Trade Invoicing Currencies and Exchange Rate Pass-through: The Introduction of the Euro as a Natural Experiment *

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Abstract

A recent literature emphasizes the prominence of dominant currencies in international trade invoicing and the role of invoice currencies in the transmission of exchange rate shocks. In this paper, we examine the introduction of the euro as a once-in-a-century natural experiment that induced a substantial shifting in invoice currencies, allowing us to test existing theories. We use unique data on the invoice currencies of the universe of export and import transactions of a small open economy trading with the Eurozone over the period 1997-2010. Before the euro, exports to the Eurozone were dominated by the US dollar, and euro legacy currencies were rarely used. The introduction of the euro led a substantial number of firms to swiftly switch their invoice currencies to euros, which eventually accounted for 40% of all transactions. We first study the determinants of the adoption of the euro in exports to the Eurozone, finding a key role for strategic complementarities and for the invoice currency of imported inputs. In the core of our analysis, we show how firms switching from dollars to euros faced a radical transformation of their exchange rate pass-through, in line with recent theories. While the literature has studied trade invoice currencies in settings in which these are very persistent firm-level choices, our findings validate the conjecture that large–scale policy changes can lead to changes in these choices, and simultaneous changes in exchange rate pass-through.

Keywords: Invoicing Currencies, Exchange Rates, Pass-through, Euro, Dominant Currency

JEL classification: F1, F3, F4

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1 Introduction

In the theory of open economy macroeconomics, the currencies used to invoice international trade transactions are key determinants of exchange rate pass–through, shaping the transmission of shocks across borders as well as optimal monetary and exchange rate policy. During the last decade, the literature has gained important insights from firm– or transaction–level data, analyzing firms' invoicing currencies and their effects on pricing [Gopinath et al., 2010, Gopinath and Itskhoki, 2010, Amiti et al., 2014, Gopinath et al., 2020, Amiti et al., 2022]. The most recent theory and evidence [Amiti et al., 2022] emphasizes that invoice currencies and desired exchange rate pass–through (ERPT) are *both* endogenous choices made by firms. At the same time, recent work has established a key role for dominant currencies (especially the US dollar) in international trade invoicing [Gopinath et al., 2020], with novel implications for the international price system. In fact, the evidence shown by Amiti et al. [2022] on the currency choice of Belgian exporters, in a context in which firms opt between using euros or dollars, is "consistent with a framework that allows for *endogenously* emerging dominant currencies."

This framework poses a challenge for identifying the effect of invoice currencies on exchange rate pass–through. Exporters' invoice currencies are extremely persistent over time, and it is difficult to find large and exogenous policy changes that induce firms to switch their chosen currencies. Because currency choices are so persistent, the evidence on their effect on exchange rate pass–through is based on comparisons *across* firms. This means that observed and/or unobserved firm characteristics might drive both the invoicing currency choice and the desired exchange rate pass–through. One useful approach to circumvent this problem is to estimate structural equations stemming from theoretical models [Amiti et al., 2022].[1] An alternative avenue, which we pursue in this paper, is to explore episodes that generate large–scale invoice currency switching.

We study the introduction of the euro as an ideal and unique once–in–a–century natural experiment that created a significant shift in the invoice currencies used for international trade. The euro became a strong candidate for a dominant currency role, competing with the US dollar at least in trade with the Eurozone. This episode allows us to measure changes in exchange rate pass–through as firms swiftly switch their invoice currencies from US dollars to euros. Such an event had not occurred probably since the US dollar took over the role of the British pound at some point earlier in the 20th century. In addition, the episode we study has the advantage of having occurred at a precise point in time due to a policy decision, allowing for a clean inference of its effects.

To study the effects of the introduction of the euro on invoicing currency choice and exchange rate

[1] [Amiti et al., 2022] estimate the causal impact of invoice currencies on exchange rate pass–through by controlling for flexible pass–through firm–level determinants derived from their model.

pass–through, we analyze rich transaction–level data on exports and imports between a small extra-Eurozone open economy (Chile) and the Eurozone over the period 1997–2010. Our data are especially well suited for our purpose, for the following reasons. First, the data are unique in its reporting of the invoice currency of every transaction for a very long period of time spanning the introduction of the euro, and including both exports and imports. We combine the trade transactions data with data on firm characteristics obtained from a census of manufacturing firms. Observing firm characteristics such as revenue and cost is crucial, as it allows us to test the existing theories of trade invoicing and exchange rate pass–through. It is worth noting that few countries report invoice currencies in customs transactions, and only Amiti et al. [2022] has used such data combining firm characteristics and invoicing currencies.[2] In fact, studies with transaction-level data have typically focused on short panels. Another fundamental advantage of our data is that we focus on exports to the Eurozone by an extra–Eurozone economy that had nearly 100% dollar invoicing prior to the introduction of the euro. The clean identification this setting enables would not be feasible if we analyzed intra–Eurozone trade.[3]

Existing theories of currency invoicing and exchange rate pass–through [Amiti et al., 2022] predict that, due to strategic complementarities, adopting the euro is more likely for exporters in industries in which a larger share of competitors price in euros (i.e. in industries with a larger degree of intra–Eurozone competition).[4] Invoicing in euros is also more likely for larger exporters, for which these strategic complementarities are stronger. In addition, due to a marginal cost channel, switching to euros is more likely for firms with imports also invoiced in euros. In addition, the theory proposes that the short-run exchange rate pass–through is in part determined by the invoice currency used.

Our findings provide support to the most recent theories of currency invoicing and exchange rate pass–through. In the first part of our analysis, we document the expansion of the euro as an invoice currency and study the firm- and product-level determinants of its adoption. We document that the euro was very successful in gaining traction as an invoice currency at the expense of the dollar. Prior to 2002, the euro legacy currencies were rarely used for invoicing Chilean exports to the Eurozone (accounting for less than 0.1% of transactions and value traded) and nearly all exports were invoiced in dollars. After the introduction of the euro in physical format, a fraction of firms immediately switched

[2]Note for instance that members of the Eurozone report trade invoice currencies only starting in recent years, and only regarding extra-Eurozone trade.

[3]The existing data [Boz et al., 2022, Kamps, 2006, Emerson et al., 1992, Hartmann, 1998] indicates that trade between Eurozone members switched from euro legacy currencies and vehicle currencies to euros. Thus, identifying the effect of invoice currencies on exchange rate pass–through is easier in our context in which trade is invoiced entirely in dollars before the introduction of the euro. In addition, firm– or transaction–level data on invoice currencies for Eurozone members during this period has not been made available in the literature.

[4]The reason is that intra–Eurozone trade shifted from being invoiced in a combination of euro legacy currencies and vehicle currencies to being invoiced almost entirely in euros [Boz et al., 2022, Kamps, 2006, Emerson et al., 1992, Hartmann, 1998]. Thus, Chilean exporters would find that competitors' prices in any Eurozone destination would be much more stable in euros than what they were before in any euro legacy currency.

to euros, and by 2010, 29.2% of transactions (accounting for 39.3% of export value) were invoiced in euros, with 37.9% of exporters invoicing at least some trade in euros.

We find that adopting the euro was substantially more likely among products facing more competition from within the Eurozone and among larger firms, which is evidence of the strategic complementarities mechanism featured in the theory of invoice currency choice.[5] In fact, consistent with [Amiti et al., 2022], we show that the effect of intra–Eurozone competition on the probability of adopting the euro was larger for larger firms.[6] We also find that exporters with a higher ratio of imports invoiced in euros over cost, and those with a lower ratio of imports in dollars over cost, were more likely to invoice exports in euros. This is in line with [Amiti et al., 2022]'s marginal cost channel. In addition, firms with a higher share of exports sold in Eurozone destinations are also more likely to invoice in euros, which suggests a fixed cost per currency used.[7] Finally, exporters that are affiliates of Eurozone multinationals also adopted the euro at a higher rate, suggesting that multinationals might make invoicing decisions globally and prefer headquarter currencies.

In the second part of the paper, which is the core of our analysis, we show that currency switching had drastic effects on exchange rate pass–through. We find a substantial change in the pass–through coefficients between the 1997–2001 and 2002–2010 periods. The short–run pass–through coefficient for the peso–dollar exchange rate to prices expressed in Chilean pesos is very close to one (1.068) in the pre-2002 period and substantially lower (0.543) in the post-2002 period. The coefficient for the peso–euro exchange rate, in contrast, is essentially zero pre-2002 (-0.014) and rises to 0.489 after the introduction of the euro. This is exactly what the theory [Gopinath et al., 2010, Amiti et al., 2022] predicts. When trade is invoiced almost entirely in dollars, the pass–through of the peso–dollar exchange rate is nearly complete and the pass–through of the peso–euro exchange rate is zero. After the euro is introduced, when trade is invoiced partly in dollars and partly in euros, both exchange rates have a more symmetric impact on prices.

Our strongest evidence compares exchange rate pass–through based on invoice currencies and the pre and post periods. For transactions invoiced in dollars the pass–through of the peso–dollar exchange rate is close to one (both before and after 2002), while the pass–through of the peso–euro exchange rate is near zero in both periods. The exact opposite is true for transactions invoiced in euros. The peso–dollar exchange rate pass–through is close to zero, while the pass–through of the peso–euro exchange

[5] We also find that invoicing in euros was more likely for exporters of differentiated goods, which is consistent with the well–documented fact that in the present as well as historically commodities are typically invoiced in dollars.

[6] That larger firms respond more in industries facing strong intra–Eurozone competition validates [Amiti et al., 2022]'s model going beyond what their empirical setting allows them to test for.

[7] Amiti et al. [2022] show that a simple extension of their baseline model, adding a fixed cost per currency used, can generate this result. They find that Belgian exporters with a higher share of Eurozone sales are more likely to invoice in euros their trade with other destinations. This type of fixed cost for currency management is also featured in Crowley et al. [2020].

rate is close to one. Once again, this result is in line with the theory. Based on a natural experiment, it validates the view that invoice currencies shape exchange rate pass–through [Amiti et al., 2022].[8]

Contribution to the Literature Our work adds, first, to the literature on the determinants of trade invoicing currency choice. Work in this area has provided many important insights in either cross-sectional contexts (based on cross-country, cross-industry, or cross-firm variation) or studying short panels in which currency choice is very persistent. The patterns and determinants of trade invoice currencies have been studied by Goldberg and Tille [2008], Goldberg and Tille [2016], Chung [2016], Martin and Méjean [forthcoming], Goldberg [2005], Devereux et al. [2017], Crowley et al. [2020] and Boz et al. [2022]. Our findings are consistent with this literature. The key difference of our paper is focusing on the introduction of the euro as a unique natural experiment, thus providing the first firm-level evidence on the emergence of a new global currency. Empirical evidence in this regard is very limited, because the only events in recent history one could study are the emergence of the euro or the emergence of the US dollar (which was presumably much more gradual over time). As far as we know, there is no evidence on the mechanisms that made the euro gain popularity as an invoice currency because aside from our paper there has been no availability of industry– or firm–level data in trade invoice currencies for that period. From a theoretical perspective, Mukhin [2022] develops a framework to analyze endogenous dominant currencies, which is shown to match the aggregate patterns of invoice currency use seen after the introduction of the euro. Our evidence could potentially be used to calibrate or validate this type of framework at a more microeconomic level.

In addition, our work contributes to the literature on exchange rate pass-through. Recent firm– or transaction–level analyses include [Gopinath and Itskhoki, 2010, Berman et al., 2012, Amiti et al., 2014, Chen and Juvenal, 2016, Cravino, 2017, Heise, 2019, Bonadio et al., 2020].[9,10] Within this literature, our paper is especially linked to work that establishes how invoice currencies shape exchange rate pass–through [Gopinath and Rigobon, 2008, Gopinath et al., 2010, Chen et al., 2022, Boz et al., 2022, Gopinath et al., 2020].[11] Our findings speak most closely to Amiti et al. [2022], who study theoretically

[8] We perform several exercises that rule out that these large changes in pass–through coefficients are due only to changes in desired pass–through, and are in fact driven by invoice currencies. We also verify the robustness of our results to a broad set of alternative specifications.

[9] This literature has been recently surveyed by Burstein and Gopinath [2014].

[10] [Cravino, 2017] uses Chilean exports with invoice currencies to study how nominal exchange rates impact output and productivity. Consistent with Gopinath et al. [2010] and with our findings, he documents that export prices are rigid in the currencies in which they are invoiced, even though his work is primarily focused on the adjustment of quantities.

[11] Gopinath and Itskhoki [2021] provide a detailed survey of the literature. Studying US export and import prices, Gopinath and Rigobon [2008] document that almost all US trade is invoiced in dollars, that international prices are highly rigid, and that exchange rate pass–through into US import prices is relatively low. Gopinath et al. [2010] find a large difference in exchange rate pass–through into US import prices comparing transactions in dollars vs. other currencies. Chen et al. [2022] study UK imports and document a pervasive use of vehicle currencies and pass–through that depends on the invoice currency used, which helps understand inflation patterns following sterling devaluations. Using a comprehensive global data of invoice

and empirically the determinants of currency choice in Belgian exports and imports, and how invoice currencies determine exchange rate pass–through. The Belgian case is interesting because firms face a choice between two competing global currencies – euros and dollars. Given the persistence in invoice currencies and the short panel used, the effect of invoice currencies on exchange rate pass–through is based on a comparison *across* firms estimating structural model–derived regressions. In that paper, the causal effect of invoice currencies on pass–through is obtained by controlling for firm–level flexible pass–through determinants. In this regard, our main contribution to the exchange rate pass–through literature is leveraging what we believe is the ideal natural experiment to establish the relationship between invoice currencies and exchange rate pass–through. Our findings turn out to be in full support of recent theories, and we view our empirical approach as complementary to Amiti et al. [2022]'s and to the rest of the existing empirical evidence.

Methodologically, our approach based on a natural experiment stemming from a one-off policy event resembles Auer et al. [2021], who study the unexpected appreciation of the Swiss franc against the euro in 2015. Our episode and goal, however, are very different. We study a policy establishing a new currency (which, key to our identification strategy, induced substantial invoice currency switching), while Auer et al. [2021] study the effects of an appreciation on border and retail prices. Other work taking advantage of large devaluations includes Corsetti et al. [2022], who study exchange rate pass-through around the Brexit referendum and Cravino and Levchenko [2017], who establish the distributional consequences of Mexico's 1994 devaluation.[12]

The rest of the paper is organized as follows. We provide a brief theoretical discussion to guide our empirical work in Section 2. In Section 3 we describe the data sources. Next, we examine the patterns and determinants of the adoption of the euro in Section 4. Finally, the core of our analysis, in Section 4 establishes how large–scale switching to invoicing in euros fundamentally changed exchange rate pass–through.

2 Theoretical discussion

We first provide a brief theoretical discussion to guide our empirical work. Our discussion is based on the model by Amiti et al. [2022], which unifies the literature on invoice currencies and exchange rate pass–through.

currency use and country–pair level exchange rate pass–through regression, Boz et al. [2022] find that that pass–through into import prices of the dollar (or euro) exchange rate is larger for countries with a higher share of trade invoiced in dollars (or euros) respectively.

[12] Corsetti et al. [2022] find substantial differences in exchange rate pass–through for trade invoiced in different invoice currencies around the Brexit referendum in 2016. They report there are no significant changes in invoicing due to that episode, although UK firms have been gradually moving away from invoicing in sterling.

Consider Chilean firms exporting to Eurozone destinations. In principle, these firms can choose between producer currency pricing (invoicing in Chilean pesos), local currency pricing (invoicing in euros after it was introduced or euro legacy currencies before), or dominant currency pricing (invoicing in US dollars).[13] In practice, the Chilean peso is not used, so we focus the discussion on the latter two options.[14]

Given our empirical setting, our discussion is focused on short–run exchange rate pass–through. Consider an environment with sticky prices, such that in each period only a fraction of prices can be adjusted after the state of the world (which includes exchange rate movements) is revealed. For the set of prices that are adjusted, exchange rate pass–through will be equal to desired exchange rate pass–through. For prices that cannot be adjusted, exchange rate pass–through is completely determined by the invoice currency. Exports invoiced in dollars have complete pass–through of the peso–dollar exchange rate to the price expressed in Chilean pesos; exports invoiced in euros (or euro legacy currencies) feature a complete pass–through of the peso–euro (or peso–legacy currency) exchange rate to the price in pesos.

Desired exchange rate pass–through is a function of the exposure of cost and of desired markups to exchange rates.[15] Cost exposure to the peso–euro exchange rate is a function of the ratio of imports invoiced in euros over variable cost. In the same way, cost exposure to the peso–dollar exchange rate is a function of the ratio of imports invoiced in dollars over variable cost. Exposure of the desired markup to the exchange rates depends on the markup elasticity with respect to price, and on the elasticity of competitors' prices to the exchange rates. As Amiti et al. [2019] show and following Amiti et al. [2022], markup elasticity is increasing in firm size, which we use in the empirical analysis. For firms invoicing in euros with zero cost exposure to exchange rates and zero markup elasticities, desired pass–through of the peso–euro exchange rate to the price in pesos is complete, while pass–through of the peso–dollar exchange rate to the price in pesos is zero. For firms with cost exposure to the peso–euro exchange rate (i.e. firms with some imports in euros) and also to the peso–dollar exchange rate (i.e. firms with some imports in dollars), desired pass–through of the peso–euro exchange rate to the price in pesos is incomplete, and pass–through of the peso–dollar exchange rate is also non–zero. For firms invoicing in euros with non–zero exposure of desired markups to the peso–euro and peso–dollar exchange rates, pass–through of the euro–dollar exchange rate to the price in pesos again incomplete, and pass–through of the peso–dollar exchange rate is again non–zero. The same logic applies to firms invoicing in dollars

[13] Of course, Chilean exports could also be invoiced in other vehicle currencies, but we leave this possibility out of the discussion since it is not observed in the data and given the dominant role of the US dollar in global trade.

[14] Beyond the trade–offs in Amiti et al. [2022], the lack of use of the Chilean peso as an invoice currency could be related to the fact that Chilean pesos are not typically available in foreign exchange markets outside Chile.

[15] To avoid repetition, in the following paragraphs "euros" refers to actual euros (after its introduction) or to euro legacy currencies (prior to its introduction).

(switching the terms dollar and euro accordingly).

When choosing invoice currencies, firms seek to minimize the variance of prices expressed in the chosen currency. Firms prefer to invoice in euros (i.e. local currency pricing) when they have high cost and desired markup exposure to euros, and low cost and desired markup exposure to dollars. Alternatively, firms prefer to invoice in dollars (i.e. dominant currency pricing) when they have high cost and desired markup exposure to dollars, and low cost and desired markup exposure to euros.[16]

Our interpretation of the effect of the introduction of the euro in terms of this theoretical framework is the following. Prior to its introduction, intra-Eurozone exports were invoiced in various legacy currencies.[17] Before the euro was introduced, a price index of competitor's prices in a specific destination (for example Spain) would not be constant in Spanish currency, as some exporters would invoice in francs, marks, etc. and the franc/peseta, mark/peseta, etc. exchange rates would fluctuate. After the introduction of the euro, with most intra–Eurozone imports (and probably a larger share of extra–Eurozone imports) invoiced in euros, the competitor price index in any Eurozone destination would be much more stable in euros than what it was before in euro legacy currencies.[18] Through the markup exposure channel, this would give Chilean exporters a larger incentive to invoice in euros. In addition, if firms increase the use of euros in their imports, this would increase cost exposure to the euro, also providing an incentive to switch to euros the invoicing of their exports.[19]

The introduction of the euro would thus change exchange–rate pass–through by changing the invoice currency of Chilean exports and by changing desired pass–through. Through both channels, it would lead to a larger pass–through of the peso–euro exchange rate and a weaker pass–through of the peso–dollar exchange rate to prices in pesos.

3 Data sources

Our analysis is based on a unique dataset that combines export and import transactions of Chilean firms during the period 1997–2010, with characteristics for a subset of these firms obtained from a census of manufacturing firms. The three essential features of the data are that they include the invoice currency used in every single transaction, that they span the period of the introduction of the euro, and that we can observe a set of firm–level variables including revenue, variable production cost and multinational

[16] Firms prefer to invoice in pesos (producer currency pricing) when they have low cost and desired markup exposure to both euros and dollars.

[17] Evidence in this regard is found in Emerson et al. [1992] (table 7.2) and in Hartmann [1998].

[18] Evidence that intra–Eurozone trade was conducted in euros after its introduction is found in Kamps [2006] and Boz et al. [2022].

[19] One could consider the simultaneous choice of invoice currencies for both exports and imports, but as Amiti et al. [2022] point out, invoicing currencies for imports seem to be less of an active decision for firms.

status.

Data linking firms with the invoice currencies of their international trade transactions are rare, and have not been available in long panels or for the period around the introduction of the euro for any country. In fact, in many countries these data are not collected, are collected through surveys only, or have been collected only very recently.[20] Customs records including invoice currencies have become available for a few countries including the United Kingdom [Chen et al., 2022, Crowley et al., 2020, Corsetti et al., 2022], Belgium [Amiti et al., 2022], Canada [Goldberg and Tille, 2016] and Chile [Cravino, 2017].[21] While data on invoicing currencies obtained from either customs records or surveys have led to important insights, not observing firm characteristics limits the possibilities of testing theories of currency invoicing and exchange rate pass-through. The only existing dataset on invoice currencies combined with firm characteristics we are aware of is that used by Amiti et al. [2022] for Belgium, who combine export and import customs transactions with extra–EU countries and the income statements of all incorporated firms during 2017–2020.

Export and import transactions Our main source of data is the universe of customs export and import transactions records for Chile during the period 1997–2010.[22] For each transaction, we observe the date (at a daily frequency), the identity of the Chilean exporter or importer, the value and quantity traded, the country of origin (for imports) or destination (for exports), HS 8–digit codes describing the product traded, and the invoice currency used.[23]

We focus on Chilean exports to the twelve countries that adopted the euro since its inception: Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, and Spain.[24] This set of twelve countries represents 12 percent of Chilean exports over the 1997–2010 period, fraction which is very stable over time.

[20] For instance, Goldberg and Tille [2008] point out that *"The U.S. Customs Service collects the data on the value of imports and exports, but do not keep any data on the currency in which trade is conducted"*. Evidence on the invoice currency of US trade is available only from the BLS survey on import and export prices, used by Gopinath and Rigobon [2008] and Gopinath et al. [2010]. Similarly, Amiti et al. [2022] indicate that *"The Belgian Customs Office only began to collect these data in a systematic way at the beginning of 2017, which were then processed by the National Bank of Belgium. Because the Customs Office only records extra–EU transactions, the currency data are only available for trade transactions with countries outside of the European Union. All international trade transactions that take place within the European Union are collected by a different authority, the Intrastat Survey, which does not report the currency of invoicing."*

[21] Specifically, Cravino [2017] uses customs exports records with invoice currencies for the the wine sector (2003–2011) and for all sectors (2009–2011).

[22] The data are obtained from the Chilean Customs agency. The export transactions have been used in several papers including Wagner and Zahler [2015] and Morales et al. [2019]. The import transactions data have been used by Blum et al. [2010].

[23] In the baseline sample we exclude copper exports. Copper is Chile's main export commodity and accounts for a large share in value of Chile's exports but a small share of export transactions. For example, in year 2002 copper accounts for 57.0% of exported value and 4.8% of export transactions to the Eurozone.

[24] All these countries except Greece adopted the euro in January 1999. We also include Greece in the sample because it joined the Eurozone in January 2001, before the euro was available in physical format. We exclude several other European countries that adopted the euro later on. We show later that our results are robust to excluding Greece from the sample.

In the subsequent analysis, we aggregate data by exporting firm, HS 8–digit product, country of destination and quarter. We choose quarters because on one hand we want to work at the highest frequency possible and on the other hand the data are too sparse at the monthly level as many firms export sporadically. We compute unit values as the ratio between value and quantity, and refer to these unit values as prices.

The dataset of exports to Eurozone countries contains 208 thousand firm–HS8–destination–time (year–quarter) cells and 7.4 thousand exporting firms over the entire 1997–2010 period. Columns 1 through 4 in Appendix Table A.1 report summary statistics.

Census of Manufactures To obtain further characteristics of these firms, we combine the customs transactions data with the Chilean Census of Manufactures (ENIA, or *Encuesta Nacional Industrial Anual*). We are able to match the customs data to ENIA using firm tax identifiers for the period 1997–2006. The variables we use from ENIA are firm revenue and variable production cost, defined as the sum of the wagebill plus the cost of materials.

In our empirical analysis, we report results considering *all* exporters to the Eurozone, but the ENIA subsample will allow us to tie our analysis more tightly to recent theories of invoicing currency choice. Note that the core results in our analysis, linking exchange rate pass–through to invoice currencies, are based on the full sample. The availability of the variable production cost is particularly useful as it will allow us to construct the ratio between the share of imports invoiced in euros and this cost, which is a key determinant of the invoicing currency choice. In columns 5 through 7 in Appendix Table A.1 we report summary statistics for the Census of Manufactures sample. We see that the Census of Manufactures sample accounts for about half of the exports to the Eurozone in the full sample. While the firms in the Census of Manufactures sample are on average larger compared to the full sample, the table shows that both samples are remarkably similar in terms of the share of exports and imports invoiced in euros and dollars in all years.

Exchange rates and price indexes We complement our dataset with quarterly Chilean peso vs. US dollar and Chilean peso vs. euro exchange rates as well as consumer price level indexes for Chile and each Eurozone member. These variables are obtained from the IMF's International Financial Statistics.[25] Before 2002, the Chilean peso–euro exchange rate is replaced by the exchange rate between the Chilean peso and each of the euro legacy currencies (French franc, German mark, Spanish peseta, Italian lira, etc) using the conversion rates between these legacy currencies upon the introduction of the euro.

[25] Quarterly exchange rates are computed as the average of daily exchange rates.

Other data sources Finally, we use data from Dun and Bradstreet to identify firms that are multinational affiliates with headquarters in Eurozone countries. We also use data from the UN's COMTRADE database to construct product–level measures of intra–Eurozone import shares for each Eurozone country.

4 The swift adoption of the euro as a trade invoicing currency

We start our analysis by documenting patterns and determinants of the adoption of the euro as an invoice currency in Chilean trade with Eurozone countries. The euro was introduced in non-physical form in January 1999 (becoming available for bank transfers, etc.) and in physical form in January 2002. Prior to the introduction of the euro, Chilean exporters had the choice of invoicing their sales in US dollars (the primary vehicle currency of Chilean exports), euro legacy currencies (French francs, German marks, Spanish pesetas, Italian lire, etc.), other vehicle currencies (such as the British pound) or Chilean pesos.

The first finding we document is that euro legacy currencies were rarely used for invoicing exports to Eurozone countries.[26] The Chilean peso was also almost never used, both in exports to the Eurozone or elsewhere.[27] Other vehicle currencies were not popular either.[28] Consequently, prior to 2002 Chilean exports to the Eurozone were invoiced almost exclusively in US dollars. Once the euro was introduced in physical format in January 2002, we see a swift growth in its popularity as a trade invoice currency. Figure 1a plots the share of exported value invoiced in euros or euro legacy currencies between 1997 and 2010 at quarterly frequency. By 2004 this share was 10% and by 2010 it had reached 30%. The share of transactions invoiced in euros grows even faster, implying that euro-invoiced transactions are on average smaller (see Figure 1b). By 2010, more than 40% of transactions were invoiced in euros. We also count the share of Chilean exporting firms with at least one transaction in euros. This share reaches almost 30% by 2005 and almost 40% by 2010, as shown in Figure 1c. This implies that euro-invoicing became popular among many firms, and the large share of trade invoiced in euros is not driven by a few large exporters. Finally, the share of HS8 products with at least one transaction in euros (in Figure 1d) also increases reaching more than 40% by the end of the period. Appendix Figure A.1 shows that the adoption of the euro for export invoicing was common across all the largest Eurozone destinations.

[26] The fact that we rarely see trade invoiced in euro legacy currencies is not a matter of reporting format in customs declarations. First, we do observe *some* invoicing in legacy currencies, and second, euro invoicing after 2002 starts growing continuously from the very low level of trade previously invoiced in legacy currencies.

[27] For example, in year 2002 less than 0.003% of worldwide export transactions and exactly zero export transactions to the Eurozone were invoiced in Chilean pesos.

[28] The share of exports to Eurozone destinations invoiced in currencies other than Eurozone currencies or US dollars was 0.02% during 1997-2001 and 0.69% during 2002-2010 (measured in terms of the fraction of firm–product–destination–time (year–quarter) cells) and 0.0% and 0.01% respectively measured in terms of value.

Further, Appendix Figure A.5 in Section A.2.2 shows that the growth over time in the share of trade invoiced in euros was seen not only in the aggregate but also *within* firm–product–destination cells.

Appendix Figure A.2 illustrates the growth of the euro as an invoicing currency across the largest HS2 sectors among Chilean exports to the Eurozone. It shows that this pattern was common across all industries, even though there are some differences in the extent to which this occurred. In fact, in the largest HS2 sector, beverages (consisting almost entirely of wine), the share of cells invoiced in Eurozone currencies jumped from zero to 20% almost immediately, reaching more than 60% by the end of the decade. We also find (see Appendix Figure A.3) that the growth in exports invoiced in euros was stronger among affiliates of multinationals located in the Eurozone, among importers from the Eurozone, and among larger exporters. Further, we show in the same figure that the overall trend is also seen among firms in our Census of Manufactures subsample, which will be used in part of our empirical analysis.

In Appendix Figure A.4, we show that the euro became even more popular as an invoice currency of Chilean *imports* from Eurozone countries (i.e. Eurozone exports). A key difference with the case of exports is that between 20% and 30% of the value imported and more than 40% of transactions were invoiced in euro legacy currencies prior to 2002. Nevertheless, there is a sudden switching around the introduction of the euro. By 2010, the share of imports invoiced in euros had reached about 45% and the share of transactions, almost 80%. In addition, by the end of the period almost 90% of firms and 90% of products had at least some transactions invoiced in euros.[29]

We now document the product and firm-level determinants of the adoption of the euro in Chilean exports to the Eurozone.[30]

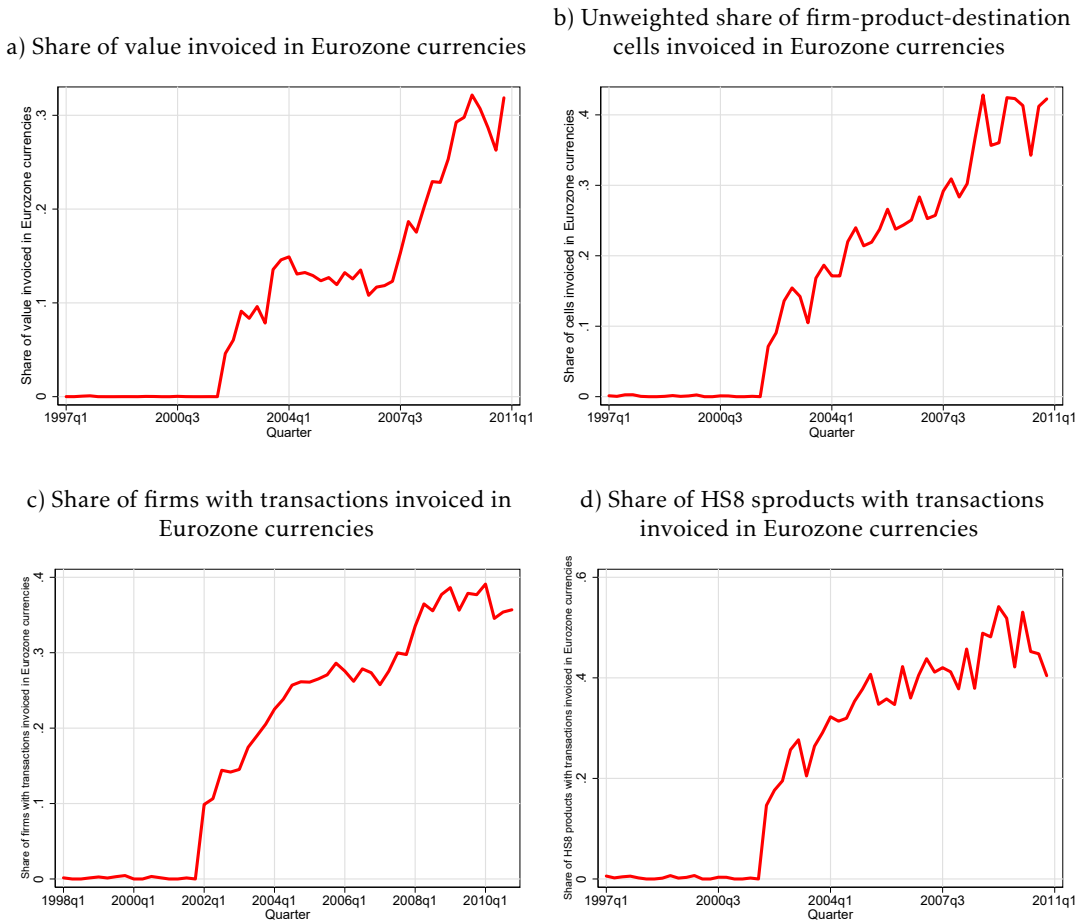
Product-level determinants As theories of trade currency invoicing highlight [Bacchetta and Van Wincoop, 2005, Devereux et al., 2004, Gopinath et al., 2010, Amiti et al., 2022], and following the discussion in Section 2, a firm is more likely to invoice in the destination currency (local currency pricing) if its competitors also do so. In our setting, we can test the role of strategic complementarities by measuring the effect of the market share of Eurozone competitors in each destination and industry.[31] As we argued

[29] A potential explanation for the higher use of euros in Chilean imports (compared to exports) is that as Amiti et al. [2022] argue, invoice currencies are mostly an active choice of the exporting firm. Most of the sales and costs of Chilean exporters are in dollars or pesos (as they sell locally or to non-Eurozone destinations), while most of the sales and costs of Eurozone exporters are most likely in euros (or legacy currencies). Thus, European exporters have a stronger incentive to invoice in Eurozone currencies than Chilean exporters.

[30] In Appendix Table A.2 (in Section A.2.3) we show using a variance decomposition that products and firms are important in accounting for variation in invoice currencies, and that firms are the dominant determinant.

[31] A corollary of the theoretical framework based on Amiti et al. [2022] and discussed in Section 2 is that the larger the market share that an exporting country has in a given industry in the destination market, the higher the probability that exports are invoiced in the producer currency. In our setting, however, the producer currency (the Chilean peso) is essentially never used, and the dollar and euro are the only options in practice.

Figure 1: Share of exports to the Eurozone invoiced in Eurozone currencies



Note: This figure shows the share of Chilean exports to Eurozone countries invoiced in Eurozone currencies (i.e. euros or legacy currencies) by quarter between 1997 and 2010. Panels A and B report the share value and share of firm-HS8-destination cells invoiced in Eurozone currencies respectively. Panels C and D report the share of firms and HS8 products with at least one transaction invoiced in Eurozone currencies respectively.

in Section 2, evidence suggests that after the introduction of the euro, all or most intra–Eurozone trade started being invoiced in euros. This implies that the Eurozone competitors' market share proxies for the degree to which competitors price in euros.[32,33]

We implement this notion by measuring for each HS6 product p, year t and destination country c the share of imports M_{pcst} sourced from other Eurozone countries $s \in EZ$ out of imports from all countries

[32] Amiti et al. [2022] study strategic complementarities in currency choice between Belgian exporters in each destination and sector. Given our setting, we focus instead on competition from within the Eurozone faced by Chilean exporters.

[33] Ideally we would consider domestic sales as well as part of the purchases of a given destination from within the Eurozone, but we do not have product–level data on domestic sales at such a fine level of aggregation.

s:[34]

$$\text{Destination EZ Import Share}_{pct} = \frac{\sum_{s \in EZ} M_{pcst}}{\sum_s M_{pcst}}. \tag{1}$$

Following the literature [Goldberg and Tille, 2008, 2016], another product characteristic that influences the probability of invoicing transactions in euros is product differentiation, given that historically commodities have been usually invoiced in US dollars. To account for this, we include a dummy variable for differentiated products originally constructed by Rauch [1999].[35]

To assess the role of product level determinants, we estimate the following equation on a 2002-2010 sample with the probability of a given transaction being invoiced in euros as the dependent variable.[36] We estimate a linear probability model due to the inclusion of destination and time (year-quarter) fixed effects:

$$\Pr(\text{Euro})_{fpct} = \beta_1 \cdot \text{Destination EZ Import Share}_{pct} + \beta_2 \cdot \text{Differentiated}_p + \gamma_c + \delta_t + \epsilon_{fpct} \tag{2}$$

The results are reported in Table 1.[37] The positive and statistically significant coefficient on the destination's Eurozone import share is very stable across columns.[38] Based on column 3, a one standard deviation increase in this import share is associated to a 7.0 percentage point increase in the probability of invoicing in euros, thus confirming the predictions of existing theories regarding the role of strategic complementarities.[39] In addition, the probability a transaction is invoiced in euros is approximately 5.5 percentage points larger for differentiated products.

Firm-level determinants We now turn to documenting firm-level determinants that explain the probability of invoicing in euros. We present results based on all exporters as well as for a subset of exporters for which we have additional firm characteristics drawn from the Chilean Census of Manufactures.

Amiti et al. [2022] show that differences in export invoice currency choice across firms are determined by the markup elasticity and by cost exposure to exchange rates. As we discussed in Section 2, in any given industry firms with larger markup elasticities are more likely to invoice in euros (i.e. to

[34] Data to create this measure is obtained from COMTRADE. We use HS6 products because this is the most disaggregate measure that is internationally comparable.

[35] Rauch [1999] divides products into those traded in organized exchanges, referenced goods, and differentiated goods. We define a dummy variable equal to one for the differentiated goods category and zero otherwise.

[36] We do not include the period prior to 2002 in our regressions in this section, because the share of exports invoiced in euro legacy currencies prior to the introduction of the euro is almost zero. Specifically, only 32 firm–product–destination–time (year–quarter) cells are invoiced in Eurozone currencies during 1997–2001.

[37] Summary statistics for the variables used in the regressions in this section are provided in Appendix Table A.6.

[38] Note that column 3 replaces the destination and time fixed effects by destination × time fixed effects, with nearly identical results.

[39] These results are related to and consistent with Goldberg and Tille [2016] who studying Canadian imports find that exporting countries with larger market shares are less likely to use the destination country's currency (local currency pricing). They find that this is not in favor of the producer's currency, but of vehicle currencies (US dollars).

Table 1: Probability of invoicing in euros: Product-level determinants.

	(1)	(2)	(3)
Destination EZ Import Share	0.063*	0.070**	0.070**
	(0.026)	(0.025)	(0.025)
Differentiated		0.055*	0.055*
		(0.028)	(0.028)
Destination F.E.	Yes	Yes	No
Time F.E.	Yes	Yes	No
Destination × time F.E.	No	No	Yes
Observations	148883	147616	147616

Notes: This table reports the estimation of equation (2). Each observation is a firm–product (HS8)–destination–time (year–quarter) combination. Standard errors are clustered at the HS6 product level. ** and * indicate statistical significance at the 1% and 5% level.

use local currency pricing). Also, firms with a larger ratio of imports invoiced in euros to cost should be more likely to invoice in euros, while firms with a larger ratio of imports invoiced in dollars to cost should prefer dollars. Amiti et al. [2022] provide evidence in favor of both mechanisms studying Belgian exports to extra-EU destinations during 2017-2020.

Following Amiti et al. [2022] we use firm size to proxy for markup elasticity.[40] We measure firm size using firms' world exports or revenue (the latter only in the manufacturing subsample). We are able to measure cost exposure for firms in the manufacturing subsample. We define variable cost as the sum of labor cost and materials. We then compute ratios of imports in euros and imports in dollars to variable cost.[41,42] As we discussed in Section 3, we are able to match the customs and manufacturing census data up to 2006. We compute time–invariant firm–level averages of each of these measures (revenue, imports in euros to cost and imports in dollars to cost ratios) using data for 2002 to 2006. We report results both for the 2002–2006 period as well as for the full 2002–2010 period.[43]

In addition to these mechanisms, we consider the share of a firm's exports sold to the Eurozone. We speculate that exporters have incentives to reduce the number of currencies used if there is a fixed cost per currency used.[44] If the Eurozone represents a small share of an exporter's overall export sales, it

[40] Amiti et al. [2019] argue that markup elasticities are increasing in firm size in a wide class of models.

[41] Note that this is based on imports from the entire world, not just the Eurozone. However, imports invoiced in euros come almost entirely from the Eurozone.

[42] Since the manufacturing census data are annual, we use annual imports to construct this measure, and then assign it to each quarterly observation in our sample.

[43] Results for the entire 2002–2010 period use the 2002-2006 measures of revenue and imports to cost ratios and thus rely on the assumption that these variables would not have changed after 2006 in a way that would bias our results. In any case, we find very similar results than those seen for 2002–2006.

[44] This is consistent with Amiti et al. [2022]'s extension to their baseline model, in which they add a fixed cost that can

might not be willing to use a separate currency for it, and it might choose to use the currency preferred for its larger markets (presumably the dollar). We also add a dummy variable for firms that are affiliates of Eurozone multinationals. We hypothesize that multinational firms might make decisions globally and prefer to invoice in headquarter currencies.

To assess the role of each of these determinants, we estimate the following linear probability model, with the dependent variable equal to the probability of invoicing in euros. The term X_f represents the firm–level determinants discussed above, and we include product (HS8) × destination × time (year-quarter) fixed effects.

$$\Pr(\text{Euro})_{fpct} = \beta_1 \cdot X_f + \gamma_{pct} + \epsilon_{fpct} \tag{3}$$

The results in columns 1 through 4 in Table 2 are based on the Census of Manufactures subsample, with which we can capture the markup and marginal cost channels precisely. Columns 1 and 2 include firm size (based on revenue) and the firm's Eurozone export share, while columns 3 and 4 add the ratios of imports invoiced in euros or dollars to cost. We find support for both the markup channel and the marginal cost channels of Amiti et al. [2022], as larger firms and firms with a higher ratio of imports invoiced in euros over cost are more likely to invoice in euros. In contrast, firms with a higher ratio of imports invoiced in dollars over cost have a higher probability of invoicing exports in dollars, although the coefficients are not statistically significant at conventional levels. The results are similar when considering the 2002–2006 period (in columns 1 and 3) as well as when we extend it to 2002–2010 (in columns 2 and 4). Based on column 3, a one standard deviation increase in firm revenue is associated to an 8.3 percentage point higher probability of invoicing in euros. The coefficients also indicate that a one standard deviation increase in imports in euros over cost is associated to a 14.9 p.p. higher probability of invoicing in euros.[45] We also observe that that firms with a larger fraction of exports sold in the Eurozone are more likely to invoice in euros, which, as we discussed earlier, is consistent with a fixed cost per currency. A one standard deviation increase in this share is implies a 5.1 percentage point higher probability of invoicing in euros.

In columns 5 and 6 we consider the full sample and analyze the effect of firm size (measured in terms of total (world) exports) and the share of exports to the Eurozone. We find a similar pattern relative to the previous columns. However, in this case we are not able to capture the marginal cost channel given that we don't observe cost and that only a fraction of exporters are importers. Again, the results are similar in the 2002–2006 (column 5) and 2002–2010 (column 6) samples. In addition, we add a dummy

be per–currency. Amiti et al. [2022] also provide empirical evidence in favor of this mechanism. This is also consistent with Crowley et al. [2020]'s currency management fixed cost.

[45] A one standard deviation increase in imports in dollars over cost is associated to a 11.0 p.p. lower probability of invoicing in euros, although this coefficient is not statistically significant.

variable equal to one for firms which are affiliates of Eurozone multinationals.[46] We find that these affiliates are substantially (i.e. 22.8 p.p. based on column 5) more likely to adopt the euro.[47]

Our data and setting allow us to test the existing theory further. A prediction of Amiti et al. [2022]'s model is that larger firms (i.e. firms with a higher markup elasticity) are more likely to invoice in euros (i.e. choose local currency pricing) in response to an increase in the share of competitors invoicing in euros.[48] We test this prediction by interacting our measure of each destination's share of imports sourced from the Eurozone with firm size. This is the measure introduced earlier in equation (1), which is based on the assumption that intra–Eurozone trade is invoiced in euros. We estimate the following regression using the Census of Manufactures subsample, such that we can control for cost exposure:

$$\Pr(\text{Euro})_{fpct} = \beta_1 \cdot \text{Size}_f + \beta_2 \cdot \text{Size}_f \cdot \text{Dest. EZ Imp. Share}_{pct} + \beta_3 \cdot \left(\frac{\text{Imp. Euro}}{\text{Cost}}\right)_f + \beta_4 \cdot \left(\frac{\text{Imp. USD}}{\text{Cost}}\right)_f + \gamma_{pct} + \epsilon_{fpct} \tag{4}$$

The results are shown in Table 3. Columns 1 and 2 measure firm size using total world exports, while columns 3 and 4 use firm revenue. We report results both for 2002–2006 and 2002–2010. We see that, consistent with the theory, the positive and statistically significant coefficient in the interaction term in all columns implies that larger firms are more responsive to a higher share of intra–Eurozone competition. This evidence provides support for a key mechanism in Amiti et al. [2022]. Note that the empirical setting in Amiti et al. [2022] does not allow them to test this specific implication of their model.

In Appendix Section A.2.4 we provide robustness checks showing that the results in Tables 1 through 3 are robust to excluding the small share of observations (less than 0.6%) invoiced in currencies other than the euro or dollar. In all cases, the results are very close to our baseline results.

Summing up, we have found that immediately after its introduction, strategic complementarities and cost exposure explain the adoption of the euro by exporters to the Eurozone. In addition, firms' share of exports to the Eurozone, as well as multinational linkages, also played a role.

5 The effect of the euro on exchange rate pass–through

We have established that the introduction of the euro led to a substantial number of firms quickly switching the invoice currencies used in their exports to the Eurozone from dollars to euros. We now

[46] We did not include the multinational affiliate dummy in the Census of Manufactures subsample given that the number of such firms in that sample is very small.

[47] Amiti et al. [2022] find that in Belgian exports, firms with inward or outward FDI are more likely to use local or dominant currency pricing relative to producer currency pricing. Goldberg and Tille [2016] also find a role for foreign ownership in Canadian imports.

[48] See lemma 3 in Amiti et al. [2022], in which the markup elasticity multiplies the derivative of the competitor's price index expressed in local currency to the local currency / producer currency exchange rate.

Table 2: Probability of invoicing in euros: Firm-level determinants

	(1)	(2)	(3)	(4)	(5)	(6)
	Census of Manufactures Subsample				Full Sample	
	2002-2006	2002-2010	2002-2006	2002-2010	2002-2006	2002-2010
log Revenue	0.111**	0.110**	0.083*	0.084**		
	(0.022)	(0.015)	(0.036)	(0.026)		
EZ Export Share	0.081**	0.069**	0.051**	0.046**	0.049**	0.058**
	(0.020)	(0.010)	(0.014)	(0.013)	(0.012)	(0.011)
Euro-Invoiced Imports / Cost			0.149**	0.110**		
			(0.031)	(0.021)		
Dollar -Invoiced Imports / Cost			-0.110	-0.068		
			(0.082)	(0.053)		
EZ Multinational Affiliate					0.228**	0.167**
					(0.040)	(0.031)
log Total (World) Exports					0.060	0.078*
					(0.028)	(0.026)
Prod. (HS8) × Dest. × Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11321	20044	11321	20044	60248	119129

Notes: This table reports the estimation of equation (3). Each observation is a firm-product (HS8)-destination-time (year–quarter) combination. Columns 1 through 4 refer to the Census of Manufactures subsample. Columns 5 and 6 refer to the full sample. All continuous variables are standardized to have mean zero and standard deviation one. Standard errors are clustered by firm, product (HS6), destination and time (year–quarter) using multiway clustering. ** and * indicate statistical significance at the 1% and 5% level.

move on to the core of our analysis, and show that this led to a large change in the pass–through of the peso–euro and peso–dollar exchange rates to export prices.

The literature documents how exchange rate pass–through depends on the invoice currency used [Gopinath et al., 2010, Amiti et al., 2022]. This result in the literature is based on environments in which invoice currencies are very persistent within each firm [Amiti et al., 2022], so the difference in pass–through is based on a comparison across firms. However, the literature has also established that *both* the choice of invoice currencies and the desired pass–through of exchange rates to prices are functions of firm characteristics. Thus, we argue that an ideal setting to study the relationship between invoice currencies and exchange rate pass–through is one in which we can observe how changes in invoicing decisions induced by an exogenous, large-scale policy change, lead to changes in pass–through. This is exactly the environment that we study. We emphasize again that a key advantage of our setting is that while nearly all exporters invoiced in dollars prior to the introduction of the euro, a substantial fraction of them switched to euros after 2002, while others kept using the dollar. In addition, while the introduction of the euro led to changes in the invoice currency choice, it did not significantly affect the Chilean economy.

Table 3: Probability of invoicing in euros: Interaction between destination intra–Eurozone import share and firm size

	(1) 2002-2006	(2) 2002-2010	(3) 2002-2006	(4) 2002-2010
Destination EZ Import Share × log Total (World) Exports	0.031*	0.024**		
	(0.011)	(0.007)		
Destination EZ Import Share × log Revenue			0.025*	0.020*
			(0.010)	(0.007)
log Total (World) Exports	0.116*	0.113**		
	(0.040)	(0.034)		
log Revenue			0.066	0.073*
			(0.035)	(0.032)
Euro-Invoiced Imports / Cost	0.153**	0.116**	0.163**	0.122**
	(0.034)	(0.020)	(0.032)	(0.019)
Dollar-Invoiced Imports / Cost	-0.125	-0.089	-0.119	-0.086
	(0.088)	(0.057)	(0.084)	(0.056)
Prod. (HS8) × Dest. × Time F.E.	Yes	Yes	Yes	Yes
Observations	11401	19587	11181	19211

Notes: This table reports the estimation of equation (4). Each observation is a firm-product (HS8)-destination-time (year–quarter) combination. The sample is restricted to the Census of Manufactures subsample in all columns. All continuous variables are standardized to have mean zero and standard deviation one. Standard errors are clustered by firm, product (HS6), destination and time (year–quarter) using multiway clustering. ** and * indicate statistical significance at the 1% and 5% level.

We estimate standard pass–through regressions as shown in equation (5) in which each observation corresponds to a firm (f)–product (HS8) (p)–destination (c)–time (year–quarter) (t) combination and the sample consists of Chilean exports to the twelve Eurozone countries which adopted the euro since its inception and spans the fourteen-year period 1997–2010. Our regressions follow the literature closely. The dependent variable is the log change in the price (expressed in Chilean pesos) between periods $t-1$ and t.[49] We include firm–product (HS8)–destination fixed effects. The regressors of interest are the log change in the peso–euro and peso–dollar nominal exchange rates. These are defined such that an increase in these variables implies a depreciation of the peso. Recall that in the case of the euro, prior to 2002 we use the exchange rate between the peso and the euro legacy currencies (francs, marks, pesetas, etc.).[50] We are not able to include time (year–quarter) fixed effects, given that the coefficients on the exchange rates are identified based on variation over time. We do include dummies for quarters to account for seasonality (not shown in eq. 5). In addition, in some results we include year fixed effects,

[49] Following the literature, in our baseline results we exclude extreme price changes, which can be due to mismeasurement or the fact that there can be different products within each HS8 product code. We drop observations with quarter–to–quarter price ratios above 3 or below 1/3, which represent 2.5% of our observations. However, we also show that our key results are robust to using all observations.

[50] For that reason, the peso–euro exchange rate has a subscript ct, even though after 2002 it does not vary by destination.

such that the identification is based on variation *across* quarters *within* years. We also control for log changes in the consumer price index in the exporting country (Chile) and each destination country. Finally, we cluster standard errors by time period (year–quarter). Note that, like Gopinath et al. [2020], we estimate this regression at quarterly frequency taking advantage of the disaggregated nature of our data.

$$\Delta p_{fpct} = \gamma_{fpc} + \beta_1 \Delta e_t^{USD} + \beta_2 \Delta e_{ct}^{EURO} + \epsilon_{fpct} \tag{5}$$

The results are shown in Table 4.[51] In column 1 we include only the peso-dollar exchange rate, and find a pass–through coefficient close to one (0.807). In column 2 we instead include only the peso–euro exchange rate, and again find a high pass–through coefficient (0.709). When we include both exchange rates simultaneously (see column 3), we find a higher pass–through coefficient for the peso–dollar exchange rate (0.615) than for the peso–euro exchange rate (0.313). Finding that *both* exchange rates have a contemporaneous pass–through to prices is consistent with the fact that in our sample part of the transactions are invoiced in dollars and part in euros. Given the fact that the introduction of the euro could have induced general equilibrium effects, we show in columns 4, 5 and 6 that our results are very similar when we add year fixed effects to our baseline equation. This implies that the identification is solely based on variation across quarters but *within* years, and differences in the macroeconomic environment pre and post 2002 are absorbed by the year fixed effects.

Table 4: Exchange rate pass–through

	(1)	(2)	(3)	(4)	(5)	(6)
Δe^{USD}	0.807**		0.615**	0.766**		0.593**
	(0.083)		(0.057)	(0.078)		(0.068)
Δe^{EUR}		0.709**	0.313**		0.805**	0.383**
		(0.087)	(0.052)		(0.127)	(0.084)
Firm × Product × Dest. F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	No	No	No	Yes	Yes	Yes
Quarter F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	79323	79323	79323	79323	79323	79323

Notes: This table reports the estimation of equation (5). All columns control for changes in exporting and importing country price levels. Standard errors are clustered by time (year–quarter). ** and * indicate statistical significance at the 1% and 5% level.

As we documented earlier, prior to 2002 Chilean exports to Eurozone countries are almost entirely invoiced in dollars. Our next step is allowing for different pass–through coefficients for the pre–2002

[51] Summary statistics for the variables used in the regressions in this section are provided in Appendix Table A.7.

and post–2002 periods. We augment equation (5) and estimate the following equation in which we interact the exchange rates with a dummy variable equal to zero during 1997–2001 and equal to one during 2002–2010. Once again we sometimes include year fixed effects (such that the estimation is based on variation across quarters within years). The control variables and estimation details are otherwise the same as above.

$$\Delta p_{fpct} = \gamma_{fpc} + \beta_1 \Delta e_t^{USD} + \beta_2 \Delta e_t^{USD} \times \text{Post2002}_t + \beta_3 \Delta e_{ct}^{EURO} + \beta_4 \Delta e_{ct}^{EURO} \times \text{Post2002}_t + \epsilon_{fpct} \quad (6)$$

As we report in the first two columns in Table 5, we indeed find a substantial change in the pass–through coefficients between the 1997–2001 and 2002–2010 periods.[52] The pass–through coefficient for the peso-dollar exchange rate is very close to one (1.068, based on column 2) for the pre–2002 period and significantly lower (0.543 = 1.068 - 0.525) for the post–2002 period. The coefficient for the peso–euro exchange rate, on the other hand, is zero pre–2002 (-0.014) and 0.489 (=-0.014 + 0.503) after the introduction of the euro. This matches the theory [Gopinath et al., 2010, Amiti et al., 2022] closely. Pass–through of the peso–dollar exchange rate is nearly complete and pass–through of the peso–euro exchange rate is zero when trade is invoiced almost entirely in dollars. After the introduction of the euro, with trade invoiced partly in dollars and partly in euros, both exchange rates have a more symmetric impact on prices.[53]

Given that our data include the invoice currency used in each firm–product–destination–time (year–quarter) cell, we can now go one step further and allow the pass–through coefficients to differ based on the invoice currency used. As a first step, columns 3 through 6 in Table 5 go back to equation (5) splitting the sample between cells invoiced in dollars and cells invoiced in euros (or euro legacy currencies). In dollar-invoiced transactions (columns 3 and 4), the pass–through coefficient for the peso–dollar exchange rate is close to one (0.940 in column 4), while the pass–through for the peso–euro exchange rate is close to zero (0.114) and not statistically significant. In stark contrast, for transactions invoiced in euros (columns 5 and 6), the coefficient for the peso–dollar exchange rate is very low and not statistically significant (0.085 in column 6) while the pass–through for the peso–euro exchange rate is now close to one (1.019). Next, we also estimate a single regression allowing for different pass–through

[52] The only difference between columns 1 and 2 is that column 2 includes year fixed effects and column 1 does not. We find very similar coefficients in both cases.

[53] Note that between 2002 and 2010, 27.7% of firm–product–destination–time (year–quarter) cells are invoiced in euros.

coefficients based on invoice currency:

$$\Delta p_{fpct} = \gamma_{fpc} + \beta_1 \Delta e_t^{USD} \times \text{USD}_{fpct} + \beta_2 \Delta e_t^{USD} \times \text{EUR}_{fpct} + \beta_3 \Delta e_{ct}^{EUR} \times \text{USD}_{fpct} + \beta_4 \Delta e_{ct}^{EUR} \times \text{EUR}_{fpct} + \epsilon_{fpct} \tag{7}$$

The dummy variables USD_{fpct} and EURO_{fpct} are equal to one for cells invoiced in dollars and euros (or euro legacy currencies) respectively, and zero otherwise. The results are shown in columns 7 and 8 in Table 5.[54] Both columns produce very similar estimates to the split sample approach used in columns 3 through 6. In other words, in line with the recent theoretical developments, the pass–through estimates for dollar-invoiced and euro-invoiced transactions are polar opposites. Based on column 8, the coefficient on the peso–dollar exchange rate is 0.953 (and statistically significant) for transactions invoiced in dollars and 0.117 (and not statistically significant) for transactions in euros. In the same way, the coefficient on the peso–euro exchange rate is 0.116 (and not statistically significant) for transactions invoiced in dollars and 0.914 (and statistically significant) for transactions in euros.

We can go even further and allow for different pass–through coefficients based on invoice currencies *and* the pre/post periods. We thus extend equation (7) by including a triple interaction term. It is important to note that because the number of observations invoiced in euro legacy currencies prior to 2002 was almost zero, we are not able to estimate a pass–through coefficient for transactions invoiced in Eurozone currencies in the "pre" period.[55] We *are* able to allow the effect of the peso–dollar exchange rate to differ between both periods, as shown in the following equation:

$$\Delta p_{fpct} = \gamma_{fpc} + \beta_1 \Delta e_t^{USD} \times \text{USD}_{fpct} + \beta_2 \Delta e_t^{USD} \times \text{USD}_{fpct} \times \text{Post2002}_t + \beta_3 \Delta e_t^{USD} \times \text{EUR}_{fpct} + \beta_4 \Delta e_{ct}^{EUR} \times \text{USD}_{fpct} + \beta_5 \Delta e_t^{EUR} \times \text{USD}_{fpct} \times \text{Post2002}_t + \beta_6 \Delta e_{ct}^{EUR} \times \text{EUR}_{fpct} + \epsilon_{fpct} \tag{8}$$

Table 6 shows the results, which constitute our strongest evidence on the impact invoice currencies have on exchange rate pass–through. For transactions invoiced in dollars, the pass–through of the peso–dollar exchange rate is close to one both before and after 2002, while the pass–through of the peso–euro exchange rate is close to zero in both periods. For transactions invoiced in euros (which only occur after 2002), the pass–through of the peso–dollar exchange rate is close to zero, while the pass–through of

[54] The only difference between the two columns is that column 8 includes year fixed effects (so estimates are based on variation across quarters within years) while column 7 does not.

[55] During the pre–2002 period, only 32 firm–product–destination–time (year–quarter) cells are invoiced in Eurozone currencies, 19 of which are in the regression sample (i.e. have non–missing quarter–to–quarter price changes). Given that these are far too few observations to be able to estimate a pass–through coefficient for transactions invoiced in Eurozone currencies in the "pre" period, we now drop these observations from the sample. We obtain nearly identical results if these observations remain in our sample.

Table 5: Exchange rate pass–through and invoice currencies

	(1) All	(2) All	(3) Invoiced in USD	(4) Invoiced in USD	(5) Invoiced in Euro	(6) Invoiced in Euro	(7) All	(8) All
Δe^{USD}	0.846**	1.068**	0.941**	0.940**	0.125	0.085		
	(0.293)	(0.232)	(0.041)	(0.048)	(0.080)	(0.091)		
Δe^{EUR}	0.043	-0.014	0.071	0.114	0.864**	1.019**		
	(0.068)	(0.082)	(0.039)	(0.065)	(0.098)	(0.118)		
Post2002 × Δe^{USD}	-0.267	-0.525*						
	(0.294)	(0.236)						
Post2002 × Δe^{EUR}	0.328**	0.503**						
	(0.088)	(0.126)						
USD × Δe^{USD}							0.947**	0.953**
							(0.046)	(0.062)
EURO × Δe^{USD}							0.146	0.117
							(0.073)	(0.077)
USD × Δe^{EUR}							0.066	0.116
							(0.044)	(0.069)
EURO × Δe^{EUR}							0.828**	0.914**
							(0.104)	(0.112)
Firm × Prod. × Dest. F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	No	Yes	No	Yes	No	Yes	No	Yes
Quarter F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	79323	79323	53821	53821	19999	19997	74938	74938

Notes: Columns 1 and 2 report the results of the estimation of equation (6). Columns 3 through 6 correspond to equation (5), splitting the sample into cells invoiced in USD (cols. 3 and 4) or in euros (cols. 5 and 6). Columns 7 and 8 correspond to equation (7). All columns control for changes in exporting and importing country price levels. Standard errors are clustered by time (year–quarter). ** and * indicate statistical significance at the 1% and 5% level.

the peso–euro exchange rate is close to one (0.934 based on column 2). The results are very similar in columns 1 and 2 (which adds year fixed effects, such that the identification is based on variation across quarters within years).

As we argued in our theoretical discussion in Section 2, short–run pass–through depends both on the invoice currency and on desired pass–through. We have shown that the peso–euro exchange rate coefficient is statistically significant and close to one *only* for transactions invoiced in euros, which implies it is likely that these results are driven by invoice currencies, and not by changes in *desired* (i.e. flexible–price) pass–through. However, it might be the case that desired pass–through changed *differently* for firms switching to euros than for firms that kept using the dollar after 2002. We now show that changes in desired pass–through are not driving the observed differences in pass–through. We do so in three different ways. First, we replace the year fixed effects by firm × year fixed effects. These absorb any differential change in desired pass–through across firms between pre and post 2002.[56]

[56] Even further, these firm–year fixed effects absorb any differential change in pass–through across firms between different

These results are shown in column 3 in Table 6 and the coefficients are similar to those reported earlier. Our second approach is to focus on industries with more sticky prices. As the theoretical discussion indicates, pass–through for these goods would be driven more by invoice currencies and less by desired pass-through. We merge to our data Nakamura and Steinsson [2008]'s measure of the frequency of price changes in different industries.[57] Among products with non–missing measures of price change frequencies, we restrict the sample to those with below median frequencies (i.e. those with more sticky prices). These results are shown in columns 4 and 5, and again convey the same message than our baseline results. Last, firms that import in euros would be more likely to see changes in desired pass-through. If firms that switch to euros and firms that remain using the dollar differ in terms of their imports in euros, this could lead to a differential change in desired pass–through. For this reason, our third approach consists of limiting the sample to firms with zero imports from Eurozone countries.[58] These results are shown in columns 6 and 7, and once again, are very similar to the baseline results.

Finally, Table 7 presents a set of robustness checks to these core results. First, we exclude the 2008–2009 global financial crisis, restricting our sample to 1997–2007. Column 1 shows the results are very similar to the baseline estimates. Second, recall that the euro was introduced in physical format in 2002, but in non–physical format (for bank transfers, etc.) in 1999. Our baseline results took 2002 as the relevant pre/post cutoff, because that is when firms start adopting the euro as an invoice currency, while we don't observe a change in 1999. However, column 2 shows that our results are robust to excluding the period 1999–2001 from the regressions (thus leaving 1997–1998 and 2002–2010 in the sample). Third, we find very similar results when we exclude Greece, which adopted the euro in non–physical format in 2001 instead of 1999 (see column 3). Fourth, it could be that multinational firms' international prices are less responsive to market forces. We show in column 4, however, that our results are robust to excluding multinational affiliates of Eurozone corporations. We also check that our results are robust to including country × year and product × year fixed effects (see column 5). These absorb any country–specific or product–specific shock at annual frequencies. In this case, the identification of the pass–through coefficients uses variation across quarters within years.[59] We also explore alternative types of clustering. Specifically, column 6 shows the results are robust to clustering by firm, HS6 product, destination, and time (year–quarter) using multiway clustering. Last, while our baseline results drop observations with extreme price changes (in line with the literature), column 7 shows our results are robust to including all observations.

years.

[57] We obtain these data from Fajgelbaum et al. [2020], who have created a measure for NAICS 4–digit industries. We then use a concordance provided by the Census Bureau to translate it to HS6 codes.

[58] We find similar results if instead we analyze firms with zero imports invoiced in euros.

[59] Note that we cannot include country × time (year–quarter) or product × time (year–quarter) fixed effects as they would absorb all the variation used to identify the pass–through coefficients.

Table 6: Exchange rate pass–through and invoice currencies

	(1) All	(2) All	(3) All	(4) Sticky Prices	(5) Sticky Prices	(6) Non Importers	(7) Non Importers
USD × Δe^{USD}	0.772*	1.052**	0.872**	0.909**	0.803*	0.932**	0.794**
	(0.300)	(0.231)	(0.258)	(0.320)	(0.373)	(0.235)	(0.239)
USD × Post2002 × Δe^{USD}	0.173	-0.125	0.063	0.099	0.143	-0.004	0.135
	(0.302)	(0.238)	(0.266)	(0.328)	(0.379)	(0.245)	(0.252)
EURO × Δe^{USD}	0.144	0.110	0.069	0.043	0.035	0.122	0.081
	(0.074)	(0.078)	(0.079)	(0.079)	(0.087)	(0.078)	(0.084)
USD × Δe^{EUR}	0.037	-0.028	-0.039	-0.029	-0.054	-0.087	-0.100
	(0.073)	(0.082)	(0.102)	(0.130)	(0.132)	(0.089)	(0.109)
USD × Post2002 × Δe^{EUR}	0.035	0.195	0.210	0.088	0.179	0.249	0.295
	(0.092)	(0.125)	(0.149)	(0.163)	(0.180)	(0.131)	(0.150)
EURO × Δe^{EUR}	0.830**	0.934**	0.914**	1.015**	0.965**	0.900**	0.841**
	(0.104)	(0.114)	(0.137)	(0.120)	(0.153)	(0.118)	(0.145)
Firm × Prod. × Dest. F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	No	Yes	No	Yes	No	Yes	No
Firm × Year F.E.	No	No	Yes	No	Yes	No	Yes
Quarter F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	74917	74917	72797	39922	38806	65709	63538

Notes: This table reports the results of the estimation of equation (8). The sticky prices sample in columns 4 and 5 refers to observations with a below–median frequency of price change according to Nakamura and Steinsson [2008]'s measure. The non–importers sample in columns 6 and 7 refers to observations corresponding to exporting firms that do not import from Eurozone countries in the year associated to the observation. All columns control for changes in exporting and importing country price levels. Standard errors are clustered by time (year–quarter). ** and * indicate statistical significance at the 1% and 5% level.

Summing up, our findings indicate that invoice currencies have a drastic impact on short–run exchange rate pass–through, such that there is complete pass-through to export prices in pesos of the peso–dollar exchange rate for transactions invoiced in dollars, and complete pass-through of the peso–euro exchange rate for transactions invoiced in euros. Given our empirical setting, we believe our results can be interpreted as a causal effect of invoice currencies on pass–through, and are not driven by other confounders, such as changes in desired pass–through. We believe the evidence derived from this unique natural experiment validates the most recent theoretical framework [Amiti et al., 2022] and the literature on which it builds. In addition, it shows that large and fast changes in invoice currencies are possible, and that they come with equally large changes in exchange rate pass–through.

Table 7: Exchange rate pass–through and invoice currencies: Robustness checks

	(1) Up to 2007	(2) Exclude 1999–2001	(3) Exclude Greece	(4) Exclude MNs	(5) Alternative Fixed Effects	(6) Alternative Clustering	(7) Incl. Extreme Price Changes
USD × Δe^{USD}	1.154**	1.109**	1.069**	1.073**	0.961**	1.052*	1.010**
	(0.244)	(0.240)	(0.247)	(0.227)	(0.240)	(0.385)	(0.349)
USD × Post2002 × Δe^{USD}	-0.106	-0.185	-0.136	-0.141	-0.042	-0.125	-0.208
	(0.275)	(0.251)	(0.254)	(0.234)	(0.248)	(0.426)	(0.388)
EURO × Δe^{USD}	0.005	0.109	0.110	0.114	0.080	0.110	0.135
	(0.158)	(0.078)	(0.075)	(0.077)	(0.074)	(0.073)	(0.126)
USD × Δe^{EUR}	-0.036	-0.110	-0.035	-0.014	-0.036	-0.028	-0.017
	(0.091)	(0.138)	(0.089)	(0.081)	(0.097)	(0.066)	(0.132)
USD × Post2002 × Δe^{EUR}	0.149	0.283	0.199	0.180	0.200	0.195	0.356
	(0.145)	(0.165)	(0.130)	(0.123)	(0.139)	(0.095)	(0.374)
EURO × Δe^{EUR}	0.974**	0.933**	0.930**	0.933**	0.943**	0.934**	0.964**
	(0.155)	(0.114)	(0.106)	(0.114)	(0.123)	(0.091)	(0.219)
Firm × Prod. × Dest. F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year F.E.	Yes	Yes	Yes	Yes	No	Yes	Yes
Country × Year F.E.	No	No	No	No	Yes	No	No
Product (HS8) × Year F.E.	No	No	No	No	Yes	No	No
Quarter F.E.	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	51578	65209	72783	74540	73679	74917	76437

Notes: This table reports the results of the estimation of equation (8). All columns control for changes in exporting and importing country price levels. Standard errors are clustered by time (year–quarter), except in column 6 in which they are clustered by time (year–quarter), firm, product (HS6) and country using multiway clustering. ** and * indicate statistical significance at the 1% and 5% level.

6 Conclusions

We have used the introduction of the euro as a unique natural experiment to test the theory of trade currency invoicing and exchange rate pass-through. We have done so by using novel transaction-level data including the invoice currencies of the universe of export and import transactions of a small open economy – Chile – trading with the Eurozone over the period 1997-2010.

We first document that while euro legacy currencies were almost never used to invoice exports to the Eurozone, starting in 2002 a substantial fraction of exporters swiftly switched to invoicing in euros, at the expense of the US dollar. While the literature has found invoice currencies to be a very persistent firm-level choice, we find that a large policy shock can indeed generate fast and large adjustments by exporting firms in this regard, in line with the conjecture of Amiti et al. [2022].

In this unique context, we start by studying the determinants behind firms' choice to switch to invoicing in euros. We first establish an important role for strategic complementarities: switching to euros was more likely for firms in industries facing more competition from within the Eurozone, and for

larger firms. In addition, we find support for a cost channel, such that firms with a higher share of cost in euros were more likely to adopt the euro as their invoice currency. Third, we also see more switching to euros among firms for which the Eurozone represented a larger share of its total exports (suggesting a per–currency fixed cost) and affiliates of Eurozone multinationals (suggesting that multinational firms might make decisions globally and prefer to invoice in headquarter currencies).

The core of our analysis shows that this large change in invoice currencies matters: we document a substantial change in exchange rate pass-through once the euro was introduced. Prior to 2002, the pass-through of the peso–dollar exchange rate to prices is close to one, while the coefficient corresponding to the peso–euro exchange rate is close to zero. After 2002, prices respond to both exchange rates similarly. In addition, we see that the pass-through of the peso-dollar exchange rate to prices is close to one for transactions invoiced in dollars, and close to zero for transactions invoiced in euros, while the opposite is true for the peso–euro exchange rate.

Our strongest evidence of the effect of the introduction of the euro on exchange rate pass-through comes from comparing pass–through coefficients based on the invoice currency used and the pre and post periods. For transactions invoiced in dollars the pass–through of the peso–dollar exchange rate is close to one in both periods, while the pass–through of the peso–euro exchange rate is near zero in both periods. For transactions invoiced in euros, in contrast, the peso–dollar exchange rate pass–through is close to zero, while the peso–euro exchange rate pass–through is close to one.

Looking at an event of the past, our findings carry important implications for the future. Our evidence suggests that future policy changes implemented by large economies can lead to fast and substantial changes in invoice currencies, and consequently on the transmission of exchange rate shocks.

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A Appendix

A.1 Appendix to Section 3: Data

Table A.1: Descriptive Statistics

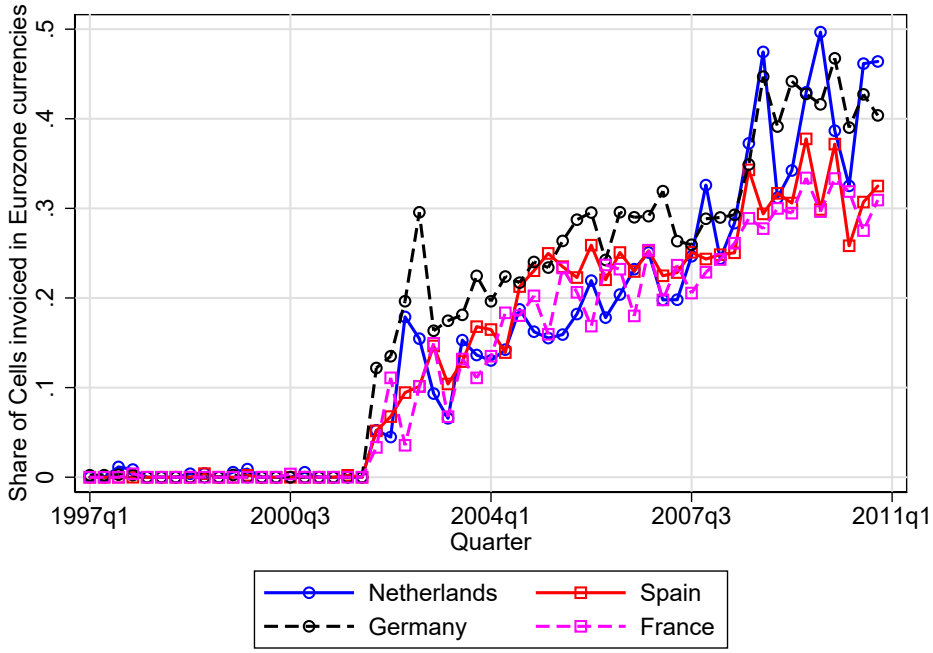
	Full sample				Census of Manufactures Subsample		
	1997	2002	2006	2010	2002	2006	2010
Total exports to EZ (million USD)	1222	1254.3	2707.7	2719.7	597.3	1346.7	1150.9
Number of firms	1235	1545	1818	1800	274	254	189
Mean number of products exported to EZ	2.6	3.9	3.7	3.7	3.9	4.3	4.3
Mean number of EZ destinations	1.8	1.8	2	2.1	2.3	2.6	2.7
Mean export value to EZ	989.4	811.8	1489.4	1511	2179.9	5302.1	6089.5
Median export value to EZ	65.5	47.2	66.2	93.8	132.3	184.9	337.9
Mean share of EZ exports	0.477	0.488	0.491	0.436	0.274	0.287	0.264
Mean share of EZ exports invoiced in Eurozone currencies	0.002	0.079	0.2	0.275	0.115	0.237	0.337
Number of importers	427	505	562	510	139	145	118
Number of importers from EZ	306	361	367	356	123	125	103
Mean import value from world among importers from world	8619.4	8061.8	6208.2	7753	9405.6	11257.1	9294
Median import value from world among importers from world	224.7	173.1	127.8	201.7	1192.7	1512.5	1480.9
Mean import value from EZ among importers from EZ	1703.6	1982.5	2019.8	2232.3	1892.6	1945.5	2570
Median import value from EZ among importers from EZ	163.7	157.9	154.5	177.3	453.9	518.1	496.3
Mean share of imports invoiced in Eurozone currencies among importers from world	0.172	0.217	0.218	0.241	0.217	0.226	0.208
Mean share of imports invoiced in dollars among importers from world	0.772	0.719	0.738	0.706	0.705	0.717	0.743

Notes: This table reports descriptive statistics for the sample of Chilean exporters to Eurozone destinations described in Section 3. All values are in thousands of US dollars of 1997 unless noted otherwise.

A.2 Appendix to Section 4: The swift adoption of the euro as a trade invoicing currency

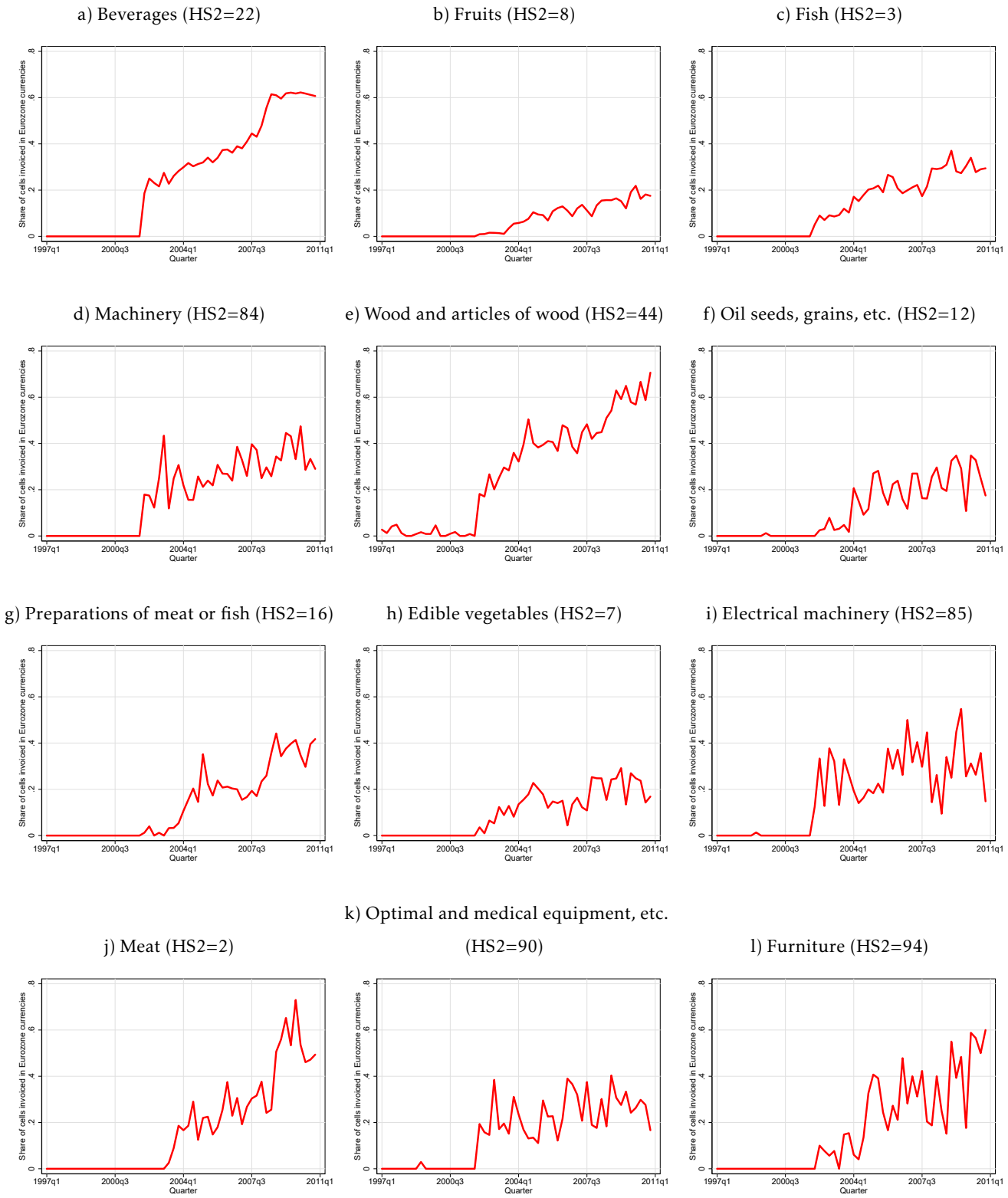
A.2.1 Trends in the adoption of the euro as an invoice currency

Figure A.1: Share of exports to main Eurozone destinations invoiced in Eurozone currencies



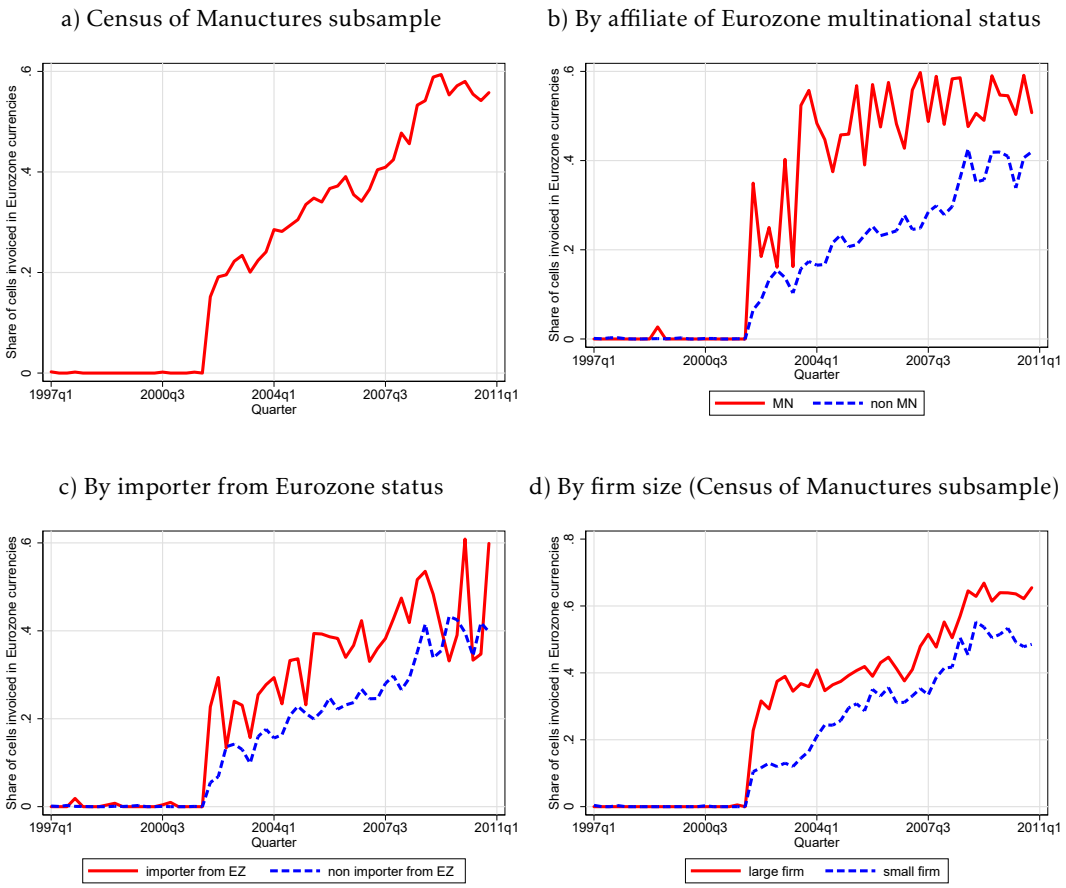
Notes: This figure reports the share of firm-product-time (year-quarter) cells invoiced in Eurozone currencies for each of the largest Eurozone destinations of Chilean exports.

Figure A.2: Share of exports to the Eurozone invoiced in Eurozone currencies



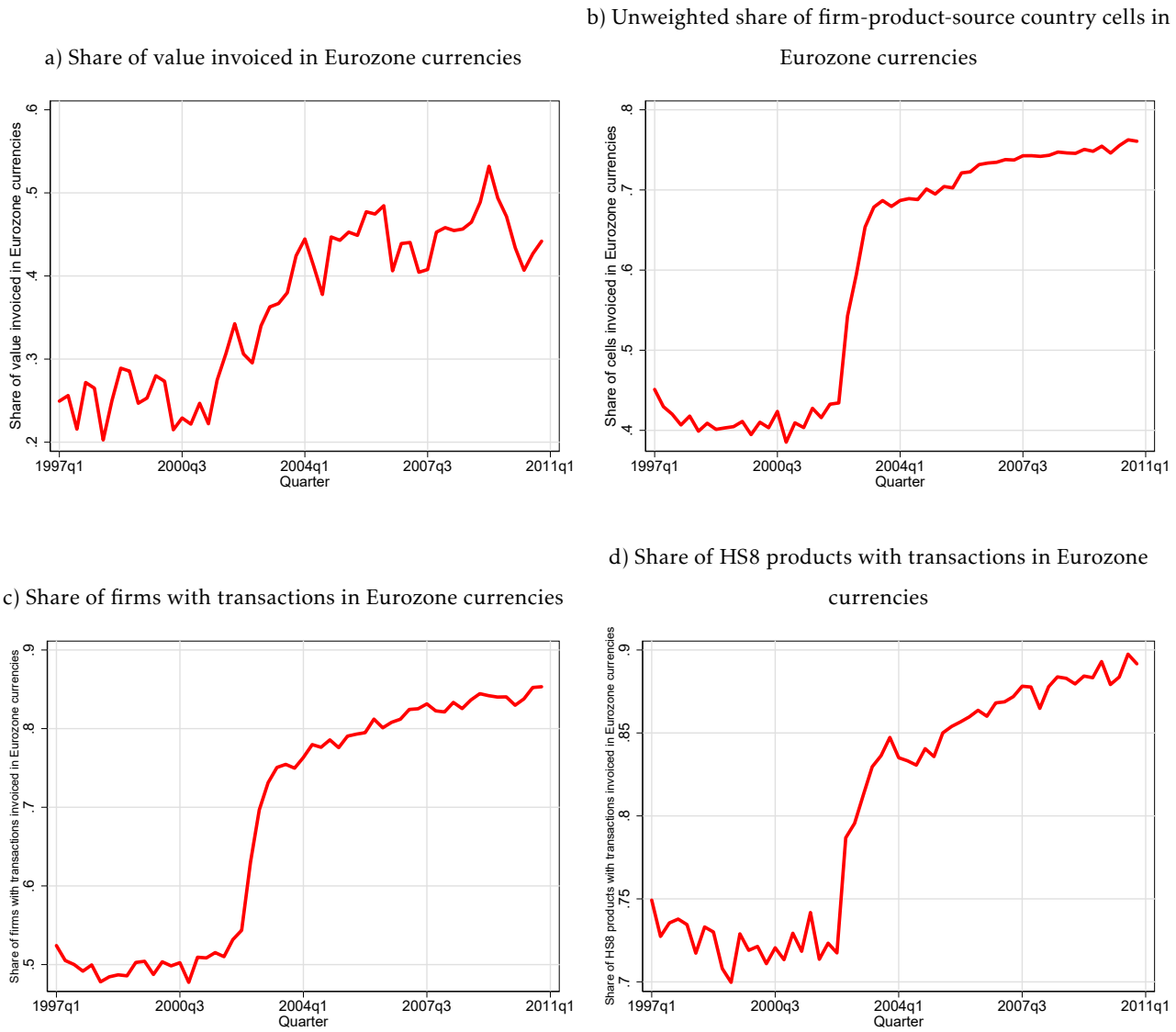
Note: This figure shows the share of Chilean exports to Eurozone countries invoiced in Eurozone currencies (i.e. euros or legacy currencies) by quarter between 1997 and 2010. All panels report the share of firm-HS8-destination cells invoiced in Eurozone currencies. Each panel consists of an HS2 sector, and we report data for the twelve largest sectors measured in terms of the number of firm–product (HS8)–destination–time (year–quarter) cells over 1997–2010.

Figure A.3: Share of exports to the Eurozone invoiced in Eurozone currencies



Note: This figure shows the share of Chilean exports to Eurozone countries invoiced in Eurozone currencies (i.e. euros or legacy currencies) by quarter between 1997 and 2010. All panels report the share of firm-HS8-destination cells invoiced in Eurozone currencies. Panel A is restricted to the Census of Manufactures sample. Panel B splits the sample between fims that are affiliates of Eurozone multinationals and the rest. Panel C splits the sample between firms that are importers from the Eurozone in the current period and the rest. Panel D is restricted to the Census of Manufactures sample and splits this sample between firms with above and below median size, measured in terms of revenue, using average revenue over 2002—2006 as in Section 4.

Figure A.4: Share of imports from the Eurozone invoiced in Eurozone currencies

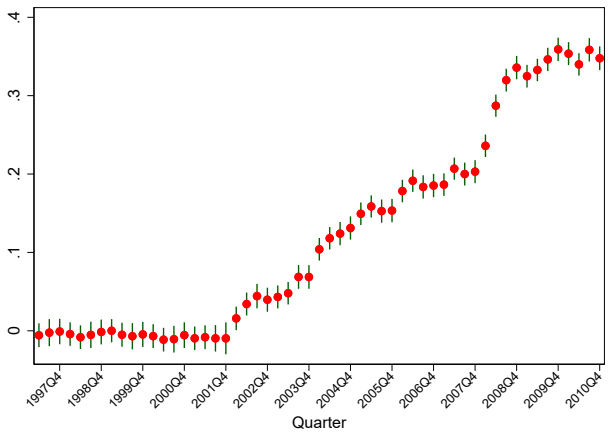


Note: This figure shows the share of Chilean imports from Eurozone countries invoiced in Eurozone currencies (i.e. euros or legacy currencies) by quarter between 1997 and 2010. Panels A and B report the share value and share of firm-HS8-source country cells invoiced in Eurozone currencies respectively. Panels C and D report the share of firms and HS8 products with at least one transaction invoiced in Eurozone currencies respectively.

A.2.2 Within–firm changes in invoice currencies

Here we show that the increasing popularity of the euro as an export invoicing currency was, to a large extent, a *within* firm-product-destination phenomenon. To this end, we estimate a regression of the probability of invoicing in euros on product × destination × firm fixed effects and year-quarter dummy variables. We plot the estimated coefficients on these year-quarter dummy variables to reflect

Figure A.5: Within firm-product-destination probability of invoicing exports in Eurozone currencies



Notes: This figure plots the estimated coefficients on time (year-quarter) dummies in equation (A.1).

the evolution of the within firm-product-destination probability of euro invoicing.

$$Pr(Euro)_{fpct} = \sum_{s=1997Q1}^{2010Q4} \beta_s \cdot 1[t = s] + \gamma_{fpc} + \epsilon_{fpct} \tag{A.1}$$

The results are shown graphically in Figure A.5. We can see an increase in the probability of invoicing in euros over time of similar magnitude than that shown earlier in Figure 1.

A.2.3 Variance Decomposition

To get an initial sense of the importance of products and firms in accounting for invoicing choices, we report a simple variance decomposition. Specifically, we estimate regressions of the probability of invoicing in euros as a function of various sets of fixed effects introduced by turn, and report the R-squared statistic in each case. These results, computed separately for 2002 and 2010 are shown in Table A.2. They indicate that firms explain a much larger share of the variance than products or destinations. Focusing on the second column, corresponding to year 2010, product fixed effects account for 35% of the variance, destinations for 6% and firms for 76%.[60] Finally, introducing product × destination × firm fixed effects accounts for 96% of the variance. This pattern is quite similar for year 2002.

[60]Note that by construction these percentages are not intended to add up to 100%

Table A.2: Probability of invoicing in euros: Variance decomposition

	2002	2010
Product	0.23	0.35
Firm	0.66	0.76
Destination	0.04	0.06
Product × Firm × Destination	0.90	0.96

Notes: This table reports the R-squared statistic from linear regressions of the probability of invoicing a firm × product × destination × time (year–quarter) observation in euros on various sets of fixed effects in each row for years 2002 and 2010.

A.2.4 Robustness Checks to Tables 1, 2 and 3

■ Tables A.3, A.4, and A.5 reproduce the results in Tables 1, 2 and 3 dropping the small number of observations (less than 0.6%) that are not invoiced in euros nor dollars.

Table A.3: Probability of invoicing in euros: Product-level determinants.

	(1)	(2)	(3)
Destination EZ Import Share	0.063*	0.070**	0.070**
	(0.026)	(0.025)	(0.026)
Differentiated		0.059*	0.059*
		(0.029)	(0.029)
Destination F.E.	Yes	Yes	No
Time F.E.	Yes	Yes	No
Destination × time F.E.	No	No	Yes
Observations	147786	146532	146532

Notes: This table reports the estimation of equation (2). Each observation is a firm–product (HS8)–destination–time (year–quarter) combination. Standard errors are clustered at the HS6 product level. ** and * indicate statistical significance at the 1% and 5% level.

Table A.4: Probability of invoicing in euros: Firm-level determinants

	(1)	(2)	(3)	(4)	(5)	(6)
	Census of Manufactures Subsample				Full Sample	
	2002-2006	2002-2010	2002-2006	2002-2010	2002-2006	2002-2010
log Revenue	0.111**	0.110**	0.081*	0.083**		
	(0.023)	(0.015)	(0.036)	(0.026)		
EZ Export Share	0.082**	0.075**	0.052**	0.051**	0.049**	0.058**
	(0.021)	(0.011)	(0.015)	(0.012)	(0.012)	(0.011)
Euro-Invoiced Imports / Cost			0.154**	0.114**		
			(0.033)	(0.022)		
Dollar -Invoiced Imports / Cost			-0.114	-0.072		
			(0.086)	(0.057)		
EZ Multinational Affiliate					0.237**	0.174**
					(0.045)	(0.031)
log Total (World) Exports					0.061	0.080*
					(0.029)	(0.028)
Prod. (HS8) × Dest. × Time F.E.	Yes	Yes	Yes	Yes	Yes	Yes
Observations	11149	19597	11149	19597	59944	118338

Notes: This table reports the estimation of equation (3). Each observation is a firm–product (HS8)–destination–time (year–quarter) combination. Columns 1 through 4 refer to the Census of Manufactures subsample. Columns 5 and 6 refer to the full sample. All continuous variables are standardized to have mean zero and standard deviation one. Standard errors are clustered by firm, product (HS6), destination and time (year–quarter) using multiway clustering. ** and * indicate statistical significance at the 1% and 5% level.

Table A.5: Probability of invoicing in euros: Interaction between destination intra–Eurozone import share and firm size

	(1) 2002-2006	(2) 2002-2010	(3) 2002-2006	(4) 2002-2010
Destination EZ Import Share × log Total (World) Exports	0.032*	0.025**		
	(0.011)	(0.007)		
Destination EZ Import Share × log Revenue			0.027*	0.022*
			(0.011)	(0.007)
log Total (World) Exports	0.118*	0.115**		
	(0.041)	(0.035)		
log Revenue			0.064	0.071*
			(0.034)	(0.031)
Euro-Invoiced Imports / Cost	0.157**	0.119**	0.168**	0.126**
	(0.036)	(0.021)	(0.034)	(0.021)
Dollar-Invoiced Imports / Cost	-0.130	-0.097	-0.123	-0.091
	(0.093)	(0.063)	(0.087)	(0.060)
Prod. (HS8) × Dest. × Time F.E.	Yes	Yes	Yes	Yes
Observations	11228	19140	11009	18764

Notes: This table reports the estimation of equation (4). Each observation is a firm–product (HS8)–destination–time (year–quarter) combination. The sample is restricted to the Census of Manufactures subsample in all columns. All continuous variables are standardized to have mean zero and standard deviation one. Standard errors are clustered by firm, product (HS6), destination and time (year–quarter) using multiway clustering. ** and * indicate statistical significance at the 1% and 5% level.

A.2.5 Summary statistics for regressions in Tables 1, 2 and 3

Table A.6: Summary statistics for invoicing regressions

	Mean	St. Dev.	10th pct.	50th pct.	90th pct.
Column 3 in Table 1:					
Dep. var: 1[Euro]	0.28	0.45	0.00	0.00	1.00
Destination EZ Import Share	0.35	0.22	0.07	0.31	0.71
Differentiated	0.19	0.39	0.00	0.00	1.00
Column 3 in Table 2:					
Dep. var: 1[Euro]	0.34	0.47	0.00	0.00	1.00
log Revenue	16.62	1.25	15.10	16.58	18.23
EZ Export Share	0.30	0.24	0.08	0.24	0.62
Euro-invoiced imports over Cost	0.02	0.04	0.00	0.00	0.11
Dollar-invoiced imports over Cost	0.02	0.05	0.00	0.00	0.06
Column 5 in Table 2:					
Dep. var: 1[Euro]	0.20	0.40	0.00	0.00	1.00
EZ Multinational Affiliate	0.02	0.14	0.00	0.00	0.00
EZ Export Share	0.40	0.30	0.08	0.30	1.00
log Total (World) Exports	14.03	2.03	11.39	14.19	16.56

Notes: This table reports summary statistics for the invoicing regressions in Section 4.

A.3 Appendix to Section 5: The effect of the euro on exchange rate pass–through

Table A.7: Summary Statistics for exchange rate pass–through regressions

	Mean	St. Dev.	10th pct.	50th pct.	90th pct.
Dep. var: Δp_{fpct}	0.00	0.27	-0.23	0.00	0.23
Δe^{USD}	-0.00	0.06	-0.06	-0.00	0.07
Δe^{EUR}	0.00	0.05	-0.06	0.00	0.05
1[USD]	0.73	0.45	0.00	1.00	1.00
1[EURO]	0.27	0.45	0.00	0.00	1.00
1[Post2002]	0.81	0.39	0.00	1.00	1.00

Notes: This table reports summary statistics for the exchange rate pass–through regressions in Section 5.