How do Currencies Globalize? Firm-level Evidence on the early Adoption of the Euro *

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Abstract

At least since Krugman (1980), economists have developed theories to rationalize why some currencies become widely used as vehicles for international transactions. But at the best of our knowledge, these explanations have not been tested at the micro-level, looking at firms around the birth of a new global currency. In this paper we study the determinants of Euro-invoicing by firms, as well as its implications. Based on trade flows between Europe and a non-European emerging market, Chile, we document that before the Euro circulation European imports were invoiced almost entirely in US Dollars. Even prestigious currencies, such as the German Mark, were never relevant in our sample. In contrast, the Euro share took off immediately after its physical introduction in 2002. By 2006 a third of shipments were invoiced in Euros. Chilean exporters were more likely to start trading in Euros if the European market represented a large share of their sales, if they were affiliates of European multinationals, and if their competition was based mostly in Europe. Taken together, our evidence strongly supports theories that emphasize strategic complementarities in invoicing currency choice. We also show that the change in currency denomination is associated with real outcomes. Chilean exporters adopting the Euro not only display different exchange rate pass-through in their pricing, but also increase their shipments to Europe.

JEL classification: F3, F4, F10 F36;
Key words: Global Currencies, Exchange Rate Pass-through , Strategic Complementarity, Invoicing , Vehicle currency

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1 Introduction

A distinctive feature of globalization is the existence of international or global currencies, used for financial and commercial transactions, as well as for reserve accumulation. Back in the 19th century the pound sterling performed this role, but during the early 20th century the US Dollar took its place as the dominant currency for international transactions. More recently, however, there has been some concern about this Dollar primacy. For example, China would like to transform the yuan into a global currency.\footnote{See for example Prasad and Ye (2012)} Similar concerns were also present in the European discussions that ended up with the circulation of a new currency - the Euro. Economic research has responded to these concerns with important theoretical developments\footnote{Krugman (1980) emphasizes the role of multiple equilibria on how a currency becomes a vehicle for transactions. Within this family of explanations, Rey (2001) and Bacchetta and van Wincoop (2005) emphasize strategic complementarities. Instead, Viaene and De Vries (1992) focus on the relative bargaining power of the buyer and the seller as a central force of invoicing currency choice.}, as well as with aggregate stylized facts about the international use of new currencies, even sometimes separating their use by products and sectors of the economy\footnote{Goldberg and Tille (2008); Kamps (2006)}. Nonetheless, there seems to be no micro-level evidence focused on the firms that are early adopters of new global currencies. To fill this gap, we use the natural experiment of the creation of the Euro and benefit from a novel and detailed firm-level dataset of European imports from an emerging market. We investigate how the Euro gained popularity for international trade vis-à-vis the Dollar, exploring which firms and products were more likely to adopt it. Our second goal in this paper is to measure the real outcomes associated with the adoption of the Euro by these firms, in terms of both the exchange rate pass-through and the volume of trade.

Based on our unique data on invoicing of international trade transactions between Europe and an emerging economy, Chile, we document the switch of European imports, invoiced entirely in Dollars before 2002, to Euros. Before 2002 the German Mark and the French Franc, for example, were barely used for invoicing European imports from Chile. It was
only after the appearance of the Euro that a meaningful share of European imports from Chile was invoiced in local currency. This pattern is illustrated in Figure 1. A similar, although less dramatic shift is observed for European exports (see Figure 2).

![Graph showing share of transactions invoiced in US Dollars from Chile to the four largest European countries that adopted the Euro (France, Germany, Spain and Italy) from 1998 to 2006. The red line represents the share of transactions exported in Dollars, and the blue line represents the share of export value invoiced in Dollars. The large fall in the share of the Dollar is observed at the start of 2002, when the Euro was introduced as a physical currency.](image)

This figure displays the share of exports invoiced in Dollars from Chile to the four largest European countries that adopted the Euro (France, Germany, Spain and Italy) at a monthly frequency during the period 1998-2006. The red line shows the share of transactions exported in Dollars. The blue line represents share of export value invoiced in Dollars. The large fall in the share of the Dollar is observed at the start of 2002, when the Euro was introduced as a physical currency.

**Figure 1.** Share invoiced in US Dollars among Chilean exports to France, Germany, Italy and Spain.

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4We exclude exports of copper. Copper concentrates a large share of Chilean exports. We want to avoid a small number of very large transactions to have a large effect in our results. The graph including copper, however, follows a very similar trend.
This figure displays the share of Chilean imports invoiced in US Dollars coming from the four largest European countries that adopted the Euro (France, Germany, Spain and Italy) at a monthly frequency during the period 1998-2006. The red line shows the share of value imported in Dollars. The blue line represents share of import transactions invoiced in Dollars. The large fall in the share of the Dollar is observed at the start of 2002, when the Euro was introduced as a physical currency.

Figure 2. Share invoiced in US Dollars among Chilean imports from France, Germany, Italy and Spain.

We start by searching for firm and product characteristics that influence the decision of adopting the Euro as a currency used for trade. Our empirical work finds strong evidence showing that competition is a relevant determinant of the invoice currency choice. Within Chilean exporters to Europe, we find that firms that were engaged in tougher competition with European producers were more likely to trade in Euros. We also find that Chilean exporters that are more focused in the European market in terms of sales are more likely to price in Euros. Chilean exporters that are affiliates of European multina-
tionals are also more likely to use the Euro than other firms. Since it is estimated that a third of world trade occurs within firms (see Antràs, 2003), multinational corporate structures seem to be a relevant mechanism for the expansion of global currencies. We also report that firms usually trade in a single currency, which is consistent with models that have costs of switching across currencies. Another finding we discuss is that Chilean firms that adopted the Euro for their trade with Europe also started using it when trading with other countries. This "single-currency" effect constitutes more direct evidence on the mechanisms that allow international currencies to spread globally. As we discuss in section 3, our findings support theories that emphasize strategic complementarities between firms in their invoicing currency choice.

The currency in which trade is denominated can have important real effects. The new open economy macroeconomics models feature the effect of the invoicing currency on exchange rate pass-through, with consequences for monetary and exchange rate policy. On the immediate short run, prices are rigid in the currency in which they are denominated, and there is zero pass-through for imports denominated in the local currency and 100% pass-through for imports priced in producer or vehicle currency. Recent evidence by Gopinath, Itskhoki, and Rigobon (2011) shows that even conditional on price changes the pass-through rates are very different depending on the invoicing currency. Based on U.S. imports, local currency pricing is associated with almost full pass-through while for prices set in the producer currency pass-through is much lower. We measure pass-through of European imports from Chile and find a large difference in pass-through between imports in dollars and imports in euros conditional on price changes. In our case, both the euro/dollar (local currency / vehicle currency) and the euro/peso (local currency/producer currency) exchange rates are relevant. We find a close to 100% pass-

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5The use of a single currency within firms is, by itself, also consistent with models like Gopinath, Itskhoki, and Rigobon, 2010 where firm characteristics - like their desired medium run pass-through (MRPT) - define the currency to be chosen for invoicing (in their theory, if the firm desires as large MRPT it chooses producer currency pricing, PCP); while if the desired MRPT is small, then the firm chooses local currency pricing. However, this model by itself does not indicate why some firms switched from the dollar to the euro. This is the theme of our paper.
through of the euro/dollar exchange rate for contracts denominated in dollars, and a much lower pass-through for contracts denominated in euros.

The currency in which firms trade could also have an effect on the volume of trade with Europe. Commonly, the literature has linked exchange rate stability with increased levels of trade. Evidence suggests that the introduction of the Euro increased trade within the European Union. We measure whether trade with a non-European partner increased when firms in Chile started using the Euro instead of the Dollar for their shipments to Europe. We find a 40% increase in exports to Europe between 2001 and 2002 for firms that choose to trade in Euros in 2002. Our empirical strategy compares the change in the trade volume between firms that switched to the Euro and firms that did not. Using propensity score matching techniques, we aim to control for the fact that firms self select into a currency: it was a choice. A number of papers have measured the effect on the Euro on trade, and more in general, the effect of monetary unions on trade using the gravity equation and data on aggregate trade flows. Rose (2000) found a large impact of monetary unions on trade. Baldwin, DiNino, Fontagné, De Santis, and Taglioni (2008) review this literature and describe the shortcomings of the estimation methods based on the gravity equation, and, using firm level data for several European countries to assess the effect of the Euro on trade, they find a more moderate but still positive effect on trade than most of the earlier literature. There is little evidence on how global currencies are born at the microeconomic level. There is, however, a literature on the determinants of global currency status. Flandreau and Jobst (2005) study the factors explaining a currency’s global status during the 19th century. They conclude that “economic mass, and thus the share in international trade is a powerful driver of international monetary leadership”...”The implication must be that money and trade and components.” From the theoretical point of view, Krugman (1980) and more recently Rey (2001) have explored the various equilibria in currencies used in international trade. In Rey (2001), transaction costs of currency exchange related to liquidity with trade flows to determine which national currency serves
the role of a vehicle currency for trade.

To the best of our knowledge, this is the first paper that uses data linking firm characteristics with the invoicing currency of these firms’ international trade transactions. Another characteristic that distinguishes our paper from previous work is our focus on the introduction of the Euro as a natural experiment that expanded the set of available currencies used for trade invoicing.

The rest of the paper is structured as follows. Section 2 describes the data and patterns on the persistence of the currency choice. Section 3 explores which firms are more likely to invoice in Euros. Section 4 deals with the effect of adopting the Euro on economic activity, and is divided in two parts. The first one investigates how differences in invoicing currencies used by firms are systematically associated with differences in exchange rate pass-through. The second one measures the effect of adopting the euro on the volume of trade. Section 5 concludes and outlines the work we plan to include in future versions of this paper.

2 Data on shipments to and from Europe

We use transaction level data on exports and imports collected by Chilean Customs for the period 1998-2006. The distinguishing feature of the data is that it includes the invoice currency of every transaction. Additionally, we observe the identity of the Chilean firm involved, the value and quantity traded, the country of origin or destination, and an identification of the product based on the Chilean HS 8 digit classification. Data linking

\footnote{Goldberg and Tille (2011) study invoicing currency choice with data on canadian imports at the transaction level, without information on the firms involved. Most of the analyses involving invoicing currency choice of U.S. imports have used data from a BLS survey of international prices(Gopinath and Rigobon, 2008; Gopinath, Itskhoki, and Rigobon, 2010; Neiman, 2008), which consists of a sample of firms’ in each product. This data contains prices reported by firms in a questionnare, not information on actual transactions. For a discussion of the limitations of the BLS data for pricing analysis see the comment by Emi Nakamura avail- able at http://www.columbia.edu/~en2198/papers/gopinathetal_discussion_wtf.pdf . Nakamura points out that the price series have gaps; that is survey data and that maybe there is a lot of long-term relationships and bargaining that goes beyond Gopinath et al interpretation.}

\[6\]
firms with the invoice currencies of their international trade transactions has not been used in the past, to the best of our knowledge. Progress in empirical work regarding invoice currencies used in international trade has been slow due to difficult access to the data. In fact, in some countries this data is not collected. 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 U.S. trade is available from a BLS survey on import and export prices. This is described by Gopinath and Rigobon (2008) and Gopinath, Itskhoki and Rigobon (2011). In our empirical work, we restrict ourselves to analyzing trade between Chile and the twelve countries that adopted the Euro since its origin: France, Germany, Italy, Spain, Austria, Belgium, Finland, Greece, Ireland, Luxembourg, The Netherlands, and Portugal. The first four countries in this list are the larger trading partners of Chile within this group and we study trade with this group separately at times. We observe that in 2006, 30% of the export transactions from Chile to Europe were invoiced in Euros, and practically all the rest was invoiced in Dollars. The Chilean Peso plays almost no role in Chile’s international trade.

We complement our dataset with daily exchange rates for the peso-dollar, peso-euro, and euro-dollar pairs obtained from the Chilean Central Bank, as well as monthly price level indexes for the Euro Zone and Chile. Finally, we identify affiliates of European multinationals using data from the International Trade Centre. The International Trade Centre (ITC), a joint project of United Nations and the World Trade Organization, provides data on multinational affiliates in developing countries. Descriptive statistics are provided in Table 1.

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7 The only evidence in this sense has come from surveys and questionnaires with small numbers of firms, such as Friberg and Wilander (2008) for Swedish firms and Ito et al (2010) for Japanese firms. Also, the BLS data commented before is a survey; although an extensive one.

8 See the table 1 in Goldberg and Tille’s (2008) working paper
**Table 1.** Descriptive Statistics at the Firm Level in 2002 and 2006

<table>
<thead>
<tr>
<th>FIRM LEVEL</th>
<th>Exports to the Eurozone in 2002</th>
<th>Exports to the Eurozone in 2006</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Std. Dev</td>
</tr>
<tr>
<td>Firm’s share of Export transactions in Euros</td>
<td>0.0854</td>
<td>0.2462</td>
</tr>
<tr>
<td>Firm’s share of Exported Value in Euros</td>
<td>0.0880</td>
<td>0.2520</td>
</tr>
<tr>
<td>Total Firm Exports (log USD)</td>
<td>13.384</td>
<td>2.305</td>
</tr>
<tr>
<td>1: European Multinational</td>
<td>0.0235</td>
<td>0.1517</td>
</tr>
<tr>
<td>Share of exports to Europe</td>
<td>0.4017</td>
<td>0.3745</td>
</tr>
<tr>
<td>Entered European market during or after 2002</td>
<td>0.3176</td>
<td>0.4657</td>
</tr>
<tr>
<td>Number of Firms</td>
<td>1316</td>
<td>1630</td>
</tr>
</tbody>
</table>

A first finding is that firms seem to price either in Dollars or in Euros, but not in both. Figure 3 shows a bimodal distribution of firms according to their invoice currency use, with some trading only in Dollars and others, only in Euros.\(^9\)

\(^9\)Jointly, these two currencies are used in more than 99.5% of transactions.
The figure shows the distribution of firms according to the share value exported to Europe that they invoice in Euros in 2006. The sample is composed by 603 firms that exported more than 10 transactions to Europe in that year. It is evident from the figure that most firms choose a single currency, Euros or Dollars.

**Figure 3.** Distribution of Firms according to their use of the Euro.

Another finding we present is that the choice of an invoice currency seems to be a long term commitment for firms. We find that once exporters start trading in Euros, it is very likely that they will trade in Euros in subsequent periods. The unconditional probability that a firm uses the Euro at a given date after using it in the previous transaction to the same destination country is 84%.

The bimodality of the distribution and the persistence of a firm’s trading currency are consistent, although not sufficient proof, of the existence of meaningful fixed costs of switching to a different currency.
3 Which firms trade in Euros?

Which firms adopted the Euro? Which products are more likely to be traded in Euros? Our goal in this section is to investigate how the Euro gained popularity. Understanding which firms and products started being traded in Euros in its earliest years can help us understand how a currency becomes global. Further, it can shed light on different theories about invoice currency determination.

We look at the currency used by Chilean firms exporting to Europe. We characterize firms based on their size, the relevance of the European market for them, on whether they are affiliates of European multinationals, and by their age as exporters to Europe. We expect firms focused on the European market to be more likely to adopt the Euro: our intuition is that firms choose a currency based on their main market. Firms usually trade in a single currency, as we show with in figure 3. We also believe firms owned by European multinationals are not in a strong bargaining position and use the currency preferred by their parent companies in Europe, which we assume would be the Euro. We include firm size as a potentially relevant characteristic due to our understanding of currency choice as the outcome of a bargaining game between the exporter and the importer. Our data is incomplete in the sense that we do not observe the size of the European counterpart in a transaction, but we assume that smaller Chilean exporters are more likely to accept the preference of the European importer and trade in Euros. We also use the age of exporters thinking about the persistence of past conditions on present choices. We believe that older exporters could be more likely to maintain the status quo and trade in Dollars.

We measure an exporter’s size as its total value exported worldwide in a given year. We define a firms’ ”Euro-focus” (as a measure of the relevance of the European market for the firm) as the share of its trade with Europe over its worldwide trade. The age of an exporter is represented by a dummy variable for "new" firms, taking a positive value for firms that conducted their export to European markets during or after 2002.
We define two variables to describe products. First, we distinguish between differentiated products and commodities according to Rauch (1999)’s classification. Commodities traded in centralized markets are more likely to be traded in a single currency - the Dollar - independently from other considerations. Second, we believe that products that compete in the European market in an environment dominated by intra-european competition are more likely to adopt the Euro. For example, a Chilean firm exporting chocolates to France might face strong competition from producers in Belgium, and price in Euros to stay competitive. To capture this idea, we measure for each product (at the HS 6 level), the share of imports of European countries that comes from within Europe. We use COMTRADE data for this purpose.

Since practically all export transactions from Chile were invoiced in Dollars before 2002, all firms start from the same point. Some firms switch to the Euro, and some do not. For robustness, we carry our empirical work at the firm level and at the transaction level. At the firm level, we calculate a firms’ share exported that is denominated in Euros as the dependent variable ($s_{f}^{Euro}$), both in value and in transactions. We estimate the following regression at the firm ($f$) level, where $Z_{f}$ stands for the firm level characteristics described.

$$s_{f}^{Euro} = \beta Z_{f} + \varepsilon_{f}$$ (1)

At the transaction level, we define a binary variable that takes a value of 1 for transactions invoiced in Euros and 0 otherwise, and estimate a similar regression. Products are indexed by $i$, firms by $f$ and transactions by $\tau$. $X_{i}$ represents a vector of the product characteristics described earlier.

$$Euro_{f \tau} = \beta Z_{f} + \gamma X_{i} + \varepsilon_{f \tau}$$ (2)

The results for the firm level regression are presented in Table 2. The importance of the European market for a firm influences positively the adoption of the Euro. Firms owned
by European multinationals are also more likely to invoice in Euros. The magnitude of these coefficients is relevant. A foreign owned firm that trades solely with Europe is 30% more likely to invoice in Euros than a firm that is not foreign owned and barely exports to Europe.
Table 2. Which firms trade in Euros? Firm-level results.

<table>
<thead>
<tr>
<th>Share of Transactions</th>
<th>Coefficient</th>
<th>Standard Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Firm Exports (logs)</td>
<td>0.00104</td>
<td>(0.00542)</td>
</tr>
<tr>
<td>Foreign Owned</td>
<td>0.151**</td>
<td>(0.0620)</td>
</tr>
<tr>
<td>Share of exports to Europe</td>
<td>0.144***</td>
<td>(0.0298)</td>
</tr>
<tr>
<td>&quot;New&quot; to the European market</td>
<td>-0.0190</td>
<td>(0.0207)</td>
</tr>
<tr>
<td>Firm's main HS2</td>
<td>FE</td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>0.146*</td>
<td>(0.0860)</td>
</tr>
<tr>
<td>Number of Observations</td>
<td>1,630</td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.131</td>
<td></td>
</tr>
</tbody>
</table>

This table displays results from a linear regression with transaction level observations. The results are for the cross-section of firms trading in Euros. Significance at the 1, 5, and 10 confidence levels is denoted by ***, **, and * respectively.
Table 3. Which firms trade in Euros? Transaction-level results.

<table>
<thead>
<tr>
<th>Transaction Invoiced in Euros (1)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Total Firm Exports (logs)</td>
<td>0.0121</td>
</tr>
<tr>
<td></td>
<td>(0.00840)</td>
</tr>
<tr>
<td>Foreign Owned</td>
<td>0.306***</td>
</tr>
<tr>
<td></td>
<td>(0.105)</td>
</tr>
<tr>
<td>Share of exports to Europe</td>
<td>0.179***</td>
</tr>
<tr>
<td></td>
<td>(0.0685)</td>
</tr>
<tr>
<td>&quot;New&quot; to the European market</td>
<td>-0.0630*</td>
</tr>
<tr>
<td></td>
<td>(0.0337)</td>
</tr>
<tr>
<td>Differentiated Product</td>
<td>0.162**</td>
</tr>
<tr>
<td></td>
<td>(0.0669)</td>
</tr>
<tr>
<td>Competition with European producers</td>
<td>0.390***</td>
</tr>
<tr>
<td></td>
<td>(0.0750)</td>
</tr>
<tr>
<td>Constant</td>
<td>-0.217</td>
</tr>
<tr>
<td></td>
<td>(0.178)</td>
</tr>
</tbody>
</table>

| Number of Observations | 91,175  |
| R-squared             | 0.073  |

This table displays results from a linear regression with firm level observations. The results are for the cross-section in year 2006. Firms included are those that export to the 12 European markets that were using the Euro since 2002. The dependent variable in column 1 is a firm’s share of export transactions invoiced in Euros. The dependent variable in column 2 is a firm’s share of exported value invoiced in Euros. The independent variables are the firm’s size (log of worldwide exports), a dummy that is positive for affiliates of European multinationals, the importance of the European market for the firm (the share of total exports sent to Europe), and a dummy that is positive for firms that entered the European market during or after 2002. Both columns include fixed effects according to a firms’ principal industry defined at the HS 2-digit level. Standard errors are clustered at the firm level. Firms with total annual exports below 10 thousand Dollars are excluded. Significance at the 1,5 and 10 confidence levels is denoted by ***, **, and * respectively.
The results of the transaction level regressions (see Table 3) confirm the results in terms of the firm level characteristics that matter. They also add information on product level characteristics that are relevant. First, as previous research has documented, differentiated products are much more likely to be traded in Euros, probably confirming the fact that commodity markets function completely in Dollars. Our next finding is that competition is a key determinant of invoice currencies. Products that face a large competition from European producers are more often traded in Euros. The 40% coefficient implies that a Chilean exporter shipping a product in which European producers has a market share close to 100% is 40% more likely to invoice in Euros than an exporter shipping a product that is not manufactured in Europe.

We also explore whether Chilean exporters use the Euro in their trade with non-european countries. The Dollar is, by far, more popular in trade with countries outside Europe. However, we find that firms that are focused on the European market are more likely to use Euros in their trade with other countries as well. We measure this as follows. We observe the exports of Chilean firms to all non-european countries, and compare firms that export in Euros with firms that do not. Those that do are firms that are more focused in the European market. For firms that export in Euros to the rest of the world, the European market is twice as important (in terms of sales) than for the rest of the firms. This result speaks about the expansion of the Euro throughout the world. Our interpretation is that firms usually trade with a single currency, and if they make that decision based in their main market, then Euro-focused firms will trade in Euros with the whole world.

The evidence provided in this section supports some theories on invoicing currency determination. Baccheta and Van Wincoop (2005) emphasize the role of strategic complementarities in their model of invoicing currency choice. In their model, an exporter firm faces a trade-off between uncertainty in demand and uncertainty in price depending on whether it prices in producer or local currency, and a firm’s optimal currency choice depends on the shape of their profit function. Their model predicts that when a group of
countries form a monetary union, invoicing in the union’s currency is larger than the earlier invoicing in each of the countries’ currency. This is what we have found in the data. Goldberg and Tille (2008) also stress the role of competition. Their result is also based on a model of an exporter that chooses to price in local currency to reduce price movements, which affect demand and costs. Pricing in local currency is more likely when price movements lead to larger changes in demand due to tougher competition. There are other mechanisms that could explain the effect of competition on invoicing currency choice that we find. It could be that when a Chilean exporter sells a product that faces tougher competition from European producers, the importer in Europe has a larger bargaining power and imposes the use of Euros. A Chilean exporter trying to sell baguettes in France should be very careful of trying to please the importer!!

The idea of that the currency observed in a transaction is the outcome of a bargaining game between the exporter and the importer is included in the model by Viane and De Vries (1992). Goldberg and Tille (2011) provide evidence in this direction, showing that in Canadian imports large transactions (probably involving large importers) are more commonly priced in Canadian Dollars.

Usually, theories on invoicing currency consider an exporter selling in a single country. Our finding that firms are more likely to price in Euros if the European market imports a large share of their sales cannot be included in such models. A model in which firms have at least two markets could feature firms pricing in a single currency to both markets to avoid the higher transaction costs of using more than one currency.

4 Euro adoption and real outcomes.
4.1 Exchange Rate Pass-through

We have documented that the Euro made swift progress as an invoice currency for European imports from Chile after 2002. In this section we discuss the consequences of this event on exchange rate pass-through. We find pass-through rates conditional on price changes that differ depending on whether trade contracts are invoiced in Euros or Dollars. If it was also the case that European imports from larger trade partners switched to Euros, the consequences in terms of the transmission of exchange rate shocks into the Euro Zone could be of first order. Prices do not adjust immediately. In the very short run, a price denominated in the local currency (the importer’s currency) will have a zero pass-through, whereas a price denominated in producer or vehicle currency will have a 100% rate of pass-through. In this section, we show that even conditional on prices adjusting, the rate of exchange rate pass-through depends on the invoice currency of these prices. Gopinath, Itskhoki, and Rigobon (2010) have provided evidence in this sense, studying prices of U.S. imports. They find a small pass-through on U.S. imports when contracts are in Dollars, and a much larger pass-through for non-dollar contracts. Berman, Martin, and Mayer (2012) have studied the response of export prices of French firms to exchange rates. They have found evidence of heterogeneity in these responses according to firms’ productivity. Prices of more productive firms increase more in response to a depreciation in the real exchange rate. The data available for their study did not include the invoice currency.

Our empirical approach is as follows. We start by looking at European imports from Chile. We separate the sample between transactions in Euros and transactions in Dollars, and we construct price series for every Chilean exporting firm/HS8 product/country of destination combination. We use unit values as proxies for prices. Suppose that we observe a new price $p_t$ (in logs) for the first time in date $t$, and it lasts until date $t + \Delta t$, when a new price, $p_{t+\Delta t}$, is set. For each of these price spells $s$ we measure the duration, $\Delta t$, and the magnitude of the price change, $\Delta p_s \equiv p_{t+\Delta t} - p_t$. We set a tolerance margin
of 2% within which we consider prices to be unchanged. We measure the variation in the exchange rate \( j \) during each price spell \( s \), denoted as \( \Delta e_s^j \). Closely following the exercise of Gopinath, Itskhoki, and Rigobon (2010), we pool all these observations of price changes together, and estimate a simple pass-through regression conditional on the price changing; and we estimate separate pass-through coefficients for contracts in Euros and contracts in Dollars. The dummy variable \( E_s \) is 1 for contracts in Euros and 0 for contracts in Dollars, making our regression:

\[
\Delta p_s = \beta^{EUR} E_s \cdot \Delta e_s^{Euro} + \beta^{USD} [1 - E_s] \cdot \Delta e_s^{Peso} + \gamma Z_s + \varepsilon_s
\]  

We include fixed effects at the 4 digit level of the Harmonized System and cluster standard errors at the same level. The vector \( Z_s \) includes the cumulative inflation during the spell, both in the Euro zone and in Chile as well as the dummies for the intercept or the fixed effects. We exclude from our sample prices of multinational companies since they are less likely to respond to market forces.

The typical pass-through regression would include a single exchange rate; in this case, the Euro/Peso exchange rate. In our sample, however, we don’t have transactions invoiced in Pesos. We only observe local currency pricing (in Euros) and vehicle currency pricing (in Dollars). Chilean exporters have costs in Pesos and should thus set prices taking the Euro/Peso exchange rate into account. The Euro/Dollar exchange rate is also relevant, because for many goods the prices are set in US Dollars, no matter the country. For this reason, we also estimate a regression including both the Euro/Peso and Euro/Dollar exchange rate. In particular, 

\[
\Delta p_s = \beta^{EUR/CLP} E_s \cdot \Delta e_s^{Euro/Peso} + \beta^{EUR/US$} [1 - E_s] \cdot \Delta e_s^{Euro/Peso} + \beta^{EUR/Dollar} E_s \cdot \Delta e_s^{Euro/Dollar} + \beta^{EUR/USD} [1 - E_s] \cdot \Delta e_s^{Euro/Dollar} + \gamma Z_s + \varepsilon_s
\] 

We also exclude prices that last less than 30 days or less than two transactions. We take these precautions in order to avoid noise in the data.
The results of the estimation for equations 3 and 4 are displayed in Table 4. Column (1) indicates that when we include only the Euro/Peso exchange rate, the pass-through coefficients do not depend much on the currency denomination. For euro-denominated contracts the point estimate is 0.85 and for contracts in Dollars, it is 0.67; but the difference is not statistically significant. In terms of economic significance, the magnitude of the difference is much smaller than the analogous differences reported by Gopinath, Itskhoki, and Rigobon (2010).

When we include the Euro/Dollar exchange rate we see the importance of the invoice currency. Column (2) shows that Euro invoiced prices react to the producer currency exchange rate, Euro/Peso ($\hat{\beta}_{\text{EUR/CLP}} = 0.91; t-stat > 3$); while the Dollar invoiced prices react to the Euro/Dollar, which is the local vs. vehicle exchange rate ($\hat{\beta}_{\text{EUR/USD}} = 1.1; t-stat > 4$). From these coefficients one cannot discard that the mentioned pass-through coefficients are statistically different from one, which would mean that prices are fully adjusted in a single event: for every point of Euro depreciation there is a one to one increase in the price measured in Euros. In contrast, neither the Euro-priced goods seem to respond to the vehicle exchange rate (Euro/Dollar) nor the Dollar-Priced goods seem to respond to the producer’s exchange rate with Europe.

Taking stock, these coefficients are reassuring because what we describe as Dollar invoicing has indeed prices in Dollars, so if the Euro depreciates, the price in Euros mechanically increase by the same percentage. The the prices invoiced in Euros tend to fully react to changes in the Euro/Peso exchange rate; making again the price constant in Pesos - which is the producer’s currency.

To clarify, the fact that these prices have pass-through of 100% conditional on a price change does not mean that a Chilean exporter does not lose competitiveness when there is an appreciation of its currency vis-à-vis the Euro. On the one hand, because during all the period before the price adjustment, the revenues for the exporter are below the previous price setting. On the other hand, the fact that the price adjustments are complete in the
first adjustment (i.e. it equals the lifelong pass-through if we assume long run PPP) opens the possibility that this adjustment is being delayed; which would still be consistent with prices sticky in Euros for a long time. We will investigate this further in future versions of the paper. The close to full pass-through could also mean that real rigidities, that prevent full adjustment of prices, might be less of a concern for Chilean invoicing in Euros.
Table 4. Exchange rate pass-through

<table>
<thead>
<tr>
<th></th>
<th>ΔPrice (expressed in Euros)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
</tr>
<tr>
<td>Euro depreciation against Peso × Euro invoiced</td>
<td>0.853*** (0.170)</td>
</tr>
<tr>
<td>Euro depreciation against Peso × Dollar invoiced</td>
<td>0.673*** (0.0662)</td>
</tr>
<tr>
<td>Euro depreciation against Dollar × Euro invoiced</td>
<td></td>
</tr>
<tr>
<td>Euro depreciation against Dollar × Dollar invoiced</td>
<td></td>
</tr>
</tbody>
</table>

ΔCPI Chile and ΔCPI Euro | YES | YES |
Number of Observations   | 1,251 | 1,251 |
R-squared                | 0.230 | 0.279 |

This table displays the results of the pass-through regression for European imports from Chile conditional on price changes. Prices are proxied by unit values and measured free on board (i.e. without transport costs). We identify price changes in euro-invoiced and dollar-invoiced transactions as described in the text. The independent variable is the magnitude of the price change (in logs) measured in Euros. The dependent variables are the (log) changes in euro-peso and euro-dollar exchange rates for each type of transaction as described in equation (3). The euro-peso exchange rate is the price of one Chilean Peso in Euros. The euro-dollar exchange rate is the price of one U.S. Dollar in Euros. The euro-dollar Additional controls are the inflation in Chile and in the EMU countries, computed as the (log) change in the price levels between the initial and final duration of each price.

We exclude shipments of copper for the reasons exposed in footnote 1. Both columns include product (HS 6-digit) fixed effects. Standard errors are clustered at the product (HS 6-digit) level. Significance at the 1, 5 and 10 confidence levels is denoted by ***, **, and * respectively. Note: The above regressions were run with, but also without using the cumulative inflation as control (not shown) but the coefficients remain qualitatively similar.
4.2 Trade Volume

There is a large literature measuring the effect of the Euro on international trade. This literature has used the gravity equation and aggregate country level or sector level trade flows, with the exception of a recent paper by Baldwin et al (2008) using firm level trade flows from firms inside and outside the Economic Monetary Union. We tackle the question about the relationship between the Euro and trade levels with a new approach. Observing the invoice currency of firms’ exports to Europe allows us to identify exactly the firms that adopted the Euro from those that did not. We use a difference in differences (DID) strategy to measure the effect of adopting the new currency on the traded volume. The main issue to address is that firms self-select into the "treatment": it is not a treatment but a choice. We match firms that select into using the Euro with otherwise similar firms that kept trading in Dollars after 2002. Our approach is similar to De Loecker (2007), who studies the effect of entry into exporting on firm productivity. The outcome of interest is the average increase in exports to the EMU between 2001 and 2002 for firms that adopted the Euro, compared with the increase that would have been observed had these firms not switched to the Euro.

\[
E \{ \Delta Exp_{Euro}^{2001-2002} - \Delta Exp_{Dollar}^{2001-2002} \}
\]  

(5)

Of course, we do not observe the second term. That leads us to compare each firm that adopted the Euro in 2002 with firms that were similar in 2001 but did not adopt the Euro in 2002. We view firms’ adoption of the Euro as a discrete decision. The vast majority of firms use a single currency for most of its transactions, as figure 3 indicates. We model the propensity score (the probability of adopting the Euro in 2002) as a function of firm characteristics in year 2001. These characteristics include the firms’ size, share of exports shipped to Europe, industry, and ownership (whether the firm is an affiliate of a European multinational or not). The industry for each firm is defined as the HS 2-digit code that concentrates the majority of a firm’s exports. In our sample of firms, 50 adopt the Euro
in 2002 and 633 do not. This first stage is represented by the following equation, which is estimated using a probit model:

\[ P(Euro_{2002} = 1) = \beta_0 + \beta_1 * Z_{f,2001} + \varepsilon_f \]  

(6)

We restrict the sample to those industries with more than 10 firms. The results indicate that the balancing property is satisfied. For calculating the second stage, we restrict observations to a common support on the propensity score. For each firm that adopts the Euro, we define a control group based on the estimated propensity score. We compare the growth in the trade volume of exports to Europe between 2001 and 2002 for each firm. Our approach compares this outcome between firms that did adopt the Euro and the relevant control group of firms that kept trading in Dollars. We estimate the average treatment effect on the treated. Our results indicate that the increase in exports to Europe for firms that chose to use the Euro compared to those that did not is of 41% and statistically different from zero. The bootstrapped standard error is 0.163
5 Conclusions and Future Steps

In this paper, we have taken advantage of the introduction of the Euro as a unique natural experiment to explore several questions regarding the role of invoice currencies in international trade. To the best of our knowledge, this paper is the first one to use data that links firm characteristics with the invoice currency of their trade transactions. This allows us to explore theories of invoicing currency choice that emphasize firm level determinants, and to provide stylized facts useful for future research. A first conclusion is that invoice currencies should be considered endogenous, and there can be fast changes in the share of trade denominated in different currencies. We argue that this can have a large macroeconomic impact. A second finding worth emphasizing is that competition plays an important role in determining the currencies used for trading. We find that products exported to Europe that face tougher competition from European producers are more likely to trade in Euros.

We have shown, in line with recent evidence in the literature, that invoice currencies have an important effect on exchange rate pass-through, even conditional on price changes. Finally, we have taken a new approach to the debate on the role of the Euro on the levels of trade. We have found that firms adopting the Euro increase their exports to Europe significantly compared to similar firms that do not.

In future versions of this paper we plan to include the following. First, we will compare the extent of price adjustment in response to exchange rate shocks before and after Chilean exporters started the Euro in 2002. We will calculate within-firm changes in exchange rate pass-through for firms that switched from pricing in Dollars to pricing in Euros. Second, we will use more detailed price data. The customs data of Chilean exports includes more detailed characteristics of the products exported, including their brand and other descriptors. We will obtain and incorporate this data in our analysis in the next version.
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