The Euro as Invoicing Currency in International Trade

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Abstract
This paper investigates the determinants of currency invoicing in international trade. Although the currency of invoicing is central for the transmission of monetary policy, empirical research on this topic is scarce due to a lack of data. With a new extensive invoicing dataset and a panel model analysis this paper shows that a country’s membership or prospective membership of the EU plays a decisive role in the choice of the euro as invoicing currency. The role of the euro as vehicle currency is increasing but still limited when compared to the U.S. dollar. Monetary instability and low product differentiation favour vehicle pricing in U.S. dollar. An increase of euro invoicing due to higher exchange rate volatility supports the role of the euro as vehicle currency, however. High market power defined as the share of a country’s total exports to world exports and membership of the euro area make invoicing in the home currency (euro) more likely.

JEL classification: F41, F42, L11

Keywords: International Trade; Currency Invoicing; Panel Data.

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1. Introduction

The choice of the currency in which international trade is invoiced has important implications both at the micro- and macroeconomic level. At the firm level, the profit maximization of firms engaged in international trade is clearly affected by their choice of currency while at the macroeconomic level the currency of invoicing in international trade affects business cycle correlations between countries and the transmission mechanism of monetary policy. The consequences of currency invoicing on the pass-through of the exchange rate have been analysed in a series of theoretical and empirical papers and are at the core of the New Open Economy Macroeconomics literature. While traditional macroeconomics assumed that the price of exports is set in the currency of the exporter so that exchange rate fluctuations lead to expenditure switching away from the appreciating currency’s goods, the new macroeconomic literature allows for the possibility of pricing to market, where prices are set in the local currency and do not fluctuate with the exchange rate.\(^1\) While the early literature just assumed that exporters prefer to price in their own currency to avoid price uncertainty (monetary habitat), the more recent theoretical literature models the choice of currency invoicing as a decision between price uncertainty and quantity uncertainty. Exporters pricing in their own currency know the price they will receive, but the quantity they sell is uncertain because the price in the local market fluctuates with the exchange rate. When the demand for the exporter’s good is very sensitive to price changes, the exporter may prefer to set the price in the currency of the competitors.

The choice of currency invoicing is, thus, central both for profit maximization at the firm level and for the transmission of monetary policy. Due to a lack of data there have been, however, only a few econometric studies on the choice of invoicing currency so far. These studies consist almost exclusively of country specific evidence on Canada, the Netherlands and Sweden.\(^2\) The use of a macroeconomic multi-country database is, however, important to show the general applicability of the results as compared to single country studies. Goldberg and Tille (2005) give first empirical findings on a broader set of countries. They mainly focus on the role of the U.S. dollar as invoicing currency, though. The dataset compiled for this paper is considerably larger. It consists of 35 countries and more than 150 observations for

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\(^1\) Betts and Devereux were among the first to include pricing to market (PTM) into NOEM models (1996, 2000).

invoicing in U.S. dollar and of 29 countries and around 150 observations for invoicing in euro. Most data concerning EU countries have been collected by the European System of Central Banks (ECSB). Early data for EU countries and data on non-EU countries was assembled from different national sources like central banks and statistical offices. Besides the new dataset, the main innovation of this paper is that it has a special focus on the role of the euro as vehicle currency. In particular, I analyse whether the launch of the third stage of Economic and Monetary Union (EMU) changed the invoicing patterns in international trade and the potential role of the euro as a vehicle currency. I also shed a light on the question whether an increasing share in euro invoicing is due to economic fundamentals or to the prospects of eventually adopting the euro by most Central and Eastern European Countries.

The main finding is that the membership or prospective membership of the EU leading to the future introduction of the euro and whether the country is in a hard peg with the euro play a decisive role in the choice of the euro as invoicing currency in its trade. The introduction of the common currency in the euro area increased the invoicing in euro at the expense of the U.S. dollar. The increased invoicing in euro can be found both for vehicle currency pricing and for producer and local currency pricing. The role of the euro as vehicle currency seems to be limited, however, when compared to the U.S. dollar. The estimation results show that higher monetary instability reflected in a high inflation differential, and a low differentiation of exports lead to less euro invoicing, while the contrary is true for the U.S. dollar, which supports the impression that the U.S. dollar is the preferred vehicle currency. There are some signs for the role of the euro as vehicle currency, however. Countries with no forward market for their currency are not only more likely to invoice in U.S. dollar but also to invoice in euro. Also, if a country exhibits high exchange rate volatility vis-à-vis the euro it is more likely to invoice in euro. All in all, the euro is increasingly used as invoicing currency both for bilateral trade and for vehicle currency invoicing. This is particularly true for the countries with the prospect of adopting the euro at some point in the future.

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3 For an overview of the data and its sources see the section on data description as well as the appendix of the working paper version (Kamps 2006).
2. Theoretical Literature

The main focus of the early literature on currency invoicing in international trade focused primarily on transactions costs and the stability and attractiveness of the major currencies. Already in 1968 Swoboda (1968) argued that highly liquid currencies with low transactions costs will be chosen as medium of exchange. In the same way McKinnon (1979) reasons that homogenous goods and primary commodities are likely to be invoiced in a single vehicle currency with low transaction costs. Similarly, Magee and Rao (1980) argue that strong currencies with low inflation are preferred. Viaene and de Vries (1992) take strategic bargaining considerations into account and introduce a forward market. They find that the dominance of the exporter’s currency can be due to the monopoly power of the exporter who is more likely to have bargaining power as the firm faces a wide spread demand and not many competitors. Summing up the early literature, the main findings are that traders seek to avoid currency risk by using their own currency and that, in trade between industrialised countries exporters are in general more likely to be able to avoid the currency risk.

When currencies are free to fluctuate there is, however, not only the issue of price uncertainty but also demand uncertainty. If prices are set before the exchange rate fluctuations are known and orders are placed after the shock to the exchange rate then the exporter faces demand uncertainty if he prices in his own currency (PCP) as the “seller does not know the effective price at the time the importer will make its purchases” (Baron 1976, p.427). There is, thus, price uncertainty when exports are priced in the local currency (LCP) as the exporter does not know which price (in his own currency) he will receive and demand uncertainty when the exporter chooses producer currency pricing (PCP). There are therefore two distinctive sets of determinants for invoicing. One reason to choose a specific currency of invoicing can be to avoid demand uncertainty due to exchange rate fluctuations (LCP is chosen). The choice of LCP is therefore determined by microeconomic considerations concerning the demand and cost structure of the exporting firm as will be illustrated in the following. If an exporter is more concerned about price uncertainty because the demand for his goods is less price sensitive macroeconomic considerations as discussed before and further formalized in the theoretical literature will play the decisive role.

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4 This is the assumption usually made in the theoretical literature.
Donnenfeld and Zilcha (1991) present a first formal model in which a firm’s choice of invoicing currency is analysed. They are also among the first to develop a model on the microeconomic level in which the firm optimizes its profits. The main finding of Donnenfeld and Zilcha is that LCP is optimal for the exporting firm if the total revenue curve is concave in the foreign price. This is the case when the sensitivity of demand with respect to prices is not much higher the higher the price level. That is, if the price is set in producer currency and increases (in foreign currency) due to an appreciation of the exporting firm’s currency, profits will fall because demand will be reduced by more than the increase in profits due to the higher price received. In the case of a depreciation, demand is not extended enough to compensate for the lower price the exporting firm receives, because demand is less sensitive to the price at the lower price level. If this is the case, higher variability in foreign prices, which comes with higher volatility in the exchange rate under PCP, lowers expected profits. Thus, under these conditions, high exchange rate volatility would lead the exporting firm to choose LCP.

Bacchetta and van Wincoop (2005) use a New Open Economy Macroeconomics (NOEM) model to analyse the optimal pricing strategy of exporters. In a general equilibrium framework that also takes into account exchange rate dependent costs they derive similar conclusions to those of Donnenfeld and Zilcha. The driving factors for exporters to care about their relative prices are the demand sensitivity of costs and the price sensitivity of demand. It can be said that the higher the product differentiation, the lower the price sensitivity of demand. Exporters will, thus, prefer to invoice in their own currency if their products are highly differentiated, while they will pay attention to holding their relative prices constant if their products are less differentiated. This does not mean that less differentiated products are always invoiced in LCP, however. Bacchetta and van Wincoop build into their model the market share of the exporting country in the foreign market – that is, the share of the market that is accounted for by firms from a particular country or monetary area. Demand risk is minimized by invoicing in the currency that is most “similar” to the average invoicing

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5 Giovannini (1988) presents a similar model; his emphasis is, however, not on the firm’s invoicing decision.
6 When the “elasticity of the slope of demand for exports is not too large” (Donnenfeld and Haug 2003, p.335)
7 One of the main assumptions in NOEM is that prices are sticky. Hence, in the short run the exporter’s price can only stay the same under exchange rate movements if it is set in the local currency. This explains the close relationship between the pricing to market (PTM) literature and the currency invoicing literature.
currency chosen by competitors. For a monetary union, it is the market share of the entire currency union that matters and not the market share of an individual country. Exports of a monetary union are therefore more likely to be priced in producer currency, and imports to a monetary union more likely to be priced in local currency, because the monetary union’s market share is more likely to be dominant.

Friberg (1997) and Johnson and Pick (1997) elaborate on the Donnenfeld and Zilcha model by allowing for the possibility to set prices in a third currency: vehicle currency pricing (VCP). Friberg (1997) also finds that the choice of the optimal currency setting is closely linked to the price elasticity of foreign demand. The second best currency pricing strategy depends on the relative exchange rate volatilities. If the exchange rate towards the vehicle currency exhibits low volatility compared to the bilateral exchange rate of the exporter and importer, VCP is preferred and vice versa. Johnson and Pick (1997) introduce competition from other countries’ exporters. Now, even under LCP the demand for the firm’s product is uncertain because the competitors might not price in local currency. In such a case fixing the relative price of the competing products can be important to the exporters so they might choose a common vehicle currency. Goldberg and Tille (2005) call this behaviour of choosing the currency of the competitor a “herding effect”. In their partial equilibrium three country model a dominant share of a currency other than the one of the exporter or the importer can make vehicle currency pricing the optimal choice. This herding effect takes place for industries with homogeneous goods where producers aim at keeping their prices relative to the competitors stable.

Summing up the theoretical literature, the most important finding is that the sensitivity of foreign demand to prices matters, which can be approximated by the homogeneity or differentiation of the product. When demand is sensitive to prices the market share of the exporting country, or more specifically, the currency used by the competitors matters. When the optimal currency choice depends on the currency used by competitors, herding in the same currency is optimal. Also, currencies of countries with monetary stability are more likely to be chosen as invoicing currency.
3. Stylized Facts and the Empirical Literature

Data on currency invoicing has been very scarce to date. This is the reason why many studies rely on simple and often static comparisons of data and anecdotal evidence. The first empirical finding on local versus producer currency pricing by Grassman (1973) regarding Swedish foreign trade was that Swedish exports are mostly invoiced in Swedish kronas and Swedish imports are mostly invoiced in the exporter’s currency, while the U.S. dollar was not often used as invoicing currency. These findings contradicted the vehicle currency hypothesis and were later generalized and called Grassman’s law. This law states that PCP is dominant for manufacturing trade between industrialized countries. Trade in primary products is mostly denominated in U.S. dollar, while trade between developing and industrialized countries is predominantly invoiced in the industrialized country’s currency. The intuition behind Grassman’s law is that a firm with more bargaining power will choose its own currency to avoid exchange rate risk.\(^8\) There is anecdotal evidence linking the use of a currency to the level of product differentiation and the strength of a currency. Tavlas (1991) finds that PCP is more likely if products are differentiated. He gives this as an explanation why invoicing in Deutschmark increased from 1980 to 1987. He also argues that the stability of the Deutschmark promoted its use as invoicing currency (Tavlas 1997). Oi, Otani and Shirota (2004) find that the Yen is more often used in Japanese export industries with differentiated products like the automobile industry.

The first econometric analysis on the currency choice of Canadian imports was performed by Donnenfeld and Haug (2003). They find weak evidence of a positive relationship between LCP and exchange rate volatility. They also find a negative relationship between the exporter’s country size and invoicing in a third currency (VCP). In this study, country size is interpreted as a sign for market power with the following reasoning: The larger the country, the larger the size of the firm, the more market power for the firm.\(^9\) Thus, a firm from a large country is more likely to price in own currency and less likely to price in a vehicle currency.

Wilander (2004) performs a similar econometric analysis on currency invoicing in Swedish exports by industry for the years 1999 to 2002. His findings on exchange rate risk are,

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\(^8\) For overviews on stylized facts regarding currency invoicing see also Bilson (1983) and Hartmann (1998).

\(^9\) This argumentation is, thus, essentially different from the “herding effect” as discussed by Bacchetta and van Wincoop.
however, contrary to the evidence of Donnenfeld of Haug (2003). In particular, he finds a negative relationship between exchange rate volatility and local currency invoicing.\textsuperscript{10} Other findings of Wilander (2004) are that local currency pricing is promoted by low inflation, by the presence of a stable financial market, and the absence of capital controls and a black market. His hypothesis that less differentiated products are less likely to be invoiced in the producer currency is not explicitly tested, but the pattern in the Swedish exports, where the paper and pulp industry invoices only around 25 percent of its exports in Swedish kronas as compared to around 60 percent in the motor vehicle industry, points into that direction.

In his analysis on Dutch invoicing practices, Silva (2004) finds evidence contrary to Grassman’s law, which states that exports are predominantly invoiced in the currency of the exporter. He finds that for Dutch exports to industrialized countries, the currency of the trading partner, and not the Dutch guilder, was dominant. Furthermore, the strength of a currency, the depth of the financial market and the absence of high inflationary tendencies enhance the use of a country’s currency. Exchange rate volatility and exchange rate expectations do not prove to be decisive in the choice of the invoicing currency. Goldberg and Tille (2005) highlight the importance of organized exchange and reference pricing\textsuperscript{11} in the role of the U.S. dollar as invoicing currency. They find that the dollar’s use in these markets can explain most of the dominance of the U.S. dollar as vehicle currency. They also point out that the declining importance of organized exchanges and referenced prices could be the reason for the U.S. dollar’s declining importance as a vehicle currency.

What does the literature say about the dominance of the U.S. dollar as a vehicle currency? Wilander (2004) finds that the use of the euro as vehicle currency increased from 1999 to 2002, while this was not at the cost of the U.S. dollar but rather there was less invoicing in producer’s currency (the Swedish krona). Goldberg and Tille (2005) observe that the U.S. dollar is still the dominant currency with U.S. exports and imports to Latin America, China, Mexico, and most small countries being almost exclusively invoiced in U.S. dollar. In her analysis on accession countries Goldberg (2005) argues that the accession countries are using

\textsuperscript{10} One reason for this finding could be that his analysis is based on Swedish exports while Donnenfeld and Haug’s analysis is based on Canadian import data.

\textsuperscript{11} Reference pricing refers to goods which are not necessarily centrally traded, but for which there are common price quotations for example in insider journals. Goldberg and Tille (2005) use an index created by Rauch (1999). For further details see next section.
the euro to a degree that is higher than optimal given their trade partners’ composition of trade and the variance and covariance of macroeconomic conditions vis-à-vis the trading partners.

4. **Empirical Findings**

The main reason why there has not been more empirical research on the invoicing currency in trade is the scarcity of the data. As discussed in the previous section there are only a few econometric studies on the choice of invoicing currency and these include only evidence on Canada, the Netherlands and Sweden. While these studies are very valuable as country studies it is necessary to take in the broader picture of as many countries as possible. Goldberg and Tille (2005) give first empirical findings on a broader set of countries. My dataset is much larger\(^\text{12}\) and I will focus on the role of the euro as invoicing currency. While I also consider U.S. dollar invoicing, I will put it into a framework where the launch of the euro plays a decisive role.

4.1 **The Invoicing Database**

Annual aggregated data on currency invoicing is taken from national central banks, statistical offices and from a survey by the ECB. For an overview of the complete set of invoicing data and its sources see the appendix of the working paper version (Kamps 2006). The currency of invoicing is in most cases approximated by the currency of settlement.\(^\text{13}\) In some countries data was collected by the central banks with a reporting system covering cross-border payments (e.g. the Netherlands until 2002), other countries conduct a survey (e.g. Germany). In some countries the data on invoicing is an approximation retrieved from the currency structure of foreign exchange receipts and payments (e.g. Slovakia).

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\(^{12}\) While Goldberg and Tille (2005) use data on 25 countries for one point in time, my dataset consists of 42 countries and more than 150 observations.

\(^{13}\) For some data it is unclear whether reference is to currency of invoicing or settlement. However, the differences in the two are likely to be negligible according to Page (1977, 1981).
Figure 1: Average share of currencies used in exports and imports by region

Note: Before 1999 euro stands for the euro area legacy currencies. Other (currencies) is calculated as residual. Source: Kamps (2006); data for euro area based on extra-euro area trade, own calculations.
If a distinction is possible, data for trade in goods is chosen as compared to trade in services. For the very rare case that there is no distinction between exports and imports only overall trade is reported, this is taken as an approximation for both export and import invoicing. Before 1999 invoicing in euro is defined as invoicing in the euro area legacy currencies. Altogether the database includes data on 42 countries. I cover an estimation period from 1994 until 2004 although some data is available already for a longer time period. The dataset is, however, still unbalanced over time so that for some countries there are up to 10 observations and for others only 1.

As can be seen from Figure 1, the use of invoicing currencies differs considerably between regions. The U.S. dollar is by far the dominant currency in the Asia Pacific region, while the euro has become the dominant invoicing currency for trade of EU-25 and candidate countries (excluding euro area countries). The share of euro invoicing has increased over time, both for EU-25 countries and for extra euro area trade of euro area countries. This seems to be at the cost of U.S. dollar invoicing. The British Pound (GBP) and the Japanese Yen (JPY) only play a minor role for currency invoicing in trade.

4.2 The Explanatory Variables

First of all, some explanatory variables concerning bilateral trade are created. To control for the exports and imports to and from the U.S. and the euro area I include the respective shares of exports and imports of a country’s total exports and imports. The data are taken from the IMF Direction of Trade Statistics. This database is also used to create a measure of market power created as the share of a country’s total exports to world exports, which should reflect the size of a country’s firm. Following the approach in Goldberg and Tille (2005), to take into...

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14 For most of the EU countries data on services exists. This data is not included in this paper. It is available in the Review of the International Role of the Euro published by the ECB (2005) in December 2005.
15 This is the case only for Slovakia, data from Latvia (1994 to 2000) and for Malaysia (1999 to 2003).
16 For some countries only data on the share of some legacy currencies (mainly the DEM) is available.
17 Unfortunately, there is no data at all for Latin America. Presumably, the U.S. dollar is by far the dominant currency of invoicing in this region.
18 Invoicing in euro for extra euro area exports as a share in world exports is with around 28 percent already higher than long-run projections made by Hartmann (1998). For details on calculations see Kamps (2006).
19 This variable is important as due to a lack of bilateral invoicing data the distinction between PCP, VCP and LCP becomes almost impossible. Including the relative trade share tries to control for all invoicing in bilateral trade.
account the share of trade in differentiated products a variable is created according to the Rauch (1999) definitions. The data on commodities is taken from the UN Comtrade database. The definition of the group of products is very precise in the sense that it does not only divide into aggregated groups of commodities and non-commodities, but it is detailed up to the fourth digit code of the SITC. The share of exports and imports of differentiated products in total exports and imports is calculated for the year 2004.

To capture the influence of exchange rate risk, I set up a variable on exchange rate volatility. I construct a four-month moving average standard deviation of the nominal exchange rates of a country’s currency vis-à-vis the U.S. dollar and vis-à-vis the euro (vis-à-vis the DEM before the introduction of the euro in 1999) respectively. As variable describing a country’s monetary stability I use the inflation differential to the U.S and to the euro area (to Germany before 1999). Monthly data for both the inflation and the nominal exchange rates are taken from the IMF International Financial Statistics database. I then specify a set of dummy variables. In particular, I construct a dummy that takes on the value of 1 for all countries which are either part of the European Union in 2005 (EU-25) or are formally recognized as EU candidate countries and 0 otherwise. In addition, to take into account structural changes due to the introduction of the euro, I create a step dummy that takes on the value of 1 from 2002 on. This is when the euro currency was introduced and the use of the national legacy currencies was discontinued. To mirror the availability of a currency on the forward market a dummy is created that takes on the value 1 for all those countries (currencies) which had a forward market in 1999. Two other dummies are created that take

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20 Rauch (1999) classifies all commodities by “looking them up in International Commodity Markets Handbook and The Knight-Ridder CRB Commodity Yearbook (to check for organized exchanges) and Commodity Prices (to check for reference prices).” All products not found in these categories are differentiated goods.

21 Codes are taken from http://www.macalester.edu/research/economics/PAGE/HAVEMAN/Trade.Resources/TradeData.html#Rauch and are based on the liberal classification of Rauch (1999).

22 The share is assumed to be constant over time as the structure of trade is not likely to change from one year to another. For an overview table see appendix of Kamps (2006).

23 This dummy variable is not time-variant as it tries to capture the group of countries that have been, throughout the period under consideration, part of the EU or widely seen as prospective members of the EU.

24 I also experimented with having the dummy take on the value of 1 starting in 1999. This leads to very similar results. There are, however, only a few observations before 1999. This is why the 2002 dummy is preferred.

25 The choice of the year 1999 is somewhat ad hoc, but it is chosen to coincide with the introduction of the forward market for the euro in 1999.
on the value 1 for all those years in which a country had a hard peg either to the U.S dollar or to the euro respectively.26

4.3 Empirical Methods

As my dataset covers both a cross-sectional and a time-series dimension, I estimate a panel model. The first estimation method I use is a one-way random-effects GLS panel. The random effects model is preferred to the fixed effects model as country specific constants would result in a considerable loss of degrees of freedom. More importantly, I also want to consider time-invariant explanatory variables, which is not possible in a fixed effects model. The Breusch-Pagan Lagrange Multiplier test for a zero variance of the individual errors could be rejected for every estimation. This implies that my dataset cannot be pooled. At the same time I choose a one-way as compared to a two-way random effects model because my panel is highly unbalanced on the time dimension. To test whether the estimators are biased I perform a Hausman test comparing the coefficients of the fixed and the random effects estimation. The null hypothesis of no systematic differences cannot be rejected in almost all of the cases, so that the random effects coefficient estimates should be consistent and asymptotically efficient.

As a second estimation method I report the results for a fixed effects estimation to show the robustness of the results. The third estimation method I use is a Prais-Winston estimation with panel corrected standard errors. This controls for possible heteroscedasticity across the panel and panel specific autocorrelation. The last estimation method I apply is a Prais-Winston regression with importance weights. As the dataset includes data on very diverse economies, it is interesting to see whether the inclusion of the GDP of the country as importance weight makes a difference to the estimation results. While it would also be interesting to estimate a logit or probit model, the nature of the new dataset makes it a sub-optimal choice as there would be a loss of observations both over time and over countries as only a few countries report both the share of U.S. dollar and of euro invoicing and even less report the share of own currency invoicing. Likewise, the limited time dimension of the panel does not allow for a study of the dynamics of the panel. This would have been an interesting analysis especially with respect to the possible persistence of currency invoicing.

26 In particular, this is for the euro (DEM before 1999): Estonia (from 1992), Bulgaria (from 1998) and Lithuania (from 2002). For the U.S. dollar: Lithuania (from 1994 to 2001) and Malaysia (from 1999).
The Empirical Model for U.S. Dollar Export Invoicing

I first examine the cross-sectional and intertemporal variation in U.S. Dollar (USD) invoicing for exports of around 30 countries over a period from 1994 to 2004. The data is highly unbalanced as for some countries there is only 1 observation while for others there are up to 10 observations. The most general one-way random effects model I estimate is the following:

\[
\text{usdex}_{it} = \beta_1 + \beta_2 \text{shexus}_{it} + \beta_3 \text{eurinst}_{it} + \beta_4 \text{euroint}_{it} + \beta_5 \text{rauex}_{i} + \beta_6 \text{usexvol}_{it} + \beta_7 \text{usinf}_{it} + \beta_8 \text{fmdum}_{i} + \beta_9 \text{usdpeg}_{it} + u_{it},
\]

where \( i = 1, \ldots, 30, \ t = 1, \ldots, 10 \) (highly unbalanced) and \( u_{it} = v_i + e_{it} \), where \( v_i \) is the random error attributable to countries and \( e_{it} \) is a white noise residual. In this specification \( \text{usdex} \) is the share of exports invoiced in U.S. dollar in percentage terms and \( \text{shexus} \) stands for the share of a country’s exports to the U.S. relative to a country’s total exports. I expect a country to have a higher share of U.S. dollar invoicing the higher the share of trade with the U.S.

\( \text{Eurinst} \) is a 0/1 dummy taking on the value 1 for all EU-25 and candidate countries while \( \text{euroint} \) is a 0/1 dummy taking on the value 1 for all observations from 2002 onwards mirroring the introduction of the euro currency and the discontinuation of the legacy currencies. These two dummies should reflect whether being a (prospective or actual) member of the EU, even for those who are not yet participating in the monetary union, makes a difference in their choice of invoicing currency. The second dummy tries to capture the individual effect attributable to the introduction of the common currency. I expect both variables to have a negative impact on USD invoicing. In particular, the “herding effect” brought forward by Bacchetta and van Wincoop (2005) and Goldberg and Tille (2005) implies that because a monetary union has a higher “country” share than the individual country before, invoicing in that currency is more likely and makes the use of the USD less likely.

The impact of the variable \( \text{usexvol} \) is ambiguous. As discussed at large in the previous section, the evidence on the impact of exchange rate risk is very ambiguous. In particular the influence depends on the level of product differentiation. While for differentiated products, an exporter would want to avoid a foreign currency to limit the fluctuations of the price he

\[27 \text{In this sense the variable should capture all local currency pricing to the U.S.}\]
receives, for less differentiated products the exporter wants to limit his quantity uncertainty and tends to set prices in the same currency as the competitor.

As I cannot distinguish between differentiated goods at the industry level, I set up a variable capturing a country’s share of differentiated trade. \( RaueX \) is the time invariant share of a country’s differentiated products in total exports.\(^{28}\) This variable is constructed to account for the possibility of different pricing strategies for differentiated and non-differentiated goods, the exporter being more likely to want to keep its relative prices stable in the case that his exports are non-differentiated.\(^{29}\) The most likely assumption is that there is a natural herding in USD (also reflected in the goods traded in world markets or goods with a referenced price). Thus, \( raueX \) is expected to have a negative influence on USD invoicing since the higher the share of differentiated goods the more likely the exporter can set the price in the own currency.

\( Usinf \) reflects the monetary stability of a country. A high inflation differential with respect to the U.S. stands for economic instability, which makes the use of that country’s currency less likely. The forward market dummy \( fmdum \) reflects the presence of a forward market. If a forward market for their currency exists, exporters are more likely to be able to use their own currency as the importer can hedge the exchange rate risk. I take the presence of a forward market (already in 1999) as a sign that this country’s currency is available easily and at low cost. The existence of a forward market implies more invoicing in that currency (PCP) and less invoicing in USD (VCP). \( Usdp\text{e}g \) is a 0/1 dummy that takes on the value 1 for periods where a country’s currency is in a hard peg with the USD.

Table 1 summarizes the results of the regression. As discussed in the section on methodology the table reports several estimation methods as a robustness check. When discussing the regression results the main focus will be on the random effects regression while always checking for possible discrepancies to the other estimations. Since the dependent variable is expressed in percentage points, the coefficients of the dummy variables can be

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\(^{28}\) Defined as total exports minus exports of goods priced on world markets and referenced goods. For a more detailed description see the section on data description.

\(^{29}\) For a more detailed explanation see the section on the theoretical literature.
directly added or subtracted. The coefficients of the other variables have to be multiplied with the value of the variable to give the percentage point impact.\textsuperscript{30}

Table 1:
U.S. Dollar Export Invoicing
Dependent variable: share of exports invoiced in U.S. Dollar (in percentage points)

<table>
<thead>
<tr>
<th>Regression</th>
<th>random</th>
<th>fixed</th>
<th>PW\textsuperscript{a}</th>
<th>weighted\textsuperscript{b}</th>
</tr>
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<tbody>
<tr>
<td>Constant</td>
<td>94.95***</td>
<td>49.21***</td>
<td>92.29***</td>
<td>96.80***</td>
</tr>
<tr>
<td></td>
<td>(9.39)</td>
<td>(18.79)</td>
<td>(19.38)</td>
<td>(18.35)</td>
</tr>
<tr>
<td>Share of exports to U.S</td>
<td>0.04</td>
<td>0.04</td>
<td>0.17***</td>
<td>0.16***</td>
</tr>
<tr>
<td></td>
<td>(0.23)</td>
<td>(0.18)</td>
<td>(2.64)</td>
<td>(4.15)</td>
</tr>
<tr>
<td>EU-25 and candidates</td>
<td>-36.16***</td>
<td>-22.20***</td>
<td>-20.05***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-5.58)</td>
<td>(-5.56)</td>
<td>(-14.95)</td>
<td></td>
</tr>
<tr>
<td>Introduction of the euro (2002)</td>
<td>-4.56***</td>
<td>-4.63***</td>
<td>-2.71***</td>
<td>-2.00***</td>
</tr>
<tr>
<td></td>
<td>(-6.38)</td>
<td>(-6.32)</td>
<td>(-3.24)</td>
<td>(-4.58)</td>
</tr>
<tr>
<td>Share of differentiated exports</td>
<td>-0.35*</td>
<td>-0.51***</td>
<td>-0.46***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.81)</td>
<td>(-3.34)</td>
<td>(-3.92)</td>
<td></td>
</tr>
<tr>
<td>Exchange rate volatility to U.S.</td>
<td>-23.40</td>
<td>-22.15</td>
<td>-14.37</td>
<td>32.61</td>
</tr>
<tr>
<td></td>
<td>(-0.82)</td>
<td>(-0.76)</td>
<td>(-0.42)</td>
<td>(1.22)</td>
</tr>
<tr>
<td>Inflation differential to U.S.</td>
<td>0.32***</td>
<td>0.32***</td>
<td>0.17**</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(5.39)</td>
<td>(5.27)</td>
<td>(2.45)</td>
<td>(-0.15)</td>
</tr>
<tr>
<td>Forward market</td>
<td>-5.63</td>
<td>-8.01***</td>
<td>-16.70***</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.13)</td>
<td>(-3.15)</td>
<td>(-2.98)</td>
<td></td>
</tr>
<tr>
<td>Peg to USD</td>
<td>9.56***</td>
<td>9.33**</td>
<td>9.67***</td>
<td>6.38</td>
</tr>
<tr>
<td></td>
<td>(2.70)</td>
<td>(2.61)</td>
<td>(2.69)</td>
<td>(0.34)</td>
</tr>
</tbody>
</table>

Number of observations | 176 | 176 | 176 | 176 |
Number of countries | 36 | 36 | 36 | 36 |
Wald chi2 | 188.7 | 655.0 | 2474.0 |
R squared overall | 0.69 | 0.03 | 0.94 | 0.98 |

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

\textsuperscript{a} Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.
\textsuperscript{b} Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

Both in the random effects and in the fixed effects specification the share of exports going to the U.S. does not have a significant impact on USD currency invoicing. This is likely due to the fact that for most countries the use of the U.S. dollar as a vehicle currency is much

\textsuperscript{30} The constant need not be between 0 and 100. The economic interpretation being that it is the share of invoicing in the currency given the explanatory variables take on their average value. Thus, as is the case for euro invoicing, the constant can take on a negative value.
more important than its use in bilateral trade with the U.S.\footnote{In an alternative specification, I include the exports by Asian countries not only to the U.S. but also those going to the East Asian Dollar Block. This variable then has a significant positive impact on U.S. dollar invoicing while not affecting the other results. As the trade between East Asian Dollar Block countries still has to be considered as vehicle currency invoicing this confirms the role of the U.S. dollar as vehicle currency.} Being part of the EU, as defined above, significantly reduces the average share of exports invoiced in U.S. dollar (by around 35 percentage points). Likewise, the introduction of the euro currency in 2002 reduced export invoicing in USD by around 4 percentage points. This could point at some substitution of vehicle currency use from USD to the euro. It could, however, also be that countries of the euro area which previously relied more on USD invoicing are now able to invoice in their own currency. We will see more evidence on the role of the euro as vehicle currency in the sections on euro invoicing.

The share of differentiated products in exports has a significantly negative effect on the share of exports invoiced in USD for all estimations. This confirms the findings of Goldberg and Tille (2005). The product differentiation does matter as expected by the theory. The exchange rate risk, however, does not have a significant impact on the invoicing decision in any estimation and, as expected, yields ambiguous results.\footnote{Goldberg (2005) suggests for example that rather than on the exchange rate volatility the invoicing decision depends on a covariance between marginal cost and exchange rates.} It could be that the exchange rate volatility is not significant because the effect of exchange rate uncertainty depends on the degree of product differentiation. To test for this I include an interaction variable of exchange rate volatility and the share of differentiated products. This variable is, however, also highly insignificant.\footnote{I also experimented with including adaptive exchange rate expectations modelled as the 4 year average of the exchange rate, but this variable was insignificant. Likewise, the spread with the U.S. dollar was also insignificant. Results are available on request.} Countries with a hard peg to the USD should have a 9 percentage points higher share of exports invoiced in USD. All the dummy variables are straightforward in their interpretation as they take on the value of one for all data points included in that group. This means that the coefficients for dummy variables directly show the impact of belonging to this group on the dependent variable, while the size of the coefficients for the other variables does not necessarily say something about their importance as they have to be multiplied with the variable. Thus, the coefficient of the share of differentiated products seems to be very small. However, a country like Germany with around 70 percent of its exports being differentiated...
should ceteris paribus have around 25 percentage points less USD invoicing compared to a country like Algeria with almost no differentiated exports.

The financial stability of a country also matters for the choice of currency in trade. High inflation differentials to the U.S. significantly increase USD invoicing.\(^{34}\) A country like Indonesia with an average inflation differential to the U.S. of around 6 percentage points (from 2000 to 2004) should on average invoice around 2 percentage points more of its exports in U.S. dollar than a country with the same inflation rate as the U.S. The existence of a forward market for the country’s currency reduces the invoicing in USD by around 5 percentage points. This result is, however, only statistically significant in some of the equations. In other specifications not reported in the table, the measure of market power, that is a country’s export share in total world exports, was also included. While this did not change the other results, neither the market power of a single country nor the market power of the whole euro area were found to be significant. The same is true if GDP is taken as a measure of a country’s market power. It is not significant in any of the estimations.\(^{35}\) While the role of the euro as vehicle currency is not easy to infer from these estimation results, I have a closer look at this in the following section.

### 4.5 The Empirical Model for Euro Export Invoicing

The estimation is structured in the same way as the USD invoicing estimations;\(^{36}\)

\[
eurex_i = \beta_1 + \beta_2 \text{shexeur}_i + \beta_3 \text{eurinst}_i + \beta_4 \text{euroint}_i + \beta_5 \text{rauex}_i + \beta_6 \text{eurexvol}_i + \beta_7 \text{euroinf}_i + \beta_8 \text{fmdum}_i + \beta_9 \text{eurpeg}_i + u_i, \tag{2}
\]

where \(eurex\) is the share of exports invoiced in euro and \(shexeur\) the share of exports going to the euro area, \(eurexvol\) the exchange rate volatility vis-à-vis the euro, \(euroinf\) the inflation

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\(^{34}\) In the case of the inflation differential variable (as for exchange rate volatility), extreme data points are excluded because in relation to these extreme points, other country and time specific differences are likely to be dominated. Also, I did not want my estimations to be driven by some extreme data points. This is only the case for Indonesia in 1998.

\(^{35}\) This is the case not only for the U.S. dollar estimations, but also for the estimations for euro and home currency invoicing. Likewise, I experimented with including inflation volatility and money volatility as measures of financial stability. While the qualitative results were quite similar, these variables were not significant in any specification.

\(^{36}\) The euro area countries are left out in the euro invoicing estimation, of course. This data will be part of the home invoicing estimations.
differential to the euro area and eurpeg is a 0/1 dummy variable that takes on the value 1 for all those periods in which a country had a hard peg vis-à-vis the euro.

Table 2:
Euro Export Invoicing
Dependent variable: share of exports invoiced in euro (in percentage points)

<table>
<thead>
<tr>
<th>Regression</th>
<th>random</th>
<th>fixed</th>
<th>PW(^a)</th>
<th>weighted(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-20.59*</td>
<td>20.78***</td>
<td>-28.66***</td>
<td>-2.44</td>
</tr>
<tr>
<td></td>
<td>(-1.92)</td>
<td>(4.35)</td>
<td>(-5.73)</td>
<td>(-0.29)</td>
</tr>
<tr>
<td>Share of exports to euro area</td>
<td>0.47***</td>
<td>0.31**</td>
<td>0.67***</td>
<td>0.44**</td>
</tr>
<tr>
<td></td>
<td>(4.66)</td>
<td>(2.53)</td>
<td>(9.24)</td>
<td>(2.37)</td>
</tr>
<tr>
<td>EU-25 and candidates</td>
<td>16.99**</td>
<td>15.50***</td>
<td>7.28</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.40)</td>
<td>(4.17)</td>
<td>(0.93)</td>
<td></td>
</tr>
<tr>
<td>Introduction of the euro (2002)</td>
<td>6.34***</td>
<td>6.27***</td>
<td>4.20***</td>
<td>1.73**</td>
</tr>
<tr>
<td></td>
<td>(7.43)</td>
<td>(7.33)</td>
<td>(4.82)</td>
<td>(2.05)</td>
</tr>
<tr>
<td>Share of differentiated exports</td>
<td>0.49**</td>
<td>0.52***</td>
<td>0.17**</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(2.45)</td>
<td>(4.38)</td>
<td>(2.54)</td>
<td></td>
</tr>
<tr>
<td>Exchange rate volatility to euro</td>
<td>70.26*</td>
<td>80.41**</td>
<td>18.95</td>
<td>37.65</td>
</tr>
<tr>
<td></td>
<td>(1.95)</td>
<td>(2.23)</td>
<td>(0.53)</td>
<td>(0.98)</td>
</tr>
<tr>
<td>Inflation differential to euro area</td>
<td>-0.30***</td>
<td>-0.33***</td>
<td>-0.18***</td>
<td>-0.07</td>
</tr>
<tr>
<td></td>
<td>(-4.53)</td>
<td>(-4.91)</td>
<td>(-3.06)</td>
<td>(-0.32)</td>
</tr>
<tr>
<td>Forward market</td>
<td>-7.59</td>
<td>2.92</td>
<td>-8.78</td>
<td></td>
</tr>
<tr>
<td></td>
<td>(-1.34)</td>
<td>(1.09)</td>
<td>(-1.52)</td>
<td></td>
</tr>
<tr>
<td>Peg to euro</td>
<td>12.95***</td>
<td>13.64***</td>
<td>8.54**</td>
<td>15.54</td>
</tr>
<tr>
<td></td>
<td>(3.53)</td>
<td>(3.53)</td>
<td>(2.56)</td>
<td>(0.99)</td>
</tr>
<tr>
<td>Number of observations</td>
<td>152</td>
<td>152</td>
<td>152</td>
<td>152</td>
</tr>
<tr>
<td>Number of countries</td>
<td>29</td>
<td>29</td>
<td>29</td>
<td>29</td>
</tr>
<tr>
<td>Wald chi2</td>
<td>234.4</td>
<td>894.8</td>
<td>105.1</td>
<td></td>
</tr>
<tr>
<td>R squared overall</td>
<td>0.76</td>
<td>0.47</td>
<td>0.93</td>
<td>0.76</td>
</tr>
</tbody>
</table>

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
\(^a\) Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.
\(^b\) Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

Table 2 presents an overview of the estimation results. It shows that being part of or a candidate for the EU increases euro export invoicing by around 17 percentage points. When comparing this coefficient with the coefficient on eurinst in the USD estimations, we can see that it is smaller. The explanation for this is straightforward, as in the euro specification the
share of exports going to the euro area does have a significant positive effect as expected. This does already show that unlike the USD which is mainly used as vehicle currency, the use of the euro might rather be concentrated in bilateral trade. It is also interesting to see that being part of Europe does seem to have an impact on euro invoicing which is not necessarily linked to the higher trade share of these countries with Europe. The introduction of the common currency increased the share of exports invoiced in euro as compared to the share of exports invoiced in legacy currencies before by around 6 percentage points. This coefficient is comparable to the reduction of U.S. dollar invoicing which comes with the introduction of the euro in the USD export invoicing equation.

How important is the role of the euro as vehicle currency? The table reveals that the share of the differentiated products (rauxe) has a significant and positive impact on euro export invoicing. This is an interesting finding in the question on whether the euro is used as a vehicle currency. If the euro were substantially used as a third currency in trade, less differentiated goods would be more likely to be invoiced in euro and products with higher differentiation would be invoiced in euro to a lesser amount. The contrary is the case, and the results, thus, just reflect the lower share of U.S. dollar invoicing for more differentiated products. Or to put it the other way around, it reflects the higher share of USD vehicle currency pricing in less differentiated products like primary commodities.

The possible role of the euro as vehicle currency could also be reflected as a higher share of euro invoicing for an economy which displays high exchange rate volatility and high financial instability. The impact of the exchange rate volatility is significantly positive unlike in the case for U.S. dollar invoicing, although this finding is not stable over the different estimation methodologies. This result confirms that the findings for exchange rate risk are quite

37 A country like Estonia with around 40 percent of its exports going to the euro area has an around 20 percentage points higher invoicing in euro in addition of the around 16 percentage points due belonging to the EU.

38 I also experimented with including a geographical measure of distance. The geographical distance in combination with shexeur and eurinst is not significant. Only when either shexeur or eurinst are excluded is the measure of distance significant. The other results do not change qualitatively. This analysis was performed to control for possible collinearity between the share of exports and the dummy for being part of or a prospective member of the EU25. As both variables are significant, however, this should not be a problem but can be kept in mind when interpreting the ceteris paribus impact of the two variables.

39 The impact should still be negative even if it reflects bilateral trade with the euro area (for which I try to control), as it should make local currency pricing (the exports to the euro area invoiced in euro) less likely.
ambiguous. At the same time it gives some evidence for the theoretical argument that a more stable currency is preferred. There is, thus, a role for the euro as a vehicle currency in trade between countries with high exchange rate volatility. At the same time, if a country exhibits monetary instability it should be more likely to invoice in a vehicle currency, so that there should be a positive impact of inflation differentials on euro invoicing if the euro were used as a vehicle currency. The inflation differential with the euro area does have a significantly negative impact on euro export invoicing, however. This shows that if countries choose a vehicle currency, the choice is most likely the USD. This is then a convincing argument against a leading role of the euro as compared to the U.S. dollar. It could, however, be argued that the estimation results only reflect the choice between USD and euro invoicing, while the euro might be preferred in the choice between own currency and vehicle currency. When setting the share of export invoicing in relation to the (approximated) share of home currency invoicing leaving out USD invoicing, the inflation differential has an insignificantly positive impact on euro invoicing. It is also interesting to see that in this estimation the share of exports going to the euro area, being part or a candidate of the European Union, the introduction of the euro and the dummy for a hard peg to the euro still have significant positive effects. The share of differentiated products does still have a positive, albeit insignificant effect on euro invoicing. Another interesting finding is, that countries without a forward market are – in this specification significantly so – more likely to invoice in euro. Thus, there does seem to be a case for the euro as vehicle currency even though in comparison with the U.S. dollar the role of the euro as vehicle currency seems to be limited.

4.6 The Empirical Model for Home Currency Export Invoicing (PCP)

Unlike the estimations for U.S. dollar and euro invoicing, this estimation is a straightforward test of the PCP theory, as it tests the extent to which exports are denominated in a country’s own currency. The observations are mainly based on the home invoicing of euro area

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40 Silva (2004) also points out this lack of evidence on the impact of exchange rate risk.

41 The latter results have to be interpreted with the utmost care, however, as the transformation of data cannot be performed consistently due to a lack of bilateral data. Especially the variables including relative trade shares are critical, while the interpretation of the inflation differentials and the forward market dummy should be unproblematic. Results are available on request.
countries in extra-euro area trade. The specification of the PCP invoicing equation is as follows:

\[ \text{homex}_{it} = \beta_1 + \beta_2 \text{mp}_{it} + \beta_3 \text{eurinst}_{it} + \beta_4 \text{euroint}_{it} + \beta_5 \text{rauex}_{it} + \beta_6 \text{usinf}_{it} + \beta_7 \text{fmdum}_{it} + u_{it}, \]

(3)

where \( \text{homex} \) is the share of exports invoiced in the exporter’s home currency (PCP) and \( \text{mp} \) is the country’s export share in world exports, taken to be an indicator for market power.\(^{42}\)

**Table 3:**
Home Currency Export Invoicing
Dependent variable: share of exports invoiced in producer currency (in percentage points)

<table>
<thead>
<tr>
<th>Regression</th>
<th>random</th>
<th>fixed</th>
<th>PW(^a)</th>
<th>weighted(^b)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>-22.79**</td>
<td>26.77***</td>
<td>-50.10***</td>
<td>-34.34***</td>
</tr>
<tr>
<td>(2.00)</td>
<td>(12.64)</td>
<td>(1.45)</td>
<td>(-4.80)</td>
<td></td>
</tr>
<tr>
<td>Share of exports in world exports</td>
<td>0.49***</td>
<td>0.41**</td>
<td>0.22</td>
<td>0.36***</td>
</tr>
<tr>
<td>(2.6)</td>
<td>(2.12)</td>
<td>(1.45)</td>
<td>(5.66)</td>
<td></td>
</tr>
<tr>
<td>EU-25 and candidates</td>
<td>14.58**</td>
<td>14.53***</td>
<td>14.63***</td>
<td></td>
</tr>
<tr>
<td>(2.42)</td>
<td>(2.99)</td>
<td>(18.98)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Introduction of the euro (2002)</td>
<td>4.66***</td>
<td>4.75***</td>
<td>4.76***</td>
<td>2.41***</td>
</tr>
<tr>
<td>(4.57)</td>
<td>(4.71)</td>
<td>(3.61)</td>
<td>(5.65)</td>
<td></td>
</tr>
<tr>
<td>Share of differentiated exports</td>
<td>0.25</td>
<td>0.50***</td>
<td>0.28***</td>
<td></td>
</tr>
<tr>
<td>(1.22)</td>
<td>(4.66)</td>
<td>(3.16)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>(0.44)</td>
<td>(0.54)</td>
<td>(0.28)</td>
<td>(-1.44)</td>
<td></td>
</tr>
<tr>
<td>Inflation differential to U.S.</td>
<td>-0.11</td>
<td>-0.06</td>
<td>-0.11</td>
<td>0.00</td>
</tr>
<tr>
<td>(-0.94)</td>
<td>(-0.49)</td>
<td>(-1.05)</td>
<td>(0.04)</td>
<td></td>
</tr>
<tr>
<td>Forward market</td>
<td>30.66***</td>
<td>48.56***</td>
<td>47.85***</td>
<td></td>
</tr>
<tr>
<td>(4.00)</td>
<td>(12.25)</td>
<td>(21.18)</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Absolute value of z statistics in parentheses</th>
</tr>
</thead>
<tbody>
<tr>
<td>* significant at 10%; ** significant at 5%; *** significant at 1%</td>
</tr>
</tbody>
</table>

\(^a\) Prais-Winston regression with heteroscedastic panel corrected standard errors and panel specific AR1.

\(^b\) Prais-Winston regression with het. panel corrected standard errors. Importance weighted with GDP.

Table 3 shows that being part of or candidate for the European Union significantly increases the share of PCP in exports by around 15 percentage points. The market power of the

\(^{42}\) For the euro area countries \( \text{mp} \) is the share of extra euro area exports to world exports
exporting economy also plays a significant role. The higher the share of a country’s exports in world exports, the more likely it is to invoice in its own currency. This could of course also indicate that a country pertaining to a monetary union is more likely to invoice its (extra-union) exports in home currency already due to the fact that the common market power is higher.\textsuperscript{43} The introduction of the euro currency does have a separate significantly positive impact on home invoicing. This is because out of the 19 countries for which data is available 9 countries are part of the euro area.

The share of differentiated products has a positive sign as expected and is significant in most of the specifications. The inflation differential on the other hand is always insignificant, albeit mostly with the expected sign. The reason why the results are not so significant can partly be attributed to the fact that for the home specification there are much fewer observations and the cross section is much smaller. Another reason could be that the euro area countries don’t exhibit strong divergence in terms of inflation differentials with the U.S. If a country has a developed financial system as modelled with the forward market dummy it is more likely to invoice its exports in the own currency.\textsuperscript{44} The volatility of the exchange rate towards the U.S. dollar does not have any significant impact.

I also perform estimations on U.S dollar, euro and home currency import invoicing.\textsuperscript{45} In general, the results of the export invoicing estimations are confirmed.\textsuperscript{46} In particular, the results concerning the importance of the variables related to membership in the EU and introduction of the euro give qualitatively the same results. Altogether it can be said that the findings of the import invoicing estimations confirm that the role of the euro as vehicle currency is still rather limited, especially in comparison with the role of the U.S. dollar as a

\textsuperscript{43} This effect does, however, not seem to be very high, yet. In an alternative specification I tested for the influence of the individual countries’ market shares. They are also found to be significant and deliver comparable results.

\textsuperscript{44} I also experimented with including the private credit to GDP ratio as a measure of financial development. For the home export invoicing estimations this variable is insignificant as was the case for vehicle currency invoicing in U.S. dollar and euro. Only for the home import invoicing estimation does the coefficient become significantly positive (as expected) when the forward market dummy is excluded due to possible collinearity. This does not change the other results.

\textsuperscript{45} While from a theoretical point of view the currency of import invoicing reflects the choice of the exporter rather than the importer on the micro level, the macro level evidence of the importing country’s characteristics still give interesting insights.

\textsuperscript{46} Most results are qualitatively the same. For details see Kamps (2006).
vehicle currency. There are, however, strong signs of an increasing importance of the euro both at the cost of the U.S. dollar as vehicle currency and at the cost of local currencies.

4.7 Robustness and Goodness-of-Fit of the Model

In addition to the inclusion of a wide range of specifications to show that the significance level and the coefficients are quite stable over different specifications, I also perform Hausman tests to compare the coefficients of the random effects and the fixed effects model and find that they are not systematically different.47 As the time invariant variables drop out for the fixed effects estimations the Hausman test may not be proof enough for the validity of the random effects estimations. I therefore also report the fixed effects specifications. They deliver the same qualitative results for the time varying variables. To control for heteroscedasticity across the cross section and for autocorrelation I also present estimation results for a Prais-Winston regression with panel corrected standard errors.48 Almost all variables which are found to be significant in the random effects model are also significant for this specification and insignificant results stay insignificant. Only for the exchange rate volatility variables and the forward market dummy is there some change in the significance pattern as compared to the reference estimations. The estimation method for which results diverge the most is the importance weighted Prais-Winston regression. In this case it is not surprising that the results vary a bit as the GDP weights of the countries do differ considerably. On the contrary, it is very reassuring to see that this regression also confirms the general findings of the other regressions.

As another test for robustness I ran regressions including a dummy for every year to control for omitted variable bias. This does not change the results significantly, either. Furthermore, I experimented with including different sets of variables as mentioned in the above analysis. Not all variables which were found to be insignificant are reported as they did not change the

47 Only for euro import invoicing can the null hypothesis of no systematic difference be rejected. This does not change the qualitative results of the estimation, however.
48 I also estimated an alternative feasible GLS estimation with heteroscedasticity robust errors. Likewise, I estimate a random effects model with serial correlation robust standard errors especially constructed for unbalanced data by Baltagi and Wu (1999). Again, this does not qualitatively change the estimation results. The results for these estimations are not included in the paper as they are both qualitatively and quantitatively almost identical.
main results. As an indicator of the explanatory power of my model I include the pseudo R squared adjusted for the overall estimation as reported by stata. Although one has to interpret this R squared with caution, it indicates, that the model does have quite good explanatory power. The main contribution of the explanatory power stems from the variables reflecting the prospective future adoption of the euro. In particular, whether a country belongs to or is a candidate for the EU –, the introduction of the common currency and the share of trade with the euro area (for the euro invoicing estimations). However, even when leaving out these variables, the remaining parameters still have a significant and quite high overall explanatory power.

5. Conclusion

This paper provides empirical evidence on the determinants of currency invoicing in international trade, a topic which has received little attention so far due to data limitations. This study presents a newly constructed dataset on currency invoicing in trade for 42 countries. The paper contributes to the literature by exploring the use of the euro in invoicing of international trade. It provides a comparison of the role of the euro and the role of the U.S. dollar as world vehicle currencies.

The main findings of this analysis are that the membership or prospective membership of a country in the EU plays a decisive role in the choice of the euro as invoicing currency in its trade. At the same time, the introduction of the common currency in the euro area increased the invoicing in euro at the expense of the U.S. dollar. This effect goes hand in hand with the finding that higher market power defined as a country’s total exports in relation to world exports leads to increased invoicing in home currency for the countries of the euro area. The paper finds ambiguous evidence for the importance of exchange rate risk as a determinant of currency invoicing. Neither for the estimations of home currency invoicing nor for U.S. dollar invoicing is there increased invoicing in the vehicle currency and less home currency invoicing with higher exchange rate risk. Only for the euro invoicing estimations, there is a higher incidence of euro vehicle currency invoicing when a country’s currency is volatile. There is, thus, some evidence for an increased role of the euro as a vehicle currency. The role of the euro as vehicle currency in trade seems to be limited, however, when compared to the
U.S. dollar. The estimation results support the hypothesis that monetary instability reflected in high inflation differentials increases the invoicing in vehicle currency. But this relationship is only found for vehicle currency invoicing in U.S. dollar in the case when monetary unstable countries are involved. At the same time, while a low level of product differentiation increases vehicle currency pricing in U.S. dollar, this mainly seems to reflect the trade in organized and referenced priced goods. The data only provides partial support for the theoretical hypothesis that producer currency invoicing is likely if exports are highly differentiated, however. Summing up, it can be said that the U.S. dollar is still the dominant vehicle currency as compared to the euro. There are, however, some indications that the role of the euro as invoicing currency increased as the euro replaced the legacy currencies.

The use of this new and extensive dataset made a thorough econometric analysis of the determinants of currency invoicing possible. Data limitations, nevertheless, have to be borne in mind when interpreting the results. Industry specific country data and data on bilateral trade, if available for each of the countries in the data set, would help to refine the analysis. Also, once the time horizon of available data will be longer, research could focus on the dynamics of the invoicing process, including the question of inertia of invoicing strategies.

References


