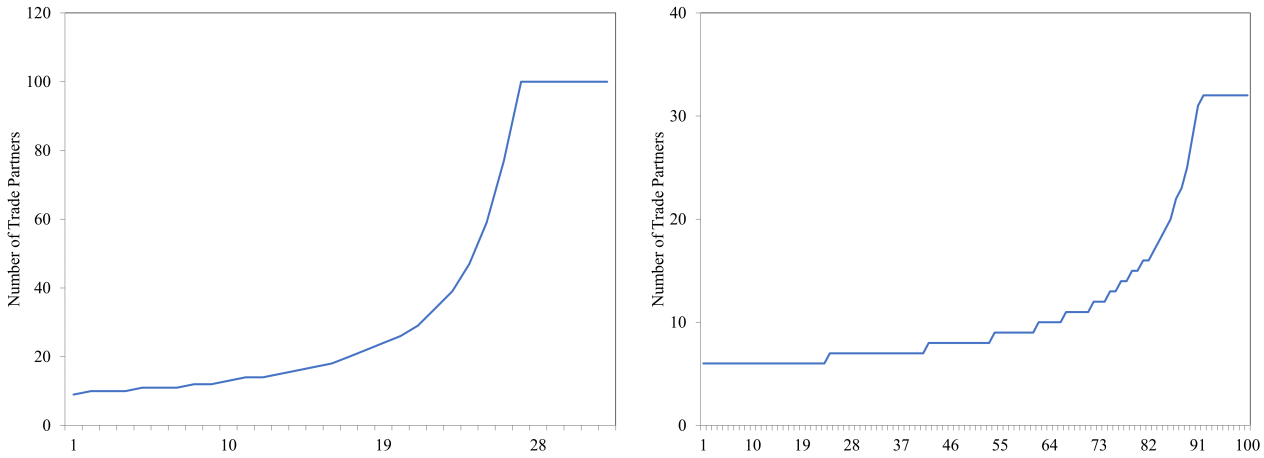
The other unknown parameters are those of the fixed costs of entering a new relationship or adding a new product to an existing relationship. These are determined as part of the same MSM framework above, which is estimated to best match the contributions of the different importer intensive margins.

4.5. Model fit

With this calibration, we can compare the implied equilibrium distributions to those presented in section 2. Figures 7(a) and (b) represent the distribution of total import value as a function of the size of importers and exporters, respectively, in the baseline steady state. In both cases, we see that the share of total imports is sharply skewed towards large buyer and seller firms. Our chosen Pareto shape parameter leads to the top importers and exporters accounting for around 29 and 12 percent of the total value of imports. This represents a lower degree of concentration than we see in the data, but nevertheless constitutes a high degree of concentration.

[14]This value is very close to the analogous elasticity in Arkolakis, Ganapati and Muendler (2019).

Figure 8: Number of Partners for Firms (model)



(a) Importers (b) Exporters

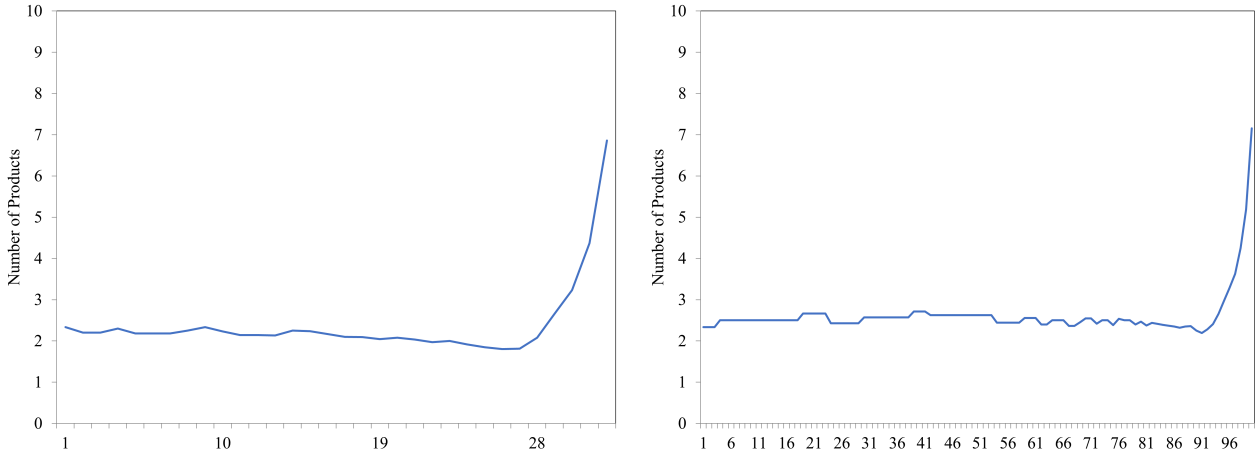
Note: Panel (a) presents the number of trade partners for each of the 32 importers (listed on the horizontal axis in order of productivity). Panel (b) presents the number of trade partners for each of the 100 exporters (listed on the horizontal axis in order of productivity).

Figure 8 illustrates the distribution of exporters per importer (panel a) and importers per exporter (panel b). As in the data, we see that the distribution is skewed to the right—the smallest importing firms have fewer export suppliers than larger importers (panel a). A similar pattern is seen for exporters in panel (b), where the smallest exporters have fewer trade partners than the larger exporters. Of note, given our calibration, the six largest importers trade with all 100 exporters, and the nine largest exporters trade with all 32 importers. This will matter when interpreting the relationship between margin adjustment and firm size, which we eloborate on below.

Next, Figure 9 presents the number of products per trade partner for importers and exporters, numbers that are analogous to the data presented in Figure 2. Panel (a) shows that the number of products per trade partner for importers is fairly flat, averaging around two products per trade partner, but increases at the top end of the distribution where the largest importer has an average of seven products per partner. The story is similar for exporters, where panel (b) shows that most firms average just over two products exported to importers, but that the largest exporter sells almost all of its products to each importer. Again, these patterns are qualitatively similar to what is seen in the data.

To explore how the contribution of the different margins of trade work within the model, we simulate the model's response to aggregate shocks. More specifically, we subject the model to a repeated series of aggregate shocks and calculate the share of the different margins in each of the model's one-period-ahead responses. We then average across all periods to calculate the shares of the buyer-seller and product extensive margins as well as the pure intensive margin,

Figure 9: Number of Products per Partner for Firms (model)



(a) Importers

(b) Exporters

Note: Panel (a) presents the number of products per trade partner for each of the 32 importers (listed on the horizontal axis in order of productivity). Panel (b) presents the number of products per trade partner for each of the 100 exporters (listed on the horizontal axis in order of productivity).

which we then compare to the quarterly margin contributions observed in the data.[15]

The aggregate shocks we focus on are demand and seller cost shocks—that is, shocks to Y and w in the model, respectively. Since the model has no intrinsic dynamics we simply solve by subjecting the model to repeated shocks to demand and cost over a two period horizon, and then average over many (350) iterations. Following the data, we calibrate the shocks so that the standard deviation of w is 10 percent, in accordance with the Canadian real trade-weighted exchange rate, and the standard deviation of aggregate demand Y is much lower at 2 percent (where the frequency is quarterly in both cases).

Table 8 presents the results of these simulations and shows that the model with the baseline calibration matches the data well in several ways. In both the model and the data, the average adjustment in total value is dominated by the pure intensive margin. This represents continual buyer-seller-product relationships adjusting the value of the relationships by increasing or decreasing the number of units being exchanged as prices adjust with the demand and cost shocks.

We also see that in the model simulations, as in the data, the share of transactions for the buyer-seller and product extensive margins is significantly higher than their value shares.

[15]Note that in the initial equilibrium, all firms are active, which essential rules out movements in the importer extensive margin. We do not see this as a problem, given that this margin is very small in the data and the focus of this paper is on the different components of the importer intensive margin.

Table 8: Model Simulation Results and Fit

	Share of Transactions		Share of Value	
	Data	Model	Data	Model
Buyer-seller extensive	24.6	25.7	8.1	3.4
Product extensive	15.9	29.6	3.4	3.8
Pure intensive	56.8	44.5	87.9	92.6

Note: The model margin contributions are based on simulating the response of the model to shocks to demand (Y) and seller costs (w) over 350 periods, and the average contributions to the model's adjustment to the shocks are reported in this table.

This reflects the fact that adjustments along these margins come from either lower productivity (and hence low market share) importers and exporters adding or dropping trade partners and/or products, and larger importers and exporters adding marginal trade partners and products. That is, there are a significant number of these relationships being created or destroyed in response to the aggregate shocks, but they are of relatively low value in the short term. The model matches quite well the transactions response for new trade partners, but overestimates the share of new products adjustment relative to pure intensive adjustment (which is simply continuing partnerships). This is not surprising, given that the model is not designed to track long term trade relationships. Nevertheless, taken together, the results presented in this subsection suggest that the model captures many of the key characteristics of the data presented in section 2.

5. Adjustment to Exchange Rate Shocks

In this section we turn our attention to the specific effects of an exchange rate shock on the formation of new buyer-seller relationships and the addition of new products into existing relationships.

5.1. Isolating the exchange rate shock

When the domestic currency appreciates, imports become cheaper.[16] This is similar to the impact of lower input costs in our model. To explore the response of the model to exchange rates, we begin by assuming that exchange rate shocks are equivalent to a homogeneous cost shock in a two-country setup, so $w(s) = w$ for all $s \in S$. We then isolate the effects of the cost/exchange-rate shock in the simulations in the previous section by regressing the change in

[16]Pass-through regressions suggest that exchange rate pass-through to import prices is typically incomplete and higher than pass-through to consumer prices. Burstein and Gopinath (2014) provide a survey on the empirical and theoretical literature on the relation between prices and exchange rates.

the number of firm-to-firm matches and change in the number of products traded within existing relationships on the changes in the exchange rate and aggregate demand. In line with the findings on heterogeneity in section 3.2 above, we also include an interaction term for the market share of each importing firm. Table 9 presents the results (which are the model counterparts to the results presented in columns II and VI in Table 6) and it first shows that an exchange rate appreciation is associated with a highly significant increase in the number of firm-to-firm matches and in the number of products traded within relationships. In addition, aggregate demand shocks increase both firm-to-firm matches and the products traded within matches. The table also shows that the response to exchange rates is larger for bigger firms—the interaction terms between market share and the exchange rate shock is significantly positive and large.

Table 9: Regressions Results Based on Model Simulation

	Change in Buyer-Seller Relationships	New Goods into Existing Relationships
Exchange rate (w)	2.07***	2.83***
Demand shock (Y)	2.00***	2.29***
Market share (MS)	-0.00***	-0.00***
$MS \cdot w$	0.10***	0.01***
Constant	-0.04***	-0.07***
Obs.	350	350

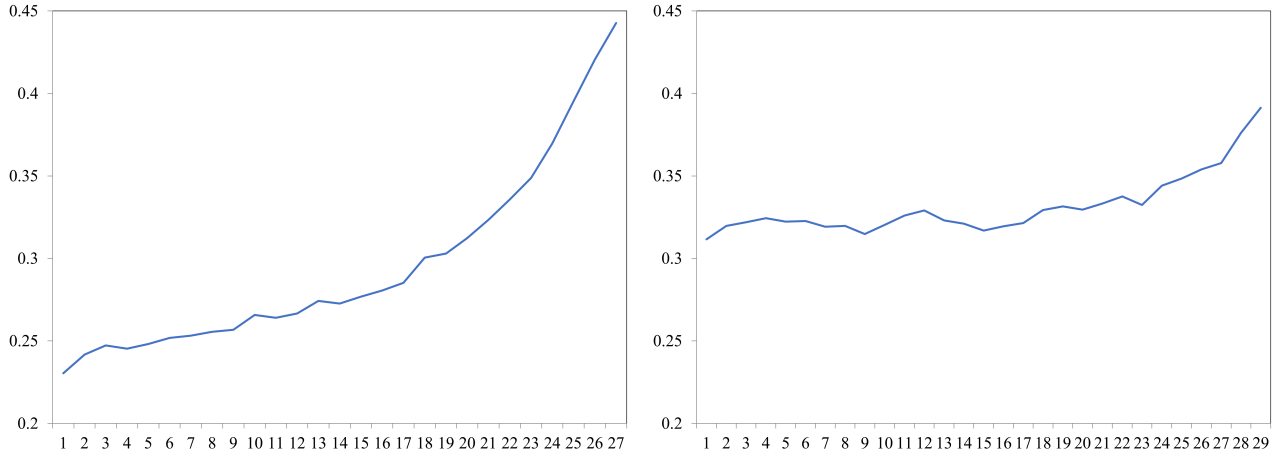
Figure 10 illustrates the importance of market share in a different way. Panels (a) and (b) show for each firm in the distribution of buyer firms, the average number of the extensive margin adjustments over the simulated data, in absolute terms, relative to all firm and product relationships.[17] We see that in terms of firm-to-firm relationship adjustment, and new product adjustment, there is a positive relationship with the buyer firm's market share. As shown in the model simulations and in accordance with the empirical findings, larger importer firms account for more of the extensive margin adjustment.

5.2. Decreasing the variance of the exchange rate shock

To go into more detail about the effects of exchange rate shocks on the different margins within the model, we replicate the simulation of the previous section but reduce the variance

[17]The model calibration implies that the most productive importers have little or no room for buyer-seller and product extensive margin adjustment because they have a relationship with all seller firms (see Figure 8a) and purchase most of the goods produced by each seller (see Figure 9a). In Figure 10 we wish to highlight the response of unconstrained firms in the model (to better reflect what is observed in the data) and so we drop the largest firms that are constrained in their ability to add (or drop) new trade partners or products in response to an exchange rate shock. The number of constrained firms is different for the buyer-seller (27) and product (29) extensive margins.

Figure 10: Importer Response to Exchange Rate Volatility (model)



(a) Number of Trade Partners

(b) Number of Products per Trade Partner

Note: Panel (a) presents the fraction of new sellers as a fraction of all buyer seller links for each buyer in the population up to the 27th buyer. Panel (b) presents the fraction of new products per seller as a fraction of all product seller links for each buyer in the population up to the 29th buyer.

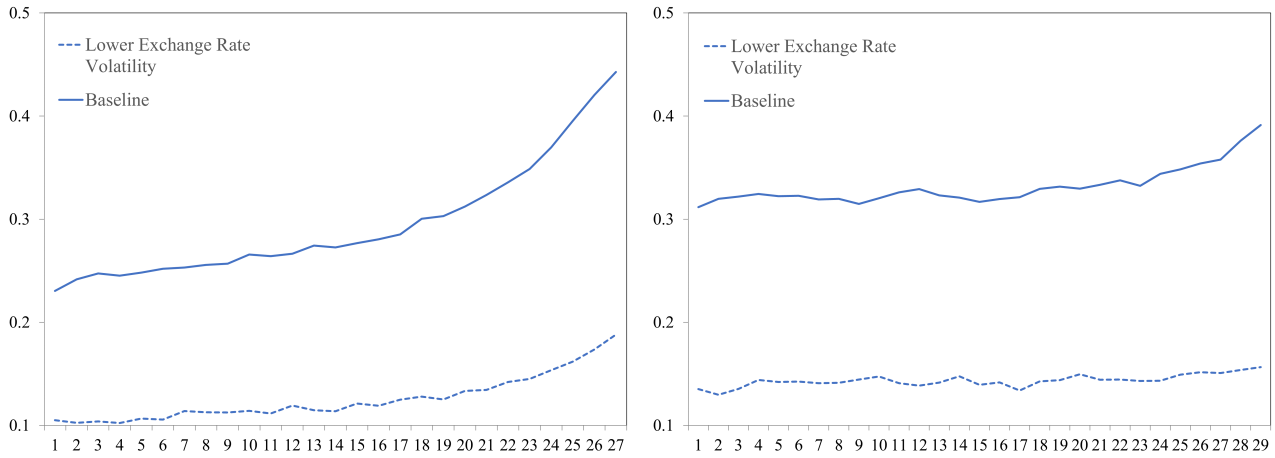
of the cost-shock/exchange rate draw by fifty percent. The difference between the baseline simulation and this current simulation, presented in Table 10, helps in the understanding of the model's response to exchange rate shocks. The fall in the volatility of the exchange rate shock has little effect on the value shares (compared with the baseline model—see column I versus column II) as imports are still dominated by the pure intensive margin. This is because any new relationships and/or products added to existing relationships are marginal and therefore have a low value relative to the core continuous relationships and products that make up the pure intensive margin.

Table 10: Model Simulations with Lower Exchange Rate Volatility

	Value Shares		Transaction Shares	
	I Baseline Model	II Less Volatile Exchange Rate	III Baseline Model	IV Less Volatile Exchange Rate
Buyer-seller extensive	3.4	1.1	25.7	12.0
Product extensive	3.8	1.3	29.6	14.1
Pure intensive	92.6	98.0	44.5	73.9

Where the model does highlight the effects of smaller exchange rate shocks is in the share of transactions. In columns III and IV, we see that a fall in the exchange rate shock has a large dampening effect on the transaction shares, as the buyer-seller and product extensive margins shares fall from a total of 55.3 percent to a total of 26.1 percent. Therefore, it is clear that within the model that exchange rate shocks have a significant effect on the formation of buyer-seller

Figure 11: Importer Counterfactual Response to Lower Exchange Rate Volatility (model)



(a) Number of Trade Partners

(b) Number of Products per Trade Partner

Note: Panel (a) presents the fraction of new sellers as a fraction of all buyer seller links for each buyer in the population up to the 27th buyer, in the baseline case and the case with lower exchange rate volatility. Panel (b) presents the fraction of new products per seller as a fraction of all product seller links for each buyer in the population up to the 29th buyer, in the baseline case and the case with lower exchange rate volatility

relationships and on the set of goods traded within relationships.

Plotting out the responses of different firms to the baseline exchange rate shock model and to the present one with lower variance in the exchange rate shock offers further insight into what is driving aggregate outcomes in the model. Figure 11 presents the response of different firms in the model in the different shock scenarios. Panel (a) present the response of firms in terms of the number of trade partners, with the baseline simulation of the previous section presented as the solid line and the counterfactual with lower exchange rate volatility presented as the dashed line. First, the dashed line lies entirely below the solid line, which highlights the importance of the exchange rate for overcoming the fixed costs of adding a new trade partner. Second, the flattening of the dashed line relative to the solid line highlights the fact that exchange rate shocks can have amplification effects operating through the response of large firms, as larger shocks lead to larger responses of large firms. Panel (b) offers similar insights as panel (a), but in terms of the number of products per trade partner for importers.

It is interesting to interpret Figure 11 in terms of the empirical results in Table 7. There we saw that the relationship and product margins adjustment in the data increases with exchange rate volatility, and that this adjustment increases with larger market share buyers. Figure 11 shows the importance of the interaction between market share and the size of exchange rate volatility. The Figure shows that lower exchange rate volatility reduces the overall adjustment along both dimensions (goods and trade partners), but also flattens the response. The positive link between market share (or equivalently productivity) and relationship and product margin

adjustment is reduced in the model with counterfactually lower exchange rate volatility. That is, with lower exchange rate volatility, even relatively large firms find it less profitable, on average, to adjust along the relationship and product margins relative to the pure intensive margin.

6. Conclusions

Our findings in the data show that the formation of new trading relationships and adjustments within existing relationships—in terms of the products traded—are important contributors to import flows in Canada. Moreover, we show that the buyer-seller extensive and product extensive margins are sensitive to movements in the exchange rate, and that larger firms react more to these shocks.

We build a model of international trade with monopolistic competition, endogenous buyer-seller matching and multi-product exporters that can replicate many of the findings relating to distributions across buyer-seller-product relationships. The model highlights how movements in exchange rates may lead to a positive relationship between appreciations of the domestic market currency and the number of trade partners importers interact with and the number of products they import.

Taken together, the stylized facts and empirical results presented in this paper suggest that exchange rate shocks can affect import flows by affecting the formation of trade relationships and the addition of new products to existing relationships. Moreover, this relationship is driven by the stronger reaction of large firms to exchange rate shocks. Simulations of the model with different degrees of exchange rate volatility highlight the important role of larger firms in driving aggregate outcomes.

While the model does not touch on the longer-run effects of exchange rate shocks operating through these channels, the data do suggest the addition of new trade partners and new products to existing relationships play an important role in longer-run trade flows and that the adjustment of large firms is a main driver of this process. To explore this in more detail, a longer time series in the data is needed along with a model with firm and trade dynamics. We leave this to further investigation.

Appendix A. Baseline logit results

As an alternative approximation for how the buyer-seller-product margins react to exchange rate shocks, we also run the following logit regressions:

$$Pr(Y_{it}) = \frac{exp(v_{it})}{1 + exp(v_{it})}, \tag{A.1}$$

Table A.11: Adding a New Trade Partner or New Product into an Existing Relationship (logit)

	New Trade Partner		New Product into Existing Relationship	
	I	II	III	IV
Exchange rate (Δex_t)	0.321***	0.364***	0.736***	0.651***
	(0.096)	(0.097)	(0.105)	(0.106)
Canadian GDP growth		-4.720***		9.300***
		(0.986)		(1.075)
Time trend	0.004***	0.002***	0.009***	0.013***
	(0.000)	(0.000)	(0.001)	(0.001)
Firm fixed effects	Yes	Yes	Yes	Yes
Quarter fixed effects	Yes	Yes	Yes	Yes
Obs.	778,847	778,847	688,628	688,628

Note: Results based on estimates of equation (A.1), where the dependent variable $Pr(Y_{it})$ is the probability that an importing firm i adds a new trade partner (columns I and II) or the probability that an importing firm adds a new product to an existing relationship with an exporter (columns III and IV).

where

$$v_{it} = c + \beta \Delta ex_t + Z_t'\gamma + \sigma time + \alpha_i + \epsilon_{it}.$$

Depending on the specification, $Pr(Y_{it})$ refers to the probability of an importer i in quarter t adding a trade partner or a new product into one of its existing relationships. All other variables in the definition of v_{it} are the same as in (3.1).

Columns I and II in Table A.11 report the results where Y_{it} is an indicator that firm i added a new trade partner in quarter t.[18] In both columns (with and without a control for demand shocks), the positive and statistically significant coefficient on the exchange rate suggests that an appreciation of the Canadian dollar increases the probability that importing firms add new trade partners. Columns III and IV report the results where Y_{it} is an indicator that firm i added a new product to an existing trade relationship in quarter t.[19] Again, both columns report a positive and statistically significant coefficient on the exchange rate term, indicating that an appreciation of the Canadian dollar increases the probability that importers add new products to their existing relationships with foreign sellers.

[18] A new relationship is flagged in the same way it was done for Table 4, Panel A. That is, the new relationship did not exist at any point over the previous four quarters.

[19] A new product added to an existing relationship is flagged in the same way it was done for Table 4, Panel A. That is, the product was not traded at any point over the previous four quarters, but the buyer-seller relationship did exist.

Table B.12: Regression Results with Alternative Measure of Firm Size ($Y_{i,t-1}$)

	Importer Partners		Importer Products		Relationship Products	
	I	II	III	IV	V	VI
Exchange rate (Δex_t)	0.081***	0.284***	0.114***	0.130***	0.059***	0.373***
	(0.029)	(0.029)	(0.030)	(0.031)	(0.014)	(0.014)
Firm size ($Y_{i,t-1}$)	-0.024***	-0.025***	-0.064***	-0.063***	-0.018***	-0.018***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
$\Delta ex_t \cdot Y_{i,t-1}$	0.013***	-0.022***	0.013***	0.007***	-0.004**	-0.135***
	(0.001)	(0.002)	(0.001)	(0.001)	(0.002)	(0.003)
$\Delta ex_t \cdot Y_{i,t-1}^2$		0.000***		0.000***		0.001***
		(0.000)		(0.000)		(0.000)
Canadian GDP growth	0.550*	0.553*	1.175***	1.177***	0.967***	0.967***
	(0.279)	(0.279)	(0.297)	(0.297)	(0.130)	(0.129)
Time trend	-0.003	-0.003	-0.001***	-0.001	-0.001***	-0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Constant	0.186***	0.189***	0.471***	0.471***	0.050***	0.049***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.002)	(0.002)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Quarter FE	Yes	Yes	Yes	Yes	Yes	Yes
Obs.	672,401	672,401	672,401	672,401	2,239,572	2,239,572

Note: Results based on estimates from alternative to equation (3.2), where the measure of firm size is the previous period's number of trade partners per importer (columns I and II), the number of products per importer (columns III and IV), or the number of products within importer-exporter relationships (columns V and VI).

Appendix B. Alternative firm-size regressions

Table B.12 presents the results from an alternative specification of regression (3.2), where instead of market share, the measure of firms size is $Y_{i,t-1}$. That is, the previous period's number of partners (columns I and II), products (columns III and IV) and products per partner (V and VI). The results are generally in line with the results in section 3.2.

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