Micro, Macro, and Strategic Forces in International Trade Invoicing

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Abstract

The use of different currencies in the invoicing of international trade transactions plays a major role in the international transmission of economic fluctuations. Existing studies argue that an exporter's invoicing choice reflects structural aspects of her industry, such as market share and the price-sensitivity of demand, the hedging of marginal costs, due for instance to the use of imported inputs, and macroeconomic volatility. We use a new highly disaggregated dataset to assess the roles of the various invoicing determinants. We find support for the factors identified in the literature, and document a new feature, in the form of a link between shipments size and invoicing. Specifically, larger transactions are more likely to be invoiced in the importer's currency. We offer a potential theoretical explanation for the empirical link between transaction size and invoicing by allowing invoicing to be set through a bargaining between exporters and importers, a feature that is absent from existing models despite its empirical relevance.

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1. Introduction

The currency in which exporters set the price of their goods – the so-called "invoicing" currency – has long been recognized as a central aspect of international economics. Specifically, it determines who among the exporter or the customer is exposed to exchange rate risk, and whether exchange rate fluctuations lead to a switching of demand between goods produced in different countries. An extensive theoretical and empirical literature has identified complementary drivers of invoicing. A first category reflects structural features of the industry in question, such as the price-sensitivity of demand and exporters' market shares. A second category of drivers reflects the need to hedge against unforeseen movements in marginal costs, for instance due to exchange rate volatility or the presence of imported inputs priced in foreign currencies.[2] In addition to the currencies of the exporter or the importer, the literature has also explored the use of "vehicle" currencies that are neither the exporter's nor the customer's.[3]

The existing literature suffers from two limitations, one empirical and one theoretical, that we address in this paper. On the empirical front, the literature relies mainly on aggregate data, potentially hiding contrasting patterns across exporters that might be apparent in more disaggregated data.[4] For instance, in a given country firms in an industry where demand is very sensitive to prices have an incentive to choose an invoicing currency that is the same as their competitors, where firms whose products are more differentiated are less subject to this "coalescing" effect (Goldberg and Tille 2008). The existence of such heterogeneity in invoicing data would improve our ability to test different theories relative to what is observable in the aggregate data.

We address this limitation by using a new highly disaggregated dataset for Canadian imports. Our data cover all Canadian import transactions between February 2002 and February 2009 (45 million observations), with information on the disaggregated industry, the invoicing currency, and the country of origin for each transaction. We begin by documenting the patterns of invoicing, both from the point of view of transactions *count* and the point of view of

[2] A non-exhaustive list of recent contributions includes Bacchetta and van Wincoop (2005), Devereux, Engel, and Storgaard (2004), Friberg (1998), Novy (2006), Goldberg and Tille (2008).
[3] Goldberg and Tille (2008, 2009).
[4] An exception is Gopinath, Itskhoki and Rigobon (forthcoming) who use BLS data to study the frequency of price adjustment in U.S. imports and the relationship to currency of invoicing. Donnenfeld and Haug (2003) provide an early look at a subsample of Canadian data for an earlier period. Goldberg and Tille (2008) survey other prior research.

transaction *value*. The U.S. dollar is extensively used, accounting for nearly 85 percent of import invoicing by count (75 percent by value). We distinguish between imports from the United States, which account for a little more than half of total imports and are nearly exclusively invoiced in U.S. dollar, and imports from other countries where the use of other currencies is more substantial. We show that the Canadian dollar is used more extensively for large shipments than smaller ones, accounting for a much larger share of imports by value than by count. Invoicing patterns are also remarkably steady over time throughout our sample period.

The drivers of invoicing are then tested through a formal econometric exercise. We consider variables that reflect industry-structure (i.e. whether demand is price-sensitive), the market share of imports from that country in the specific industry, the size of shipments, the reliance on commodity inputs in production, exchange rate volatility, dummy variables that capture the ability of various currencies to hedge shocks to marginal costs, and the exchange rate regime of the country of origin. Throughout our empirical analysis we distinguish between imports from the United States and imports from other countries.

Our analysis leads to seven main results. First, exporters in industries where demand is more price-sensitive tend to use the U.S. dollar (for U.S. exporters) or the Canadian dollar (for non-U.S. exporters) relatively more than exporters in other industries. Second, exporters in a country which has a dominant share of imports in a particular industry have a greater tendency to use their own currency. Third, large shipments have a higher likelihood of being invoiced in Canadian dollars than smaller ones, especially when the exporter has a high market share. Fourth, exporters in industries with greater use commodity and energy as inputs are more likely to invoice in U.S. dollars, reflecting the fact that dollars are the standard invoicing currency for these inputs. Fifth, exporters from countries with a volatile exchange rate make little use of their currency for invoicing trade. Sixth, we find some evidence of the invoicing use of currencies that offer a hedge against movements in production cost. Finally, there is a strong tendency for exporters in countries with a peg to the dollar to use the dollar more frequently, whereas exporters in euro area countries or with currencies that track the euro closely have a stronger tendency to use the euro.

From a theoretical perspective, the existing literature mostly treats invoicing choice as decided solely by the exporter.[5] The only role of the customer is to provide the exporter with the

[5] An exception is Viane and De Vries (1992).

downward-sloping demand that the exporters take into account. This assumption of unilateral invoicing is at odds with the evidence provided by Friberg and Wilander (2008). A survey of Swedish exporters documents that the invoicing currency is predominantly set through a negotiation between the exporter and the consumer. In addition to its lack of empirical realism, the standard model is hard pressed to generate the type of link between transaction size and invoicing selection that we observe in the data.

We address this limitation of the theory by developing a model where invoicing is set through a bargaining game between the exporter and the customer. We do not claim that this is the only setting that could lead to a role of transaction size. Instead we offer it as a way to generate this feature through an extension of the standard model.[6] Specifically, the invoicing choice is determined as a split between the exporter and the customer of the surplus from the transaction and reflects their relative negotiating power. Two main results emerge. First, a bargaining allocation is likely to make more use of the destination currency than the unilateral invoicing choice by the exporter. Intuitively, the exporter has an incentive to use her own currency to limit the impact of exchange rate movements on her unit revenue, whereas the customer gets a higher utility from having the price stabilized in her own currency. Second, the model implies that the use of the customer's currency is more pronounced for large sales. This reflects the fact that the exporter's default option is worse when negotiating with a large customer, leading her to be more accommodating to the use of destination currency. Interestingly, the impact of size on invoicing is more pronounced when the exporter has a large bargaining power in splitting the surplus. Intuitively, size represents an alternative source of bargaining strength for the customer, which she needs to rely on only if her direct bargaining power is limited.

The rest of this paper is structured as follows. Section 2 presents the new invoicing data, as well as the measures used in the econometric analysis. The econometric results are analyzed in Section 3. Section 4 reviews the invoicing drivers in the standard model, and points to its inability of accounting for the observed link between transaction size and invoicing. Section 5 extends the model by introducing a bargaining dimension. Section 6 concludes.

[6] Gopinath and Itskhoki (2009) provide an alternative approach to pricing, pass-through and by extension to invoice currency choice by using a dynamic menu-cost model and a variable markup channel generate significant variation in the frequency of price adjustment by exporters.

Section 2. The invoicing of Canadian imports

A novel database allows for a rich exploration of the various drivers of invoicing. The database covers 45 million individual import transactions for Canada, covering all imports during 2002 to 2009.

2.1 Sectoral and geographical breakdown

The Canada Border Services Agency (CBSA) records every import transaction into Canada. Each transaction is accompanied by a customs invoice with detailed information on the contents' exporting country of origin, currency of settlement, industry code (up to HS10), quantity, and value of transaction.[7] The original dataset, obtained from Statistics Canada (StatsCan) in conjunction with CBSA, contained the full roster of 44.5 million import transactions spanning the period from February 2002 through February 2009. After observing some incomplete sampling in February and March 2002 we drop those months of data and then apply other filters to the database: transactions are dropped if there is missing information for invoicing currency, industry code, country of origin, or value. We drop Canadian imports that record Canada as the country of origin, since these imports are most likely prior Canadian exports being returned to producers, or are goods re-imported for the purpose of repairs. The screened sample has 41.9 million observations. Additionally, in our econometric work (described below) we introduce variables that are country and time-specific. For tractability, we limit import observations so they are from the group of exporting countries (47) that account for a combination of most import transactions by count (covering 95.9 percent) and by value (covering 97.1 percent).

Table 1 presents a decomposition of Canadian import transactions into sixteen broad product categories, and six exporting regions. This decomposition is based on a *count* of import transactions, without regard to the value of each transaction. Table 2 provides a more conventional decomposition of imports, weighting these by value of transactions. While Canadian imports are widely dispersed across exporting countries, the United States is the largest partner of Canada by a wide margin, accounting for 59 percent of imports by count and 57

[7] The Customs Coding form can be referenced at http://www.cbsa-asfc.gc.ca/publications/forms-formulaires/b3-3.pdf

percent by value. The next-largest import sources for Canada are the eurozone, with 12 percent by count and 9 percent by value, and Asia (both East and South East Asia and China), with 14 percent by count and 13 percent by value.

The rightmost column of each of these tables shows the industry composition of Canadian imports. Clearly, industry concentration is lower than the concentration by country of origin of these imports. The dominant import industries are machinery and equipment (23 percent of imports by count and 26 percent by value), metal (13 percent by count, but only 7 percent by value), and transportation (only 3 percent by count, but 21 percent by value reflecting the high value added of this industry).

Tables 1 and 2 also show that the presence of particular countries or regions in Canadian imports varies by industry. The United States share ranges from a low of 40 percent (footwear/headgear by count; or 5 percent by value) to a high of 84 percent for mineral products, by count (77 percent for plastics/rubber by value). Eurozone countries are most prevalent in Canadian imports of chemicals, leather/furs/hides, and foodstuffs. While Asia accounts for only 14 percent of total imports (14 percent by count, 13 percent by value), its role is concentrated in specific sectors such as textiles (24 percent by count and 45 percent by value), footwear/headgear (23 percent by count and 77 percent by value) and leather/furs/hides (22 percent by count and 59 percent by value).

2.2 A broad assessment of invoicing

What are the broad patterns in the invoicing of Canadian imports? Figure 1 (upper and lower panels) presents the evolution of the share of U.S. dollars (USD), Canadian dollars (CAD), euros (EUR), and other currencies in invoicing Canadian imports. The upper panel presents invoicing shares based on transaction count, with the lower panel showing the shares based on transaction value. These figures yield some striking observations. Observe the dominant role of the USD which is used on over 85 percent of Canadian import invoices over the period between 2002 and 2009. This role has also been quite stable over time. The CAD, EUR, and other currencies each account for less than 5 percent of Canadian import invoices by count. Interestingly, quite a different pattern of currency use emerges in terms of transaction values. While the USD remains dominant, its share is lowered to 75 percent of imports. In import value comparisons there is a larger role of the CAD, at between 20 and 25 percent of imports. The role

of the other currencies remains small overall. The larger role of the CAD in terms of value than in terms of count indicates that CAD use is more concentrated among larger transactions, an aspect that we explore further below.

A complementary way to look at the invoicing pattern is to take the point of view of the exporter, and consider whether invoicing is done in the exporter's currency – the so-called "producer currency pricing" (PCP) option – in the destination currency – the "local currency pricing" (LCP) option – or in a third "vehicle currency" (VCP). Figure 2 presents a window into the geographical breakdown of exporter invoicing by showing the use of the PCP option for imports from the United States, Eurozone, United Kingdom, Japan, China, and all other countries, both by count (left panel) and value (right panel). The United States is an outlier with PCP being the dominant option. For the eurozone, UK and Japan, the degree of PCP is still substantial, and more variable over time, but its use is concentrated in transaction of relatively low value as shown by the lower shares in terms of value than in terms of count.

Figure 3 shows the shares of the three options (PCP, LCP, VCP), with the United States exporters presented as distinct from exporters from all other regions. It is revealing that, in terms of transaction counts, local currency pricing is the least prevalent pricing practice by count, regardless of whether transactions are for exports from the United States or other regions. PCP is the most prevalent form of pricing overall, reflecting both the U.S. exporter use of dollars, as well as invoicing in euros by eurozone exporters, yen by Japanese exporters, and pound sterling by United Kingdom exporters. For non-U.S. exporter transactions, VCP is the dominant option. For all exporters, the USD is the dominant choice. However, the euro also is used on invoices for countries in the geographic proximity of the euro area: the euro share in VCP is 23 percent for Eastern Europe and the FSU, 19 percent for Switzerland, 14 percent for Scandinavia, and 9 percent for Britain. A somewhat different invoicing profile especially with respect to PCP and LCP appears in terms of value, as the role of PCP shrinks to the benefit of LCP. This again reflects a more prominent use of the CAD in large transactions than in small ones. PCP plays only a minor role when we focus on non-U.S. exporters, whose exports mostly use a vehicle currency for invoicing or the CAD.

The data show a novel pattern where invoicing outcomes differ with transaction size. To illustrate the magnitude of this pattern, Table 3 provides the prevalence of LCP in the bottom 95^{th} percentile and top 5^{th} percentile of transactions (by size), by industry, and for U.S. and non-

U.S. exporters to Canada. Each panel presents the median transaction size in the bottom 95th percentile and top 5th percentile, as well as the shares of LCP. Import transactions in the top 5th percentile are generally substantially larger, and thus unlikely to merely reflect just higher quality goods. Larger transactions consistently display a substantially higher LCP share. This pattern is robust across industries, and whether one considers all transactions, or the U.S. exporters only, or focuses on exporters from the rest of the world. We have conducted formal tests using imports disaggregated at the HS2 and HS4 levels, and found consistent patterns of statistically higher use of LCP in higher value import transactions. The share of LCP rises as the transaction size rises over the upper tail of the distribution of transaction sizes by industry.

3. Econometric analysis

We now turn to a formal assessment of the invoicing patterns in the data. Our econometric tests are devised to explore the determinants of invoicing for the full (cleaned) sample of Canadian imports described above, about 42 million observations. The dependent variables are dummy variables indicating whether a given transaction is invoiced in the producer's currency (PCP=1, LCP=VCP=0), the destination currency CAD (LCP=1, PCP=VCP=0), or a vehicle currency (VCP=1, PCP=LCP=0). The regression specifications are multinomial logit, which impose the constraint that the three choice alternatives are mutually exclusive and exhaustive (the three dummy variables add up to one). We estimate separate regressions for Canadian imports from the United States (approximately 25 million observations) and for Canadian imports from countries other than the United States (approximately 17 million observations).

3.1. Explanatory variables

The range of regression variables introduced in our specifications is intended to span the main motives emphasized in the theoretical literature (discussed in section 4). We group these motives in six main categories. The first category reflects the tendency for invoicing to coalesce in a common currency, a behavior which is likely to be more pronounced in industries with homogeneous or highly substitutable goods as sales of these goods are more sensitive to price differentials with comparable goods. The second category reflects the relative strength of exporters and consumers, which could affect their weight when invoicing is set through

bargaining (section 5). The third category captures the use of commodity and energy inputs in production. As these inputs tend to be invoiced in USD, we can expect industries with higher intensity of use to make more use of the USD in invoicing as a means to hedge against fluctuations in production costs. The last three categories of variables are linked to macroeconomic volatility. Specifically, we introduce variables that measure exchange rate volatility, whether a particular currency offers a hedge against movements in production costs, and whether the exchange rate regime of the exporter's country is a peg.

The specific variables constructed for these motives are as follows:

- $Refcon^i$ and $Walrascon^i$ are relevant for the coalescing motive in invoice currency choice. They are constructed based on the Rauch Index, and following the discussion in Goldberg and Tille (2008), these measures indicate which goods are likely to be characterized by high elasticities of substitution. The Rauch index splits various industries (at the HS4 level) into three categories: reference-priced or exchange traded, Walrasian, or differentiated goods. The first two categories include goods that highly substitutable with each other, while differentiated products, including the bulk of manufacturing, have more limited substitutability. The dummy variables $Refcon^i$ and $Walrascon^i$ take the respective values of 1 if goods are reference-priced or Walrasian (respectively) and zero otherwise, so that differentiated goods are the reference category.[8] Exporters of reference-priced and Walrasian goods are expected to place a relatively high weight in limiting fluctuations of their price relative to that of their competitors, leading invoicing to coalesce around a central currency. The HS4 classifications are applied to each import at the level of HS4 industry *i*.
- $Importshare_t^{i,e}$ and $top5ind^i$, reflecting the relative bargaining strength of exporters by country *e* and importers in each industry *i*. $Importshare_t^{i,e}$ is the market share of the exporter's country in Canadian imports of the relevant industry (HS2 category). This variable is used to assess whether exporters from countries with a large market share in a particular industry are more inclined to invoice in their own currency. $Top5ind^i$ is a dummy variable equal to one if the value of the particular export transaction falls in the top 5^{th} percentile for a particular HS4 code, and is zero otherwise. The variables $importshare_t^{i,e}$ and $top5ind^i$ are used to proxy for the bargaining power of exporters and importers respectively. We

[8] While the index is originally constructed for SITC codes, we used an SITC-HS concordance to match the variables. Rauch provided a "conservative" and a "liberal" classification, of which we use the conservative index.

acknowledge that these proxies are imperfect. A preferable option would be to determine whether a specific large transaction is associated with a large importer or a large exporter. This type of distinction is infeasible in this data set, since we do not have identifiers for individual importers or exporters that would enable a link to their specific characteristics that could influence behavior.

- *Intensity*^{i}, capturing the role of commodity intensity of production. This variable, constructed by HS2 code, represents industry share of commodities such as hydrocarbons and metals in total costs, represented by the sum of producer value plus employee compensation. Given that the USD is the dominant invoicing currency for these inputs, exporters in an industry with higher commodity intensity may have an incentive to invoice in USD to hedge movements in their input costs. The data used to construct this measure are assumed common across countries and are constructed from the Standard Use Table of the United States 2002 Benchmark Input-Output tables.[9] While ideally this measure would be constructed for exporters in different countries using country-specific I-O tables, we opted to apply the U.S. I-O table to all exporting countries because of limited data availability.
- *Coefvar*$_t^e$, reflecting exchange rate volatility between the exporter's currency and the CAD. As exchange rates are all defined against the CAD, a higher value of this measure indicates more volatile macroeconomic fundamentals in the exporter's country, which may make the exporter less likely to invoice in her own currency. The measure is constructed as the coefficient of variation (to filter out level effects) of the exporter's exchange rate over a rolling lagged five-year window. The exchange rate data are from the IMF's International Financial Statistics database (series *rf*, the period-average nominal exchange rate).
- *USDhedge*, *CADhedge*, *EURhedge*, aimed at capturing the hedging benefits of different currencies. As in Goldberg and Tille (2008), this hedging variable takes a value of one if the USD, CAD or EUR are (respectively) significantly better currencies for hedging the volatility of the exporter's profits, and are zero otherwise. For instance, the EUR should represent a good hedge for an exporter whose cost of production are high in states of the

[9] The detailed I-O codes are aggregates of NAICS codes, so we used a concordance between NAICS and HS2 to determine commodity shares. Since each NAICS code can map to multiple HS2 codes, we weighted the observations by the inverse of the number of codes to which it mapped, so that each NAICS code contributed equal weight to the overall construction.

world where the EUR appreciates. Constructing these variables entail substantial steps that are described in the data appendix.

- *Dollarpeg* and *Euroarea*, reflect exchange rate regimes, namely pegs and monetary union. These dummy variables are country and time specific, and indicate whether the exporter's currency is maintaining a dollar peg or is part of the euro area or appears pegged to the euro. As the exporter's currency and the USD (or EUR) are similar options under a credible peg, we expect the exporter to be more likely to invoice in USD (or EUR) as transacting in these currencies involves smaller transaction costs. The peg classifications come from Ilzetski, Reinhart and Rogoff (2009). Since these classifications extend only through the end of 2007, we applied the end 2007 values to the 2008 and 2009 import transactions. The only country outside of the formal euro area included as "euroarea" is Denmark, whose currency closely tracked the euro during this sample period.

3.2. Econometric assessment of invoicing

The results of our econometric analysis are reported in Table 4 for imports from non-U.S. countries and Table 5 for imports from the United States. The regressions are set up so that invoicing options are taken relative to a benchmark, which we take to be the USD in all tables. In the case of imports from non-U.S. countries, invoicing in the vehicle currency pricing (VCP) option largely corresponds to use of USD, with some euro use by countries near to the euro area. The pairs of columns in each numbered regression specification in Table 4 report the influences on LCP (invoicing in CAD) or PCP of the variables indicated in the far left column of the table. In the case of imports from the United States, invoicing in USD corresponds to the PCP option. The results reported in Table 5 show the role of each regressor on the incidence of LCP or VCP (invoicing in a currency that is neither the USD nor the CAD).

The tables report the maximum likelihood estimates of coefficients, with the standard errors provided in brackets. For interpretations, it is important to recognize that the coefficient estimates are not marginal effects of the variables, which are not constant and would need to be constructed conditional on levels of each of the variables in the multinominal logit specification. Each table presents regressions focusing on the role of the separate groups of variables associated with the six main categories of invoicing motives described above. The final columns

of each table integrate the variables into single multinomial logit specifications.[10] Overall, Table 4 provides results from 10 multinomial logit regression specifications, while Table 5 provides results from only 9 specifications since the exchange rate peg variables are excluded. Coefficient estimates that are statistically significant at the 1 and 5 percent level are indicated by * and ** respectively. The tables also report the number of observations used in the regressions and the AIC statistic. All regressions include time fixed effects to capture common unobserved variability by quarter, and have standard errors clustered by month.

3.2.1. Imports from non-U.S. countries

Table 4 presents the results for Canadian imports from countries other than the United States, with VCP (invoicing in USD in practice) being the benchmark option. The regression specifications show the direction of influence of regressions on the likelihood of choosing PCP and LCP (versus VCP). Regression 2 reflects the coalescing motive. Imports from more homogeneous sectors, as indicated by values of one for the dummy variables $Refcon^i$ or $Walrascon^i$, have a higher probability of being invoiced in CAD and a lower probability of being invoiced in producer's currencies. This is consistent with a coalescing motive around the destination currency, for instance reflecting competition from domestic Canadian firms, or around the USD which is the standard invoicing currency in commodities.

Regression 3 captures the different aspects of the bargaining power of exporters and importers. Exporters from a country with a high market share in Canadian imports in the relevant industry are less likely to invoice in CAD, as they are in a stronger position vis-à-vis Canadian customers. While regression 3 shows a smaller use of the PCP option for high market share exporters, this is overturned once we control for other invoicing motives (regression 10). Large orders ($Top5ind^i$=1) are associated with a larger use of the LCP option and a smaller use of PCP. One interpretation of these results could be that larger imports are mapped to larger and more powerful customers. These transactions are then more likely to be associated with LCP if the importers prefer not to bear the exchange rate risk. The interacted terms in the regression show the increased use of LCP for large shipments is most pronounced when exporters are from a

[10] Differences across the coefficients on the regressors in the dedicated regressions versus the fully integrated regressions could occur due to correlations among the regressors in the respective data samples. Appendix Tables 3 and 4 provide coefficients of variation to suggest where such issues of correlation may arise.

country with a large market share. This can be interpreted as showing that the benefits of a high market share for an exporter are diminished when there are large customers on the other side of the transaction. With the effect of Top5Ind interacted with the mean value of market share according to the last regression column, we observe that the overall effect of being large is negative whenever exporter market share in a country exceeds about 2 percent.

Regression 4 captures the effect on invoice currency choice of the commodity intensity of production costs at the HS2 industry level. A higher intensity of commodity inputs, which tend to be invoiced in USD, reinforces the use of USD in invoicing by reducing the prevalence of both PCP and LCP. This variable sheds light on what might be the effects on invoicing of imported input use, as countries which import a large share of commodity or other inputs would likewise have an incentive to invoice their exports in the same currency as used for those imports.

The role of exchange rate volatility is captured in regression 5. We observe that exporters from countries with volatile currencies vis-à-vis the CAD are more likely to use the USD, with a reduction in the use of both the LCP and PCP options. This feature is consistent with the theoretical finding that invoicing takes place in currencies with more stable fundamentals.

The hedging motivation for invoicing is captured in regression 6. While the hedging variables have some influence on invoicing, the role of these variables remains limited and not fully consistent with theoretical priors. First, some of these terms are statistically insignificant even in a sample of about 17 million observations. Second, the use of PCP is reduced for all three hedge variables. While this is reasonable when the USD or CAD offer hedging benefits, it is less clear that hedging benefits from the EUR should reduce PCP, given the large presence of eurozone countries in the sample. Hedging benefits from the EUR, however, reduce the use of LCP, which is to be expected. Yet, hedging benefits from the CAD do not lead to a larger use of the LCP option. When the USD is a better hedging currency, invoicing is weakly tilted towards it. Overall, this mixed evidence on the hedging motive can arise either because the theory is not fully supported, or because of the challenges in building the hedging measures. It is possible that this constructed indicator variable does not appropriately account for the profit correlations that enter into producer decisions.

Regression 7 illustrates the impact of exchange rate regimes, with the findings being consistent with theoretical priors. Exporters from countries with a peg to the USD make more

use of that currency at the expense of the LCP and PCP options. Exporters from the euro area are likely to more frequently use the PCP option.

3.2.2. Imports from the United States

As previously noted, the vast majority of imports from the U.S. are invoiced in USD, which represents the PCP option for this sample of nearly 25 million exports. Some interesting results from Table 5 are that this pattern is reinforced when exported goods are highly homogeneous (regression 2) and their production inputs are highly commodity intensive (regression 4).

Regression 3 shows that the PCP option gains prevalence when the United States accounts for a large market share in Canadian imports for the industry in question. Yet, larger transactions tend to be associated with more use of the LCP option, especially when the U.S. exporter market share is high. These results are consistent with the evidence for non-U.S. exporters. Periods of relatively high volatility in the USD-CAD exchange rate are associated with larger use of third country currencies (regression 5). Regression 6 shows that our hedging variables do not systematically influence invoicing choices by U.S. exporters.[11]

3.2.3. Which factors contribute most to invoicing?

While the multinomial logit expressions do not provide a direct variance decomposition mapping, we examine the Akaike information criteria (AIC) values[12] to compare explanatory power of alternative combinations of regressors. The comparisons of AIC scores across the specifications of Tables 4 and 5 are provided in Table 6. Recall that all specifications have the USD as the dominant invoicing currency, so the fits of models are ones that best explain the deviations of invoicing from this standard.

For invoicing of exports from non-US countries, the largest contributors by far are the exchange rate regime choices of countries, whether pegging to the USD or if countries are part of the euro area. The score comparisons show that the next largest contributors are the hedging variables, although it is noteworthy that the role of these variables is likely arising because these

[11] As shown in Appendix Table 3, the Coefvar variable is highly collinear with the hedge variables, making coefficient estimates of these variables unreliable.

[12] This statistic equals -2ln (L)+2k where k is the number of parameters being estimated and L is the log likelihood. Smaller values indicate that a model explains the data better (less information is lost in fitting the model to the data) than larger values.

constructions have *EURhedge* being 0 for countries pegged to the euro, since the correlation is undefined; that is, if *EURhedge* is equal to 1, it must be something other than a euro zone country. In other words, while the hedge variables alone appear to have explanatory power, this is due to a correlation with the exchange rate regimes. Indeed, the magnitudes of the coefficients from the hedge variables decline significantly in specifications that also introduce the exchange rate regime dummy variables. The variables that capture strategic behavior by importers and exporters are the next most important determinants of invoicing choices of exporters, with the effects on explaining invoice currency selection dominating the effects of terms directly associated with exchange rate variability of currencies and intensity of commodity input use.

Exports from the United States are heavily invoiced in USD. The strategic variables that are the largest contributors to deviations from this structure are $Importshare_t^{i,e}$ and $Top5ind^i$, followed distantly by the $Refcon^i$ and $Walrascon^i$ variables. The identification is coming from the fact that large invoices are more likely to be invoiced in CAD, and less likely to be invoiced in any other currency. The commodity intensity of production, variability of bilateral exchange rates, and hedging motives contribute very little to deviations from USD use in invoicing exports to Canada.

4. The standard theoretical drivers of invoicing with multiple currencies

Our empirical results are consistent with standards theoretical models of the invoicing choice of individual firms, as well as the aggregate invoicing shares. In this section, we briefly review some of these insights in the simple model presented by Goldberg and Tille (2008). For brevity we focus on the main elements, with more detailed exposition provided in the appendix. The section concludes by showing the inability of this model to generate the observed link between transaction size and invoicing.

4.1. A simple model

Consider an exporter, located in country *e*, which sells to customers in the destination country *d*. The market is characterized by monopolistic competition, and the demand faced by the exporter is inversely related to the price of her specific brand relative to the other brands sold in the market, with a constant price elasticity of demand λ. Production relies on a technology with decreasing returns to scale, implying a larger marginal cost for higher output.

The exporter sets a price before exchange rates are realized. The price is set in currency *k*, which is a basket of the exporter's currency *e*, the customer's currency *d*, and a third vehicle currency *v*. The exporter's optimization proceeds in two steps, first choosing the composition of the invoicing basket *k*, and then setting the price that is set in that basket.

As in Goldberg and Tille (2008), the solution of the model proceeds backwards. We first solve for the optimal preset price taking the invoicing currency *k* as given. The exporter's expected profits at that price are then written as a quadratic log expansion around a steady state. Intuitively, the invoicing choice determines the exporter's exposure to exchange rate movements, as well as the correlation of her her revenue and costs. For instance, the destination currency *d* offers hedging benefits if it appreciates in the states of nature where the exporter faces high wages. Setting the price in currency *d* then implies that the unit revenue, in the exporter's currency *e*, increases precisely when costs are high. The invoicing choice is then similar to a portfolio choice, balancing exposures to risk and the hedging properties of various currencies. These aspects are reflected in the variances and covariances between the various variables, and capturing these requires a quadratic expansion of the exporter's profits.

We denote the share of currency *d* in the invoicing basket of exporter *e* by $\beta_{e,d}^{d}$. Similarly, the share of currency *v* in the basket is $\beta_{e,d}^{v}$. Each share is between zero and one, and the residual is the share of currency *e* in the basket: $\beta_{e,d}^{e} = 1 - \beta_{e,d}^{d} - \beta_{e,d}^{v}$. For instance, the case of "producer currency pricing" where the price is set in currency *e* and the customer bears all the exchange rate risk corresponds to $\beta_{e,d}^{e} = 1$, $\beta_{e,d}^{d} = \beta_{e,d}^{v} = 0$. The case of "local currency pricing" where the price is set in currency *d* and the exporter bears all the exchange rate risk corresponds to $\beta_{e,d}^{e} = 0$, $\beta_{e,d}^{d} = 1$, $\beta_{e,d}^{v} = 0$. We denote the shares of the various currencies in the price index over all the brands sold in country *d* in a similar way. Specifically, η_{d}^{d} is the share of the index that is set in currency *d*, and η_{d}^{v} is the share set in currency *v*.

In this setting, the optimal invoicing choice of the exporter in country *e* is given by:

$$(1) \qquad \beta_{e,d}^{d} = \Omega\eta_{d}^{d} + (1-\Omega)\rho(m_{e,d}, s_{e,d}) \quad ; \quad \beta_{e,d}^{v} = \Omega\eta_{d}^{v} + (1-\Omega)\rho(m_{e,d}, s_{e,v})$$

where $\Omega \in [0,1]$ is a coefficient that is higher the more demand is price-sensitive and the more the production function exhibits decreasing returns to scale. $m_{e,d}$ reflects the exogenous drivers

of production costs, namely wages as well as demand, as a higher demand is associated with a higher marginal cost in the presence of decreasing returns to scale. $s_{e,d}$ is the exchange rate between currency *e* and currency *d*, with a higher value corresponding to a depreciation of currency *e*. The ρ terms in (1) reflect the co-movements between costs and exchange rates. Specifically, a positive value of $\rho(m_{e,d}, s_{e,d})$ indicates that marginal costs are high when currency *e* is weak relative to currency *d*.[13]

The invoicing choice in (1) is driven by two factors. First, the exporter chooses an invoicing basket that is close to the one chosen by her competitors, i.e. sets her shares $\beta_{e,d}^{d}$, $\beta_{e,d}^{v}$ in line with the aggregate shares η_{d}^{d}, η_{d}^{v}. Intuitively, the exporter wants to stabilize her output by keeping her price (expressed in customer's currency) close to that of her competitors. This "coalescing" motive, captured by the first term on the right-hand side of (1), is more relevant when demand is sensitive to movements in relative prices and when fluctuations in demand affect marginal costs (i.e. Ω is large). Second, the exporter invoices in currencies that offer hedging benefits, i.e. that appreciate when her marginal cost is high. This "hedging" motive is captured by the second term on the right-hand side of (1).

The aggregate role of currencies in the market of country *d*, captured by the η terms, reflects the invoicing shares of specific firms (1), as well as the market shares of firms from different countries. These include local firms, which we assume invoice solely in currency *d*.

4.2. Empirical implications

The aggregate invoicing shares η's consist of the exporter-specific invoicing shares β's and the market shares of producers from various countries in the destination market, including local firms. The joint solution for the η's and β's combines (1) and the various market shares. For brevity we focus on the intuition behind the impact of several prominent exogenous drivers.

The first driver is the market share of various countries. The lower the share of foreign countries, the higher is the role of currency *d* in the invoicing. Intuitively, local firms invoice in currency *d*. A higher share of local firm then directly reduces the role of currency *d*. This is compounded by an indirect effect, as foreign firms increase their use of currency *d* to keep their

[13] Specifically, the ρ's are the coefficient of a regression of $m_{e,d}$ on the two exchange rates. This relationship was the concept underlying construction of the hedge variables of section 3.

prices in line with that of local firms. That indirect effect is stronger when the coalescing motive is more pronounced.

Conversely, a reduction of the share of local firms shifts invoicing away from currency *d*. We can also show that the invoicing shifts mostly to the other currencies that account for a relatively large share to start with. To sum up, we get the following implications:

> Implication 1: A higher market share for an exporting country reduces the use of the destination currency. This effect is larger in sectors with a strong coalescing motive and a large share of imports.[14]

This implication is supported by the evidence provided in Section 3, that exporters' from countries with a large market share in the industry are more likely to use the PCP option at the expense of the LCP option.

A second driver of invoicing is the use of imported inputs.[15] If firms in country *e* import inputs that are price in currency *v*, this tilts their invoicing towards currency *v*. Intuitively, this tilt reflects the hedging motive in (1). An appreciation of currency *v* raises the cost of inputs, in currency *e*, for these firms. Invoicing in currency *v* insures that their income in their own currency also increases, and thus offers a hedge against fluctuations in marginal costs. In the presence of a coalescing motive, this also shifts the invoicing of other firms even when their costs are not directly exposed to the exchange rate, as they want to keep their own price in line with that of firms from country *e*. In short, we get the following implications:

> Implication 2: When costs in an exporting country 1 are more exposed to the exchange rate with another country 2, the invoicing of all exporters shifts away from the currency of country 1 towards the currency of country 2.

Our empirical results support this implication. All else equal, exporters in sectors with a high use of commodity inputs, which are predominantly invoiced in USD, are more likely to invoice their exports in USD than in their own currency or in the CAD.

The invoicing choice of exporters also reflects macroeconomic volatility. The currency of a country characterized by large shocks, owing for instance to a weak monetary policy, is associated with larger exchange rate movements than other currencies. This volatility reduces its

[14] This aspect is discussed by Bacchetta and van Wincoop (2005).
[15] See for instance Novy (2006).

attractiveness as an invoicing currency. Similarly, the currencies of countries with stable fundamentals are more attractive, as stressed by Devereux, Engel and Storgaard (2004).

Implication 3: More volatile macroeconomic factors in a country shift the invoicing away from its currency and towards the other currencies, especially towards the currencies of countries with more stable fundamentals.

This is confirmed by our empirical evidence that countries with more volatile exchange rates vis-à-vis the CAD, reflecting more volatile domestic macroeconomic conditions, are less likely to use the PCP option for their exports.

Exchange rate regimes also affect the invoicing choice. If a country *e* stabilizes its exchange rate vis-à-vis the destination currency, it reduces the attractiveness of that currency in terms of hedging. As a result, invoicing shifts away from currency *d* towards currency *e*.

Implication 4: A reduction of exchange rate volatility by an exporting country vis-à-vis the destination raises the share of its currency in invoicing at the expense of the destination currency.

The evidence supports this implication, with exporters from countries with a peg to the USD being more likely to use that currency than their own or the CAD.

4.3. The role of transaction size

The model described in the previous section does not consider different transaction sizes. We can easily introduce that aspect in the model however. Consider that the exporter in country *e* sells to different customers in country *d*, with different customers indexed by $i \in I$, where *I* is the set of all customers. The demand from customer *i*, $C_d^i(z)$, is written as:

$$C_d^i(z) = \left[(S_{e,k(i)} P_{e,d}^{k(i)}(z))/(S_{e,d} P_d)\right]^{-\lambda} C_d^i \quad (2)$$

where $P_{e,d}^{k(i)}(z)$ is the preset component of the price, $S_{e,k(i)}$ is the exchange rate between currency *e* and currency *k(i)*, P_d is the price index of all brands in the destination market, in currency *d*, and C_d^i is the customer's overall demand for all brands. We allow for the invoicing currency $k(i)$ to differ across customers. Specifically, the invoicing shares in the destination currency *d*

and the vehicle currency *v* for customer *i* are denoted by $\beta_{e,d}^{d,i}$ and $\beta_{e,d}^{v,i}$. Similarly $P_{e,d}^{k(i)}(z)$ can differ across customers.

Customers only differ through the size of their consumption in the steady state, denoted by $\overline{C}_d^i$. They share the same price-elasticity of demand, and ex-post their overall demands fluctuate by the same percentage amount: $c_d^i = c_d$, with lower case letters denoting logs.

We introduce a link between the various customers through the production technology. Specifically, the exporter uses a technology with decreasing returns to scale in the total production:

$$Y_{e,d}(z) = (\alpha)^{-1}(\sum_i \overline{C}_d^i)^{1-\alpha}\left[H_{e,d}(z)\right]^{\alpha} \tag{3}$$

where $0 < \alpha \leq 1$. The scaling of technology (3) by the steady state level of overall demand simplifies the algebra. From this specification one may expect that the exporter treats different customers differently. For instance, the exporter could choose to make more use of currency *d* for large customers as fluctuations in their demands lead to large movements in the marginal cost of production. However, we show that this is not the case, with a detailed description provided in the appendix.

The maximization of expected profits (expressed as a quadratic log expansion around the steady state) leads to the following first-order conditions with respect to $\beta_{e,d}^{d,i}$ and $\beta_{e,d}^{v,i}$:

$$\begin{aligned}
0 &= E(m_{e,d}s_{e,d}) - E(s_{e,d})^2\beta_{e,d}^{d,i} - E(s_{e,d}s_{e,v})\beta_{e,d}^{v,i} \\
&\quad - \frac{\lambda(1-\alpha)}{\alpha}\left\{\left[\sum_i \overline{\omega}_d^i\beta_{e,d}^{d,i} - \eta_d^d\right]E(s_{e,d})^2 + \left[\sum_i \overline{\omega}_d^i\beta_{e,d}^{v,i} - \eta_d^v\right]E(s_{e,d}s_{e,v})\right\} \\
0 &= E(m_{e,d}s_{e,v}) - E(s_{e,d}s_{e,v})\beta_{e,d}^{d,i} - E(s_{e,v})^2\beta_{e,d}^{v,i} \\
&\quad - \frac{\lambda(1-\alpha)}{\alpha}\left\{\left[\sum_i \overline{\omega}_d^i\beta_{e,d}^{d,i} - \eta_d^d\right]E(s_{e,d}s_{e,v}) + \left[\sum_i \overline{\omega}_d^i\beta_{e,d}^{v,i} - \eta_d^v\right]E(s_{e,v})^2\right\}
\end{aligned} \tag{4}$$

where $\overline{\omega}_d^i = \overline{C}_d^i / \sum_j \overline{C}_d^j$ is the share of customer *i* in total steady state consumption. Taking weighted averages of these conditions across customers, we show that the average invoicing shares are identical to (1):

$$\sum_i \overline{\omega}_d^i\beta_{e,d}^{d,i} = \Omega\eta_d^d + (1-\Omega)\rho(m_{e,d}, s_{e,d}) \quad ; \quad \sum_i \overline{\omega}_d^i\beta_{e,d}^{v,i} = \Omega\eta_d^v + (1-\Omega)\rho(m_{e,d}, s_{e,v})$$

The first-order conditions (4) then imply that the invoicing shares are the same for all customers, regardless of size. Allowing for different customer sizes and an interaction through the cost of production therefore does not give rise to differential invoicing choice across customers in the simple model.

5. A bargaining view of invoicing

The previous section shows that the standard model does not account for the link between transaction size and invoicing that is found in the data. Generating this empirical pattern requires extending the model. While one can think of many ways of extending the model, we focus on relaxing the assumption of a unilateral invoicing decision by the exporter. In the simple model, customers play no role in the invoicing decision, and simply provide exporters with a demand schedule and let them choose the invoicing. Such an approach is not consistent with evidence that invoicing is set through a bargaining between firms and customers, as shown by Friberg and Wilander (2008). Allowing for exporters and customers to jointly determine invoicing is thus more empirically realistic, and we show that it allows for a link between transaction size and invoicing. This section develops a setting where invoicing is set through bargaining between consumers and firms. While more empirically appealing, this alternative setup substantially raises the degree of complexity of the analysis. We therefore focus on the problem of an individual exporter, and abstract from the aggregate invoicing shares.

The bargaining view of invoicing has largely been abstracted from in the literature. To our knowledge, Viane and De Vries (1992)[16] is the only contribution focusing on bargaining. That paper shows that the sequencing of bargaining and the relative number of importers and exporters matter for the invoicing outcome. It however considers that all shipments are of the same size, and that goods' prices are exogenous. The setting developed below, by contrast, considers that prices are endogenously determined and allows for size variation across transactions.

The essence of our results is as follows. We assume that invoicing is set through a bargaining over the splitting of exporters' and customers' surpluses, with exogenous bargaining weights. We consider that exporters' are risk averse, which implies first that they have some preference for invoicing in their own currency, but also – and more importantly – that failing to

[16] We are grateful to an anonymous referee for bringing this contribution to our attention.

sell to large customers raises their marginal utility of income. Exporters then have an incentive to be more accommodative to the needs of larger customers, which entails more use of the destination currency as this limits the customers' exchange rate exposure. Our model generates a larger use of the destination currency for sales to large customers.

Our model also implies that the impact of size on invoicing is most pronounced when the exogenous bargaining share of the customer is small. Intuitively, a customer with substantial bargaining power can directly tilt the invoicing towards her preference. By contrast, a customer with limited power cannot directly push for her preferred invoicing, but can do so indirectly by presenting the exporter with an unpalatable outside option should the bargaining fail. In other words, the power of the customer takes the forms of the formal bargaining weight and of her size, with the latter being most useful when the former is limited.

While our model generates the pattern observed in the data, it should be seen as one way to do so among several potential modeling approaches. We view our contribution as a step towards bringing bargaining into invoicing models, while recognizing that a range of alternatives can likewise be explored.[17] In designing our extension to the simple model, we aim to keep as close as possible to that model, and have the simple model be a particular case of our more general setting. We also deliberately choose not to allow for exogenous difference in the interaction between exporters and customers depending on size. For instance, one may consider that large customers have stronger direct bargaining weights, or that bargaining only takes place with such customers but not with smaller ones. While such settings can be plausible, they appear to us as being too close to "assuming our answers" and we opt not to allow for such features.

5.1. Consumer surplus

We consider sales towards several customers indexed by *i*, with the demand given by (2). As in the previous sub-section, customers only differ through the size of their steady state consumption, and ex-post overall demands fluctuate in step: $c_d^i = c_d$. Customer *i* gets concave utility from her consumption of brand *z*, which generates a preference for an invoicing currency that stabilizes consumption. The utility takes a standard CRRA form:

$$U_d^i(z) = (1-\gamma_d)^{-1} E[C_d^i(z)/\overline{C}_d^i]^{1-\gamma_d} \quad ; \quad \gamma_d \geq 0 \tag{5}$$

[17] For instance, one could consider a setting with increasing returns to scale where large customers are valued as they lower production costs for all sales.

The inclusion of $\overline{C}_d^i$ in (5) ensures that the size of the consumer does not affect its utility. Our specification of a utility defined at the level of each brand, instead of over a complete basket of brands, simplifies the analysis by shutting down spillovers across the demands for different brands. In our analysis, we focus on the case of $\gamma_d \geq 1$ which is empirically more relevant.

The utility (5) is obtained only if the exporter and the customer reach an agreement in their bargaining over invoicing. Should they fail to do so, the alternative utility for the customer is equivalent to a consumption equal to a fraction $\zeta_d^i \leq 1$ of $\overline{C}_d^i$. The surplus that the customer gains from successful bargaining is then:

(6) $$SC_{e,d}^{k(i)} = (1-\gamma_d)^{-1} E[C_d^i(z)/\overline{C}_d^i]^{1-\gamma_d} - (1-\gamma_d)^{-1}(\zeta_d^i)^{1-\gamma_d}$$

5.2. Producer surplus

The exporter of brand z uses a technology with decreasing returns to scale:

(7) $$C_d^i(z) = (\alpha)^{-1}(\overline{C}_d^i)^{1-\alpha}\left[H_{e,d}^i(z)\right]^{\alpha} \quad ; \quad 0 < \alpha \leq 1$$

For simplicity, we assume that there are different production lines for different customers, so that the demand by a customer does not affect the marginal costs of producing for other customers. Our specification thus differs from (3). We opt for this specification for simplicity, as our earlier analysis shows that linkages through cost do not give raise to differentiated invoicing. The technology is also scaled by the level of steady state demand, which ensures that steady state marginal costs and prices are equalized across customers. The profits that the exporter gets from selling to customer *j* are denoted by $\Pi_{e,d}^{k(j)}(z)$. We assume that the exporter's utility of her profits takes a CRRA form:

(8) $$Q_e^J(z) = (1-\gamma_e)^{-1} E\left[\sum_{j\in J} \Pi_{e,d}^{k(j)}(z)\right]^{1-\gamma_e} \quad ; \quad \gamma_e \geq 0$$

where *J* is the set of customers to whom the exporter can sell brand *z*. Our exposition will focus on the case of $\gamma_e \geq 1$.

If the firm fails to reach an agreement with customer *i* she will only sell to the other customers in the set *I*.[18] The surplus of the exporter from successful bargaining with customer *i* is then:

$$(9) \qquad SE_{e,d}^{k(i)} = (1-\gamma_e)^{-1} E\left[\Pi_{e,d}^{k(j)}(z) + \sum_{j\neq i} \Pi_{e,d}^{k(j)}(z)\right]^{1-\gamma_e} - (1-\gamma_e)^{-1} E\left[\sum_{j\neq i} \Pi_{e,d}^{k(j)}(z)\right]^{1-\gamma_e}$$

The impact of profits on the exporter's marginal utility is an important difference from usual models in which the discount factor is not influenced by the pricing and invoicing decisions. In particular, it implies that the exporter's marginal utility of income is higher when negotiating with a larger customer, making her more willing to accommodate the customer's preferences.

The exporter's profits are affected by decisions on both pricing, $P_{e,d}^{k(i)}(z)$, and invoicing, $\beta_{e,d}^{d(i)}$ and $\beta_{e,d}^{v(i)}$. We consider that these are set in two stages. First, invoicing is set through a bargaining between the exporter and the consumer. Second, the exporter sets the price by taking the invoicing and demand (2) as given. The first step is forward-looking and takes the conditional pricing choice of the second step into account.

This assumption that invoicing is set through a bargaining process, but prices are not, warrants further discussion. It differs from the standard approach in bargaining models where agents first maximize the joint surplus and then split this surplus between them. While following the latter approach has obvious appeal, it does not allow us (to our knowledge) to obtain the case of unilateral invoicing and pricing as a particular case of the more general solution. By contrast, limiting bargaining to the invoicing shares and letting exporters set the price unilaterally encompasses the simpler model developed in section 4 as a particular case. We thus opted for that limited inclusion of invoicing in order to remain as close as possible to the standard setting. Our choice of a setting encompassing the standard one is done solely to keep the focus on bargaining over invoicing, and should not be interpreting as a judgment against broader bargaining models. Richer inclusions of bargaining in the context of invoice currency choice are clearly desirable, but we leave them for future research.

5.3. Pricing

[18] In equilibrium the firm sells to all customers. We can therefore evaluate the firm's outside option in its bargaining with a specific customer as the utility from sales to all other customers.

The exporter sets $P_{e,d}^{k(i)}(z)$ to maximize (8). This leads to a standard expression where the expected discounted marginal revenue is a markup over the expected discounted marginal cost. The price is then affected by the ex-post co-movements between the variables of the model, a feature akin to a risk premium. An additional complication over our earlier model is that the discount factor used in setting the price is itself a function of the profits. The preset price can be written as a quadratic expansion around the steady state:

$$\frac{\alpha+\lambda(1-\alpha)}{\alpha}\, p_{e,d}^{k(i)}(z) = \frac{1}{2}E\left[mc_{e,d}^{k(i)}\right]^2 - \frac{1}{2}E\left[mr_{e,d}^{k(i)}\right]^2 + E\left[disc_{e,d}^{k(i)}(mr_{e,d}^{k(i)} - mc_{e,d}^{k(i)})\right] \tag{10}$$

where $mr_{e,d}^{k(i)}$ reflects the drivers of the marginal return, $mc_{e,d}^{k(i)}$, reflects the drivers of marginal costs, and $disc_{e,d}^{k(i)}$ is the discount factor that is inversely relative to denoting the linear component of profits, $\pi_{e,d}$:

$$\begin{aligned}
mr_{e,d}^{k(i)} &= -(\lambda-1)[\beta_{e,d}^{d(i)} s_{e,d} + \beta_{e,d}^{v(i)} s_{e,v}] + z_{e,d} \\
mc_{e,d}^{k(i)} &= w_e + \frac{1}{\alpha} z_{e,d} - \frac{\lambda}{\alpha}[\beta_{e,d}^{d(i)} s_{e,d} + \beta_{e,d}^{v(i)} s_{e,v}] \\
disc_{e,d}^{k(i)} &= -\gamma_e \left[\frac{1}{\alpha+\lambda(1-\alpha)} z_{e,d} - \frac{\alpha(\lambda-1)}{\alpha+\lambda(1-\alpha)} w_e \right] = -\gamma_e \pi_{e,d}
\end{aligned}$$

where $z_{e,d} = \lambda[s_{e,d} + p_d] + c_d$. (10) shows that altering the invoicing shares impacts the exposure of the exporter to fluctuations in exchange rates and marginal costs, and leads her to alter the level at which she sets the prices. The utility of the exporter (8) can also be expressed as a quadratic approximation around the steady state.

5.4. Invoicing

In the first step of the solution, the exporter and the customer set the invoicing shares to maximize the following measure of joint surplus that combines (6) and (9):

$$SJ_{e,d}^{k(i)} = \left[SE_{e,d}^{k(i)}\right]^{\delta}\left[SC_{e,d}^{k(i)}\right]^{1-\delta} \tag{11}$$

where $\delta \in [0,1]$ reflects the relative bargaining power of the exporter. We do not allow for this power to differ depending on the customer size, as this would be too immediate a way to generate a link between size and invoicing. The surpluses (6) and (9) can be written as quadratic

approximations around the steady state, which shows that the gap between each surplus and its steady-state value reflects expected cross products of the deviations of the exchange rates, wages and consumption from steady state values. The joint surplus (11) can be written in a similar form, giving a quadratic expression in the invoicing shares $\beta_{e,d}^{d(i)}$ and $\beta_{e,d}^{v(i)}$.

For brevity we focus on the optimization with respect to the invoicing share of the destination currency, $\beta_{e,d}^{d(i)}$, with the analysis for $\beta_{e,d}^{v(i)}$ following similar steps. The derivative of the joint surplus (11) with respect to the invoicing share takes the form (for brevity we abstract from some coefficients that do not alter the message of the model):

$$\frac{\partial SJ_{e,d}^{k(i)}}{\partial \beta_{e,d}^{d(i)}} = \frac{\partial SE_{e,d}^{k(i)}}{\partial \beta_{e,d}^{d(i)}} + D_d^i[\overline{\omega}_d^i, \delta] \frac{\partial SC_{e,d}^{k(i)}}{\partial \beta_{e,d}^{d(i)}} \tag{12}$$

where $D_d^i[\overline{\omega}_d^i, \delta]$ is an increasing function of customer size measured by her steady-state share of overall consumption, $\overline{\omega}_d^i$, and is a decreasing function of the exporter's bargaining power, δ. Both derivatives on the right-hand side of (12) are decreasing linear functions of the invoicing share of the customer's currency, $\beta_{e,d}^{d(i)}$.

The optimal invoicing shares are obtained by setting (12) and the corresponding condition with respect to the share of the vehicle currency to zero. The invoicing shares are then:

$$\beta_{e,d}^{d(i)} = \psi^s \eta_d^d + \psi^w \rho(w_e, s_{e,d}) + \psi^c \rho(c_d, s_{e,d}) \tag{13}$$

$$\beta_{e,d}^{v(i)} = \psi^s \eta_d^d + \psi^w \rho(w_e, s_{e,v}) + \psi^c \rho(c_d, s_{e,v}) \tag{14}$$

where the ρ terms are regressions coefficients defined in the same way as in (1), and the ψ's are coefficients.

The unilateral invoicing assumption of the standard model corresponds to the situation where the exporter holds the entire bargaining power ($\delta = 1$). In that case $D_d^i = 0$ in (12) and the invoicing shares (13)-(14) are identical to (1). Under this allocation, the marginal impact of the customer's currency invoicing share on the customer's surplus (6) is:

$$\begin{aligned} \left.\frac{\partial SC_{e,d}^{k(i)}}{\partial \beta_{e,d}^{d(i)}}\right|_{\text{unilat}} &= \lambda^2 \frac{(\gamma_d - 1)\alpha - (\gamma_e - 1)}{\alpha + \lambda(1-\alpha)} [\eta_d^d E(s_{e,d})^2 + \eta_d^v E(s_{e,d} s_{e,v})] \\ &+ \lambda \frac{(\gamma_d - 1)\alpha - (\gamma_e - 1)}{\alpha + \lambda(1-\alpha)} E c_d s_{e,d} + \lambda\alpha \frac{(\gamma_e - 1)(\lambda - 1) - (\gamma_d - 1)\lambda}{\alpha + \lambda(1-\alpha)} E w_e s_{e,d} \end{aligned} \tag{15}$$

The customer's surplus is affected by the level of the preset price and the ex-post volatility of consumption. Welfare is reduced when the exporter sets a higher price (10), an aspect captured by the $\gamma_e - 1$ terms in (15). Increasing the invoicing share of the destination currency boosts the exporter's exposure to exchange rate volatility, inducing her to charge a higher price. In addition, lower demand ($c_d < 0$) reduces the exporters' profits and increases her discount factor. If the exporter's currency appreciates when demand is low ($Ec_d s_{e,d} > 0$), raising the invoicing share of the destination currency adversely affects her as she faces a low revenue in her currency at the same time that demand is low. This induces her to set a higher price. Finally, high wages ($w_e > 0$) lower profits and increase the discount factor. If the exporter's currency depreciates when wages are high ($Ew_e s_{e,d} > 0$), raising the invoicing share of the destination currency generates a favorable hedge against these costs as the exporter receives more in terms of her own currency when wages are high. This induces her to reduce her price.

The customer's surplus is also lowered when demand is volatile, either because the relative price of the brand is volatile or because aggregate demand fluctuates. This dimension is captured by the $\gamma_d - 1$ terms in (15). Increasing the invoicing share of the customer's currency above the unilateral allocation reduces the volatility of the exporter's brand relative price, which benefits the customer. In addition, the sensitivity of the customer's surplus to the invoicing share is lower when the customer's currency is already used substantially in the unilateral invoicing. This is the case if for instance this currency offers a good hedge against fluctuations in wages ($Ew_e s_{e,d} > 0$). Increasing the use of the destination currency then yields only a moderate gain for the customer. Finally, a higher use of the destination currency limits the impact of fluctuations in demand, c_d, on the customer's surplus, if the exporter's currency depreciates when demand is high ($Ec_d s_{e,d} > 0$). Intuitively, invoicing in the exporter's currency then lowers the relative price of her good when demand is already high, thereby magnifying demand volatility.

The customer's surplus then balances the impact on the preset price with that on demand volatility. The second aspect dominates if the customer is sufficiently more risk averse than the exporter, i.e. $(\gamma_d - 1)\alpha > (\gamma_e - 1)$. (15) also shows that a use of the customer's currency in invoicing above its share in the unilateral outcome is not necessarily in the customer's interest, as the burden this places on the exporter leads her to set prices at a higher level.

We focus on the case where (15) is positive, so that increasing the invoicing share of currency d from its value under unilateral invoicing benefits the customer. The unilateral allocation is thus characterized by $\partial SE_{e,d}^{k(i)} / \partial \beta_{e,d}^{d(i)} = 0$ and $\partial SC_{e,d}^{k(i)} / \partial \beta_{e,d}^{d(i)} > 0$. We can show that the second derivatives of the exporter's and consumer's surpluses (64) and (9) are negative. It follows that the invoicing under a bilateral bargaining process ($\delta < 1$) entails a larger share of the customer's currency than the unilateral invoicing. The bilateral invoicing allocation is then characterized by $\partial SE_{e,d}^{k(i)} / \partial \beta_{e,d}^{d(i)} < 0$ and $\partial SC_{e,d}^{k(i)} / \partial \beta_{e,d}^{d(i)} > 0$. Our results can be summarized by the following implication:

Implication 5: The optimal invoicing under bargaining is likely to call for a larger use of the destination currency than under a unilateral choice by the exporter.

5.5. Invoicing and consumer size

The role of the consumer size is derived by setting (12) to zero, and differentiating the resulting expression with respect to the invoicing share and the size of demand. Abstracting from some scaling coefficients for brevity, this implies:

$$D_d^i[\overline{\omega}_d^i, \delta] \frac{\partial SC_{e,d}^{k(i)}}{\partial \beta_{e,d}^{d(i)}} d\overline{\omega}_d^i = d\beta_{e,d}^{d(i)} \tag{16}$$

As $\partial SC_{e,d}^{k(i)} / \partial \beta_{e,d}^{d(i)} > 0$ at the bargained allocation, both sides of (16) are positive. The share of the customer's currency in the invoicing basket is then larger for bigger customers: $d\beta_{e,d}^{d(i)} / d\overline{\omega}_d^i > 0$.

Intuitively, the marginal value of exporter's profits is higher when she fails to reach an agreement with a large customer than when she fails to do so with a smaller one. When bargaining with a large customer, the firm is more amenable to moving the use of the local currency beyond the level that it would unilaterally choose.

The central element of our result is not just the fact that failing to reach an agreement with a large customer entails substantial foregone profits, but that the marginal value of these profits is larger. If the firm is risk-neutral ($\gamma_e = 0$) then the function H in (16) is always equal to one and its derivative is zero, implying that customer size has no impact on the outcome of the bargaining process.

The impact of customer's size on the invoicing decision depends on the value of the derivative of the customer's surplus with respect to the invoicing share. If the bargaining allocation is substantially tilted towards the customer's preferences, because of a limited bargaining power of the exporter for instance (a small δ), the derivative of the customer's surplus, $\partial SC_{e,d}^{k(i)} / \partial \beta_{e,d}^{d(i)}$, is small as the bargaining process brings the customer close to her preferred invoicing allocation. Going beyond the bargained allocation then entails only a limited gain for the customer. The left hand side of (16) is then small and customer's size has little impact. Intuitively, being a large customer offers little additional benefit when the customer already has a substantial role in the bargaining process. By contrast, only large customers can tilt the invoicing allocation in their favor when their direct bargaining weight is limited. Our analysis can be summarized in the following implication:

Implication 6: Under a bargaining determination of invoicing, the use of the destination currency is more pronounced for larger customers. This is especially the case when the bargaining allocation is close to the unilateral one.

This implication is in line with our empirical evidence that transaction in the top 5th percentile of a specific industry are more likely to be invoiced in the destination currency. It is also consistent with the finding that the impact of transaction size on invoicing is most pronounced in industries where the exporter is from a country with a large market share, a proxy for her bargaining power.

5.6. Discussion

Our model shows that moving the choice of invoicing from a unilateral decision by a firm to a bargaining process substantially alters the results. First, it leads to a larger use of the destination currency. Second, the use of destination currency is *more* pronounced for larger sales, as the marginal value of profits is then high. Finally, the impact of customer's size is larger when customers otherwise have little direct influence on the bargaining process.

Our bargaining model also offers a channel through which firms in large countries are *less* likely to invoice in the currency of their consumers. In the model, for brevity we considered that the firm only sells to foreign consumers. The model could be extended to include domestic sales by the firm in its own country. A firm with a large domestic market would have a lower marginal utility of profits than a firm with a smaller home market, and thus be less amenable to shift its

invoicing towards the destination currency. In addition, the firm could to have a larger bargaining power δ, which further reduces its willingness to accommodate the needs of foreign consumers. While we have not assessed the impact of the various drivers considered in section 2 in our alternative model, the results are likely to be qualitatively similar.

As discussed at the beginning of section 5, we view our model as the *first* step towards including bargaining in the invoicing process. We do not consider that this model represents the final stage in such a research effort for two reasons. First, we limited the bargaining to invoicing, and kept the pricing decision in the hands of the exporter. This choice is motivated by our desire to have the extended model encompass the simple one of unilateral invoicing as a particular case. Our setting however does not take the form of a maximization of the joint surplus, followed by a splitting of this surplus, which is more standard in bargaining models.[19] Developing broader bargaining models is clearly a promising avenue for research. Second, our approach abstracts from alternative channels through which invoicing could be different for large customers. One would be a model with increasing returns to scale where firms are more willing to accommodate the invoicing preferences of large customers as large sales drive production costs down.

6. Concluding Remarks

The extensive literature on international trade invoicing is affected by two limitations that this paper addresses. On the empirical side, existing studies only consider aggregate data. We instead test a range of possible determinants of invoicing by using a new highly disaggregated dataset for 45 million Canadian import transactions. While the U.S. dollar is the dominant currency for imports from the United States, other currencies play a substantial role in imports from other countries, which account for nearly half of overall imports by count. We find strong support for a direct role of exchange rate arrangements, coalescing in a common currency, use of commodity inputs in production, and for the bargaining power of importers. The connection between transaction size and invoicing is a new aspect in the invoicing literature. We find only mixed support for invoicing decisions influenced by profit hedging considerations.

On the theory side, existing studies consider that invoicing is unilaterally set by exporters, a feature that is not supported by survey evidence. We introduce interplay between customers and exporters in the selection of invoicing currencies by considering bargaining

[19] See for instance Blanchard (2000) in the context of the labor market where firms and workers choose the employment level to maximize that overall surplus, and bargain over the wage to split the surplus.

between the exporter and the customer. Two main results emerge. First, the bargaining solution calls for a larger use of the destination currency than the unilateral invoicing. Second, the use of the customer's currency is more pronounced for large sales. This is especially the case when the direct bargaining power of exporters is high.

Our conclusions provide a new perspective on the determinants of invoicing currency use, and, through this, on international policy transmission through exchange rate movements. For instance, a shift from a large number of relatively small imports to a handful of larger ones, such as large retail chains, could boost the use of the importers' currency and thus limit the pass-through of exchange rate movements to import prices. This link between industry concentration and pass-through has not been addressed to our knowledge, and offers an interesting counterpoint to the standard view in the literature that large exporters always have an advantage in determining pricing features. Another implication is that a shift by emerging markets away from dollar pegs towards floating exchange rates could lower the use of the dollar as an invoicing currency, as could declines in dollar use in sales of specific commodities in global markets . Such a reduction in the global role of the dollar could have profound implications for the international transmission of policy, as discussed by Goldberg and Tille (2009).

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Table 1. Regional Exporter Presence in Canadian Imports by Broad Industry Group, by Count

Percent Share in Import Transaction Counts							
Broad Industry Category	United States	Eurozone	East and SE Asia	China	Other Americas	All Other Countries	Percent of Total
Animal Products	68.2	5.0	9.9	4.6	3.0	9.3	1.0
Vegetable Products	60.6	7.9	7.5	5.9	3.8	14.3	3.1
Foodstuffs	61.7	11.8	7.8	3.5	1.6	13.5	3.2
Mineral Products	84.0	4.6	1.5	3.2	0.7	6.1	1.5
Chemicals	70.3	11.5	2.8	3.3	0.4	11.6	9.8
Plastics/Rubbers	63.7	11.2	7.8	3.3	0.9	13.2	7.0
Leather/Furs/Hides	44.2	14.3	13.1	9.3	1.9	17.2	1.0
Wood Products	66.3	9.8	8.2	4.7	1.0	9.9	7.2
Textiles	42.8	13.6	14.6	9.2	1.4	18.4	9.3
Footwear/Headgear	39.7	12.9	18.2	15.1	1.9	12.1	1.2
Stone/Glass	52.9	13.3	9.7	6.8	1.7	15.7	4.6
Metals	61.7	11.4	7.3	4.6	0.8	14.2	13.2
Machinery/Electrical	56.3	13.4	8.8	3.5	0.9	17.1	23.2
Transportation	65.4	10.3	5.9	3.2	0.8	14.3	2.8
Miscellaneous	54.5	11.6	10.7	6.5	0.5	16.2	10.9
Service	67.2	8.9	7.1	2.9	0.7	13.1	0.8
Total	58.9	11.8	8.6	5.0	1.0	14.7	

Table 2. Regional Exporter Presence in Canadian Imports by Broad Industry Group, by Value

Percent Share in Import Transaction Value							
Broad Industry Category	United States	Eurozone	East and SE Asia	China	Other Americas	All Other Countries	Percent of Total
Animal Products	62.3	5.5	8.3	7.9	4.2	11.8	0.8
Vegetable Products	69.6	5.5	3.7	2.8	6.2	12.2	1.9
Foodstuffs	58.6	17.7	4.0	1.9	4.9	12.8	3.0
Mineral Products	26.9	4.6	0.3	0.4	1.3	66.5	10.9
Chemicals	59.0	19.3	1.3	2.0	1.2	17.2	7.8
Plastics/Rubbers	76.9	5.1	5.4	6.0	0.4	6.1	4.7
Leather/Furs/Hides	14.4	15.9	5.3	53.2	3.0	8.2	0.4
Wood Products	79.4	7.2	2.3	6.0	1.6	3.5	3.4
Textiles	32.2	6.7	11.4	33.2	0.9	15.6	2.7
Footwear/Headgear	4.9	11.0	11.9	64.8	3.9	3.6	0.5
Stone/Glass	55.5	8.7	2.7	8.0	11.3	13.8	2.2
Metals	64.5	7.6	4.9	9.4	3.7	9.8	6.8
Machinery/Electrical	54.5	7.9	9.0	11.1	0.3	17.2	25.7
Transportation	68.9	9.1	4.2	0.8	0.9	16.0	21.0
Miscellaneous	47.3	9.7	4.6	22.2	0.2	15.9	6.2
Service	59.6	24.0	0.7	0.9	0.1	14.7	2.0
Total	56.6	9.2	5.0	7.5	1.5	20.2	

Table 3. LCP Share and Import Transaction Size

	United States				Non-U.S. Countries			
	Median Transaction Size, CAD		LCP Share by Count		Median Transaction Size, CAD		LCP Share by Count	
Broad Industry Category	Lower 95th Percentile	Upper 5th Percentile	Lower 95th Percentile	Upper 5th Percentile	Lower 95th Percentile	Upper 5th Percentile	Lower 95th Percentile	Upper 5th Percentile
Animal Products	9,422	321,806	2.1	4.2	3,861	457,343	5.7	16.2
Vegetable Products	4,718	381,710	2.3	3.5	2,335	221,396	5.7	9.3
Foodstuffs	12,046	328,670	3.3	17.2	2,733	326,451	6.0	24.5
Mineral Products	4,882	694,664	2.5	6.9	764	27,059,727	5.2	7.0
Chemicals	2,641	257,238	3.5	11.7	1,462	262,860	6.6	19.3
Plastics/Rubbers	5,781	358,761	2.7	7.5	1,289	187,073	3.3	13.9
Leather/Furs/Hides	507	44,148	3.3	7.2	1,309	284,232	3.4	10.3
Wood Products	2,573	230,359	2.7	12.9	539	150,689	4.1	13.5
Textiles	802	120,959	3.4	5.5	1,030	180,142	4.0	10.7
Footwear/Headgear	246	25,006	4.3	8.7	1,014	375,026	4.7	7.7
Stone/Glass	2,024	191,971	3.1	5.9	1,307	183,740	4.0	8.7
Metals	2,577	258,173	2.9	5.4	925	211,080	3.7	13.2
Machinery/Electrical	5,070	472,596	2.7	6.6	2,861	560,843	3.3	10.9
Transportation	20,279	2,726,504	2.3	9.2	6,071	1,921,510	2.7	13.4
Miscellaneous	2,291	259,831	3.1	7.9	1,937	277,942	3.8	13.2
Service	2,897	554,463	4.8	13.2	1,929	545,826	6.4	20.6

Table 4. Determinants of Invoicing Currency Choice: Non-US Exports to Canada

	1		2		3		4		5		6		7		8		9		10	
	LCP	PCP	LCP	PCP	LCP	PCP	LCP	PCP	LCP	PCP	LCP	PCP	LCP	PCP	LCP	PCP	LCP	PCP	LCP	PCP
Intercept	-2.77*	-1.46*	-2.85*	-1.45*	-2.70*	-1.35*	-2.76*	-1.38*	-2.73*	-1.02*	-2.66*	-0.94*	-2.83*	-2.00*	-2.77*	-1.33*	-2.57*	-0.31**	-2.78*	-1.41*
	[0.05]	[0.10]	[0.05]	[0.10]	[0.04]	[0.09]	[0.05]	[0.10]	[0.06]	[0.16]	[0.05]	[0.08]	[0.06]	[0.10]	[0.04]	[0.09]	[0.06]	[0.15]	[0.05]	[0.13]
Refcon			0.52*	-0.10*											0.47*	-0.14*			0.47*	-0.17*
			[0.00]	[0.00]											[0.01]	[0.00]			[0.00]	[0.01]
Walrascon			0.25*	-0.22*											0.18*	-0.26*			0.24*	-0.09*
			[0.01]	[0.01]											[0.01]	[0.01]			[0.01]	[0.01]
Importshare					-8.73*	-3.19*									-8.66*	-3.22*			-7.57*	0.55*
					[0.14]	[0.04]									[0.14]	[0.05]			[0.15]	[0.04]
Top5ind					1.51*	-0.03**									1.50*	-0.03**			1.55*	0.05*
					[0.01]	[0.01]									[0.01]	[0.01]			[0.01]	[0.01]
Top5ind*					3.61*	-4.19*									3.76*	-4.24*			3.41*	-3.15*
importshare					[0.12]	[0.13]									[0.12]	[0.13]			[0.12]	[0.07]
Intensity							-0.15*	-0.80*									-0.20*	-0.97*	-1.00*	-1.76*
							[0.03]	[0.03]									[0.03]	[0.04]	[0.02]	[0.03]
Coefvar									-1.03	-10.11**							-1.3	-11.27**	-0.89**	-7.48**
									[0.89]	[3.71]							[0.85]	[3.55]	[0.41]	[1.92]
USDhedge											0.03	-0.37*					0.03	-0.36*	0.01	-0.23*
											[0.04]	[0.09]					[0.04]	[0.09]	[0.02]	[0.04]
EURhedge											-0.28*	-1.42*					-0.28*	-1.45*	0.04	-0.14**
											[0.04]	[0.09]					[0.04]	[0.09]	[0.02]	[0.06]
CADhedge											-0.1	-0.46*					-0.11**	-0.53*	0.05**	0.01
											[0.05]	[0.09]					[0.05]	[0.09]	[0.02]	[0.03]
Dollarpeg													-0.43*	-1.19*					-0.22*	-1.36*
													[0.01]	[0.02]					[0.01]	[0.04]
Europeg													0.43*	1.54*					0.44*	1.46*
													[0.00]	[0.01]					[0.01]	[0.02]
Time FE	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	16,905,286		16,905,286		16,905,286		16,905,286		16,905,286		16,905,286		16,905,286		16,905,286		16,905,286		16,905,286	
AIC	21,406,515		21,375,939		21,055,445		21,399,071		21,337,453		20,945,316		19,529,769		21,026,254		20,856,969		19,223,300	

Table 5. Determinants of Invoicing Currency Choice: US Exports to Canada

	1		2		3		4		5		6		7		8		9	
	LCP	VCP	LCP	VCP	LCP	VCP	LCP	VCP	LCP	VCP	LCP	VCP	LCP	VCP	LCP	VCP	LCP	VCP
Intercept	-3.39*	-5.32*	-3.38*	-5.14*	-3.15*	-4.75*	-3.36*	-5.31*	-3.32*	-6.09*	-3.43	-5.32**	-3.14*	-4.77*	-6.54	-6.28**	-6.29*	-6.57
	[0.02]	[0.16]	[0.02]	[0.15]	[0.03]	[0.13]	[0.02]	[0.15]	[0.03]	[0.10]	[0.52]	[1.53]	[0.03]	[0.14]	[5.80]	[1.72]	[0.37]	[198.90]
Refcon			-0.01	-1.21*									0.05*	-1.15*			0.05*	-1.16*
			[0.01]	[0.03]									[0.00]	[0.04]			[0.00]	[0.04]
Walrascon			-0.22*	-2.24*									-0.20*	-2.23*			-0.19*	-2.28*
			[0.01]	[0.10]									[0.01]	[0.10]			[0.01]	[0.10]
Importshare					-0.61*	-0.91*							-0.63*	-0.57*			-0.62*	-0.59*
					[0.03]	[0.02]							[0.03]	[0.03]			[0.03]	[0.03]
Top5ind					1.04*	-1.15*							1.04*	-1.12*			1.05*	-1.13*
					[0.02]	[0.11]							[0.02]	[0.11]			[0.02]	[0.11]
Top5ind*					0.34*	-1.11*							0.33*	-1.18*			0.32*	-1.13*
importshare					[0.03]	[0.19]							[0.03]	[0.20]			[0.03]	[0.11]
Intensity							-0.30*	-0.13**							-0.30*	-0.13**	-0.18*	0.79*
							[0.03]	[0.06]							[0.03]	[0.06]	[0.02]	[0.07]
Coefvar									-1.62**	17.32*					61.76	-43.25	61.28*	-48.6
									[0.48]	[1.88]						[33.83]	[7.32]	[3912.90]
EURhedge											0.01	0.35			-0.84	4.12*	-0.85*	5.17
												[1.62]				[0.43]	[0.10]	[53.66]
CADhedge											0.07	-0.32			1.59	1.79**	1.60*	2.72
												[1.59]				[0.84]	[0.18]	[96.59]
Time FE	Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes		Yes	
Observations	24,615,469		24,615,469		24,615,469		24,615,469		24,615,469		24,615,469		24,615,469		24,615,469		24,615,469	
AIC	8,577,390		8,553,275		8,455,446		8,577,018		8,576,619		8,576,621		8,434,003		8,576,249		8,432,849	

Table 6. Comparison of AIC Scores

Non-US		US	
Model	AIC	Model	AIC
All variables	19,223,300	All variables	8,432,849
Pegs	19,529,769	Industry + Bargaining	8,434,003
Hedges	20,945,316	Bargaining (Importshare/Top5ind)	8,455,446
Industry + Bargaining	21,026,254	Industry (Ref/Walras)	8,553,275
Bargaining (Importshare/Top5ind)	21,055,445	Coefvar	8,576,619
Coefvar	21,337,453	Hedges	8,576,621
Industry (Ref/Walras)	21,375,939	Intensity	8,577,018
Intensity	21,399,071	Time FE only	8,577,390
Time FE only	21,406,515	Intercept only	8,586,852
Intercept only	21,432,400		

Note: the AIC score is equal to $2k - \ln(L)$ where k is the number of parameters and L is the maximized value of the likelihood function.

Figure 1. Currency Use in Invoicing Canadian Imports

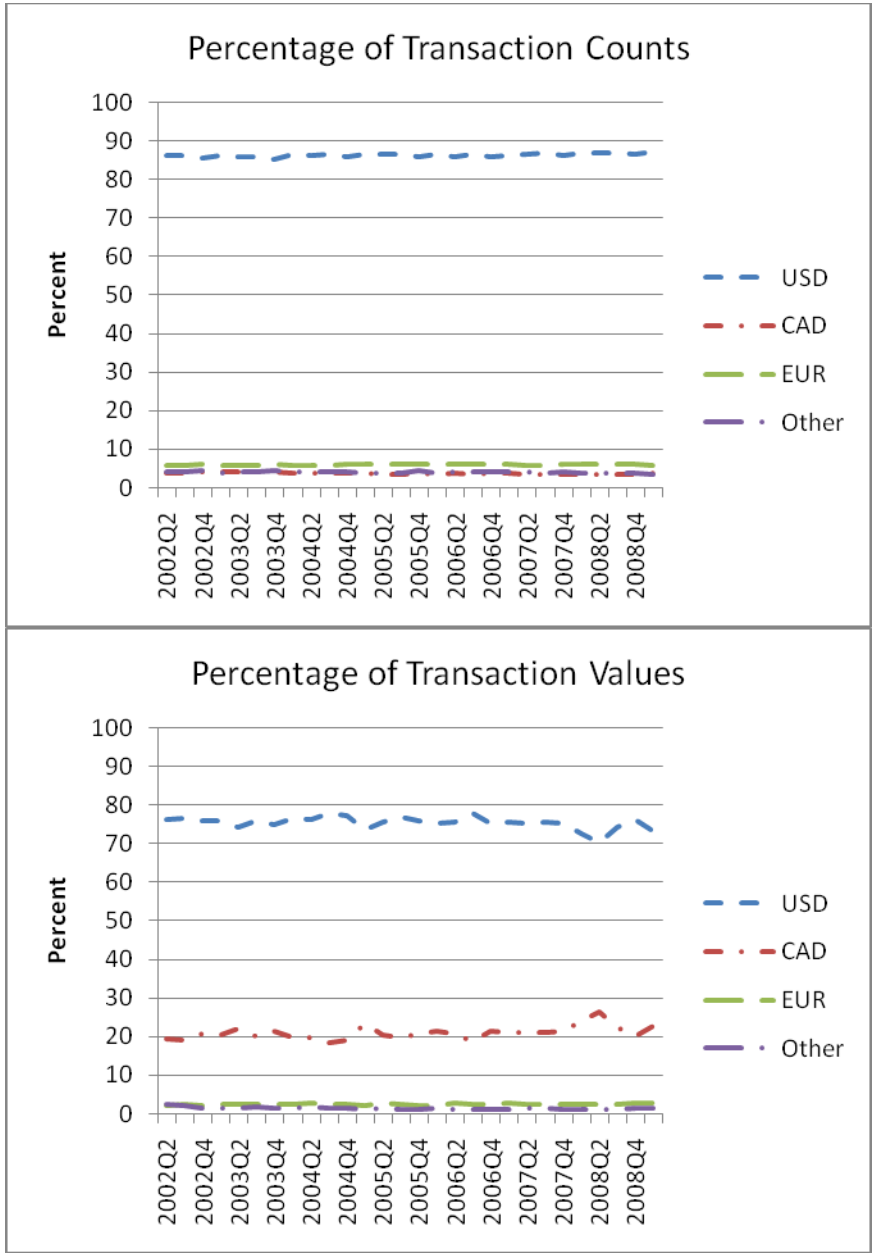


Figure 2. Prevalence of Producer Currency Pricing by Specific Exporters

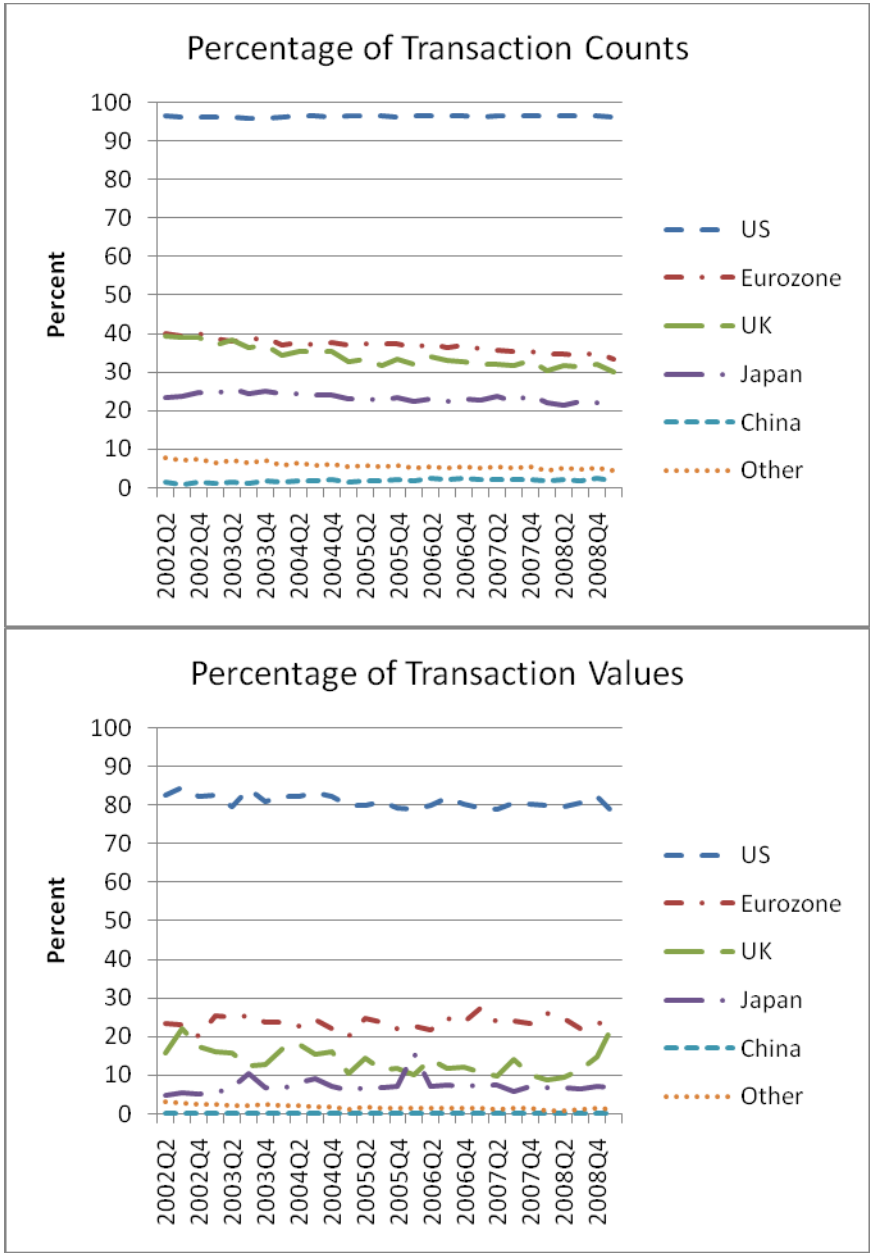
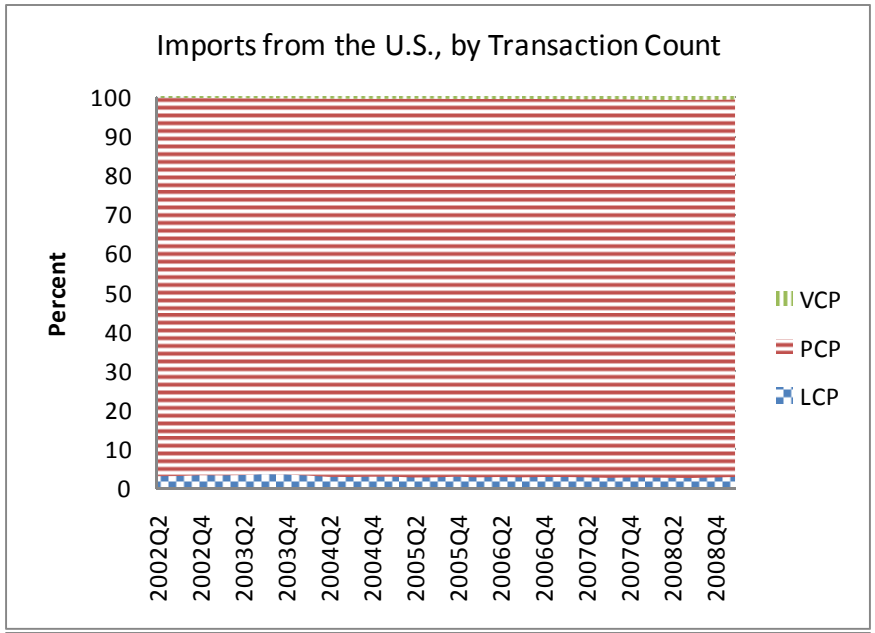
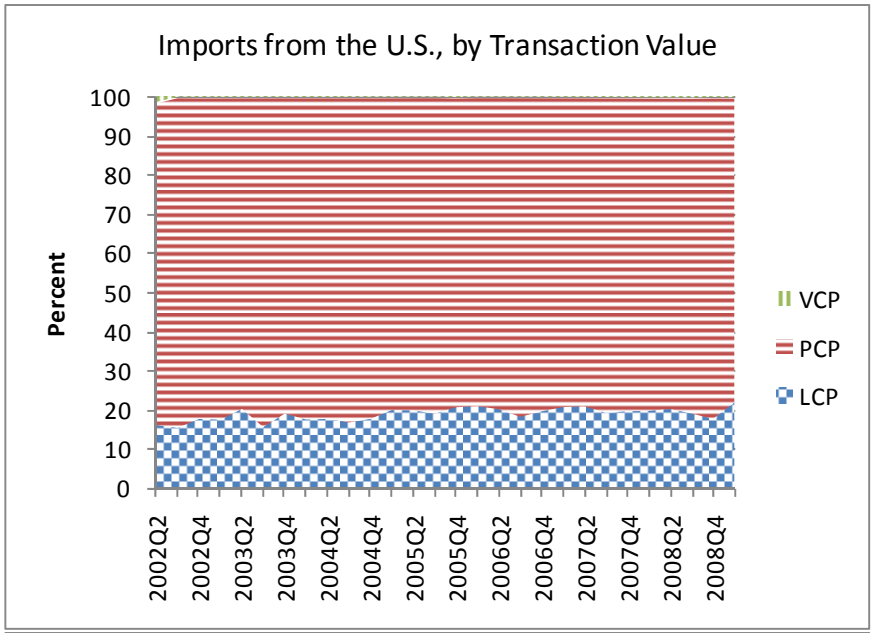
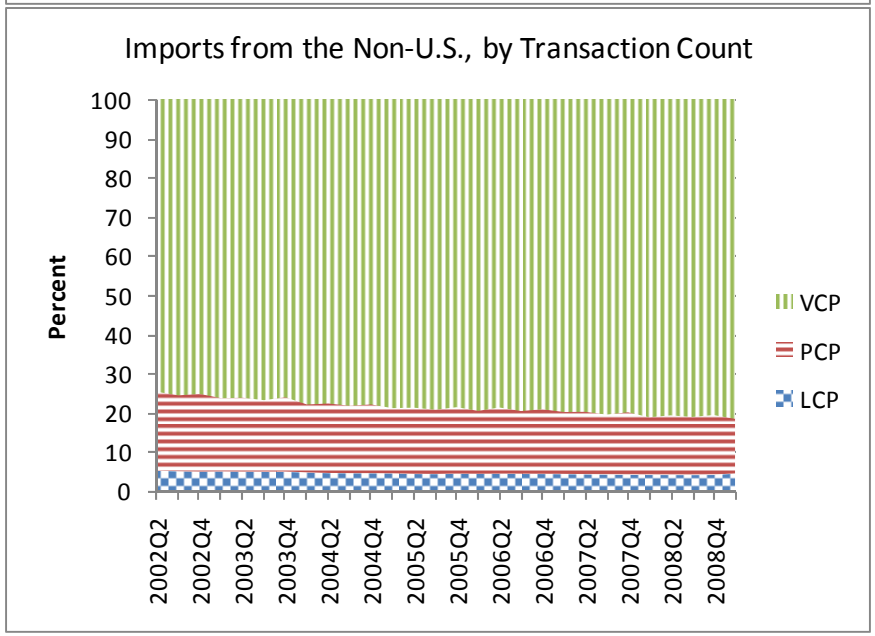
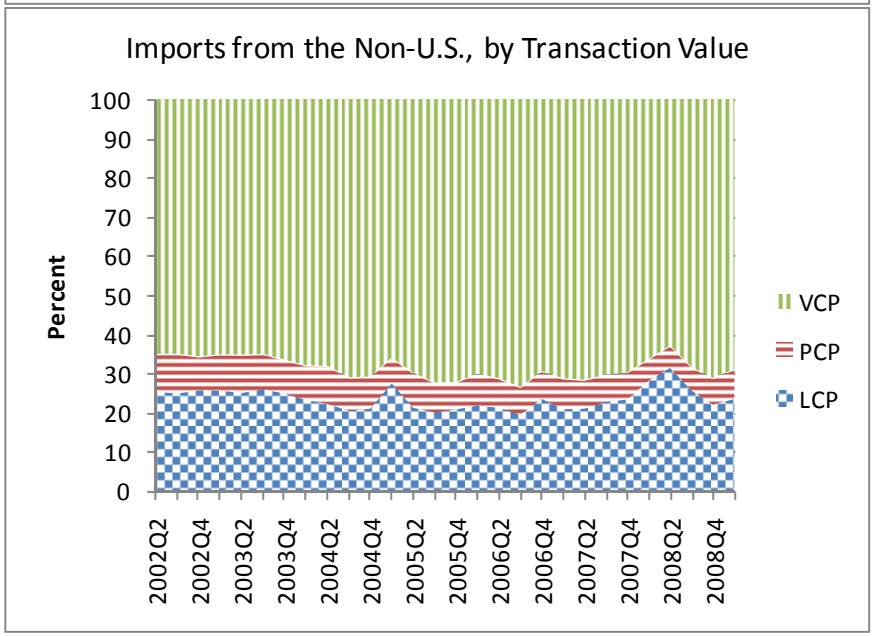


Figure 3. Producer, Local and Vehicle Currency Pricing in Canadian Import Transactions









Appendix: Constructing the hedging variable

As exposited in Goldberg and Tille (2008), the hedging motive for invoice currency selection reflects the covariances between exchange rates and producer marginal costs $\rho(m_{ed}, s_{ed})$ and $\rho(m_{ed}, s_{ev})$. The idea is that the producer should choose an invoicing currency so that revenues are highest when costs are highest, with this positive correlation helping to hedge producer profitability. Producer marginal costs are modeled as $m_{ed} = w_e + (1-\alpha)/\alpha \cdot c_d$ where w_e is the wage or producer price index representing the unit marginal cost of the exporter and c_d is the sensitivity of marginal costs to changes in demand, representing the shape of the production frontier.[20] We proxy for exporter marginal costs in each country by constructing quarterly values for m_{ed}, where the cost of inputs w_e are the logs nominal producer price indices in exporter's currency, α is set at 0.65, and c_d is the log of real consumption in Canada as the export destination market "*d*". The PPI values are more desirable than pure wages since they internalize the cost of imported inputs that can influence hedging decisions. (Even more desirable would be industry-specific production costs). s_{ev} is in units of currency *e* per unit of currency *v* so an increase is a depreciation of currency *e*.

Ideally, surprises in consumption strength and PPI would be correlated with surprise depreciations of the exporter currency to extract a preferred hedge. We do not have data coverage to run this type of experiment. Instead, we compute each m_{ed} and run a rolling correlation with three bilateral exchange rates, which are vis-à-vis dollars, euros, and CAD, over 8 prior quarters of data. A desirable hedging currency has a positive correlation and a higher correlation than the two alternative currencies. If no currencies have recent positive correlations with the m_{ed}, then all hedge dummies are given a zero value at a particular date.

Constructing each of these variables relied on careful empirical work. However, despite this care, the weakest construction is likely to be for the hedging variables *USDhedge*, *CADhedge* and *EURhedge*. Intuitively, the hedging motive argues that the currency used for

[20] For the approximately 50 countries covered as exporters to Canada we have wage data and producer price index data. For the 26 countries across which both wage and PPI data are available, these series tend to be highly correlated in most cases except for France and Japan, and positively but less strongly correlated for parts of Asia. Wage data were nominal and in the home currency from the ILO : http://laborsta.ilo.org/ . PPI data are from the IMF's IFS database.

invoicing should be the currency which generates unexpected fluctuations in revenue that offset unexpected shocks to marginal costs, stemming from either wages or the strength of demand. If, for instance, an unexpected high growth in Canadian demand raises the marginal cost, the exporter has an incentive to invoice in a currency that tends to appreciate against his own in such states, thereby boosting his unit revenue. The challenge is to implement such a construct for our sample of 47 exporters and over the full sample period. In practice, if there is a period of above trend growth in an export destination market, an exporter might value for invoicing, via the hedging motive, a currency that has tended to appreciate over similar periods of economic growth. We construct rolling correlations of exporter bilateral exchange rates against the proxy for exporter costs over the prior 8 quarters and use the pattern of observed correlations in an exporter's recent past to determine his hedging preference in period *t*. A hedging currency should appreciate (on average) when the export destination market has abnormally high growth, and should have a stronger positive correlation that would be the case if alternative currencies were used for hedging. In our data, the general trend is that the CAD is a good hedge early on in the period and late in the period. USD and EUR get some action in the middle. Across all countries and over the whole estimation period, the three currencies are about equally balanced: USD 22 percent, EUR 21 percent, CAD 26 percent and none 31 percent.

Appendix Table 1

		Percent of Observations	
Country	Frequency	By Count	By Value
Algeria	2,804	0.01	1.10
Angola	638	0.00	0.97
Australia	189,876	0.44	0.43
Austria	264,842	0.61	0.32
Belgium	283,294	0.65	0.43
Brazil	293,295	0.67	0.74
Chile	70,499	0.16	0.35
China	2,086,341	4.78	7.29
Czech Republic	166,495	0.38	0.07
Denmark	248,269	0.57	0.35
Finland	161,066	0.37	0.26
France	848,044	1.94	2.44
Germany	1,366,460	3.13	2.69
Hong Kong	379,889	0.87	0.16
Hungary	121,353	0.28	0.06
India	638,209	1.46	0.44
Indonesia	305,158	0.70	0.24
Iraq	239	0.00	0.45
Ireland	137,397	0.31	0.53
Israel	211,370	0.48	0.22
Italy	1,039,771	2.38	1.31
Japan	1,119,697	2.57	3.66
Malaysia	290,031	0.66	0.64
Mexico	804,077	1.84	3.67
Netherlands	361,875	0.83	0.51
Nigeria	5,889	0.01	0.65
Norway	90,394	0.21	1.36
Pakistan	133,013	0.30	0.07
Peru	63,036	0.14	0.33
Philippines	229,161	0.53	0.23
Poland	155,627	0.36	0.16
Portugal	133,610	0.31	0.10
Russia	59,141	0.14	0.44
Saudi Arabia	10,028	0.02	0.38
Singapore	159,667	0.37	0.32
South Africa	110,256	0.25	0.18
South Korea	593,440	1.36	1.65
Spain	336,599	0.77	0.36
Sweden	366,043	0.84	0.54
Switzerland	458,790	1.05	0.55
Taiwan	970,169	2.22	0.96
Thailand	467,332	1.07	0.52
Turkey	226,562	0.52	0.18
United Kingdom	1,027,244	2.35	3.34
United States	24,654,574	56.49	54.96
Venezuela	14,926	0.03	0.38
Vietnam	193,860	0.44	0.15
Total	41,850,350	95.89	97.12

Appendix Table 2. Coefficients of Correlation: Non-U.S. Exports to Canada

	Dollarpeg	Europeg	Walrascon	Refcon	Top5ind	LCP	PCP	VCP	USDhedge	EURhedge	CADhedge	Intensity	Coefvar	Importshare
Dollarpeg	1.00													
Europeg	-0.30	1.00												
Walrascon	0.00	-0.01	1.00											
Refcon	-0.02	0.02	-0.05	1.00										
Top5ind	0.14	-0.05	0.01	-0.01	1.00									
LCP	-0.03	0.01	0.01	0.04	0.10	1.00								
PCP	-0.16	0.33	-0.01	-0.02	-0.04	-0.10	1.00							
VCP	0.16	-0.31	0.01	-0.01	-0.01	-0.41	-0.87	1.00						
USDhedge	-0.27	0.11	0.00	0.01	-0.03	0.01	0.03	-0.03	1.00					
EURhedge	0.18	-0.40	0.00	-0.02	0.01	-0.01	-0.14	0.13	-0.36	1.00				
CADhedge	0.06	0.06	-0.01	0.01	0.01	0.00	0.03	-0.03	-0.41	-0.43	1.00			
Intensity	-0.07	0.04	0.08	0.04	0.00	0.00	-0.02	0.02	0.01	-0.02	0.00	1.00		
Coefvar	-0.11	-0.13	0.01	0.00	-0.01	0.00	-0.05	0.05	0.07	0.05	-0.16	-0.01	1.00	
Importshare	0.47	-0.14	-0.02	-0.06	0.20	-0.04	-0.07	0.08	-0.12	0.07	0.04	-0.13	-0.06	1.00

Appendix Table 3. Coefficients of Correlation: U.S. Exports to Canada

	Walrascon	Refcon	Top5ind	LCP	PCP	VCP	EURhedge	CADhedge	Intensity	Coefvar	Importshare
Walrascon	1.00										
Refcon	-0.09	1.00									
Top5ind	0.00	0.01	1.00								
LCP	-0.01	0.00	0.08	1.00							
PCP	0.01	0.01	-0.07	-0.92	1.00						
VCP	-0.01	-0.02	-0.01	-0.01	-0.37	1.00					
EURhedge	0.00	0.00	0.00	0.00	0.00	0.00	1.00				
CADhedge	0.00	0.00	0.01	0.00	0.00	0.00	-0.59	1.00			
Intensity	0.14	0.05	0.00	0.00	0.00	0.00	0.00	0.00	1.00		
Coefvar	0.00	0.00	-0.01	0.00	0.00	0.01	0.51	-0.73	0.00	1.00	
Importshare	0.01	0.21	0.04	-0.01	0.02	-0.02	-0.02	0.02	0.03	-0.06	1.00