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Invoicing Currency in International Trade: An Empirical Investigation and Some Implications for the Renminbi*

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Abstract

To play the role of a unit of account, an international currency must be a currency widely used to invoice international trade. This paper investigates the determinants of the use of currency in trade invoicing and evaluates the potential of the renminbi for the denomination of cross-border transactions in the Asia-Pacific region. In particular, we develop a simple model and establish the evidence showing that there is a convex relationship between the invoicing share of a currency and the economic size of its issuing country because of a coalescing effect and thick market externalities. We use the ratio of the foreign exchange turnover share of a currency to the global GDP share of its issuing country as a proxy for the size of thick market externalities, which we argue reflects capital account openness, financial development, and exchange rate stability of a country. This ratio is very small for the renminbi compared with that for established international currencies. Our quantitative analysis suggests that the renminbi can be a major invoicing currency in the region only if China sufficiently opens up its capital account and liberalizes its financial sector. We also draw a parallel between the renminbi and the euro and forecast the invoicing share of the renminbi in the Asia-Pacific region if the renminbi market attained the same degree of thickness as the euro.

Keywords: Invoicing Currency, Renminbi, Coalescing Effect, Thick Market Externalities, Currency Internationalization

JEL Classification: F33, F36, F47

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1. Introduction

What determines the use of a currency in the invoicing of international trade? This question is nontrivial for the management of exchange rate risk at the firm level, but also has important implications for the transmission of macroeconomic shocks across economies, especially in the form of exchange rate pass-through. There are by and large three major functions of an international currency: a unit of account (for trade invoicing and denomination of financial products, exchange rate pegging), a medium of exchange (for settlement of trade and financial transactions, foreign exchange market intervention), and a store of value (for saving, reserve currency). Reflecting its role as a unit of account, an international currency must be a currency widely used to invoice cross-border trade transactions. Understanding the potential of a currency as an invoicing currency will help shed light on the extent to which it can be used as an investment currency or a reserve currency, as the three functions are related. The acceptance for trade invoicing is an essential dimension of the international status of a currency.

This question has become more relevant in recent years as the renminbi has been increasingly used outside of China, especially in the Asia-Pacific region, an immediate neighbor and close trading partner of China. The internationalization of the renminbi was put on the policy agenda by the Chinese authorities in the aftermath of the global financial crisis of 2007-2009 (Chen and Cheung, 2011; Eichengreen, 2011; Frankel, 2012; He, 2012; Ito, 2011; McCauley, 2011; Yu, 2012). Since then, the restrictions against the use of the renminbi in current account transactions have been removed, and the scope for the use of the renminbi in capital account transactions has been gradually expanded.

Figure 1 shows an obvious and steep upward trend in the share of China's cross-border trade settled in the renminbi, from almost zero in 2009 to 16.6% in the first three quarters of 2013. Of all renminbi-settled trade, however, only about 56% was invoiced in the renminbi in 2012 (Li, 2013). There is empirical evidence that, in general, the currency used in invoicing is also the one used in actual payment (Friberg and Wilander, 2008). Thus, this disparity between settlement and invoicing is largely unique for the renminbi, showing that the government policy works in promoting renminbi settlement but the market is still hesitant to use the renminbi as an invoicing currency.[1] To put the scale of renminbi invoicing in perspective, consider the following figures (latest, to the best of our knowledge): about 99.8% of the US exports and 92.8% of the imports were invoiced in the dollar in 2003 (Goldberg and Tille, 2008), while 62.5% of exports and 49% of imports were invoiced in the euro in extra-euro area goods transactions of euro area countries in 2012 (ECB, 2013). Therefore, the share of the renminbi in invoicing China's trade is small compared with the corresponding shares of the US dollar and euro in invoicing American and Eurozone's trade respectively. Moreover, when China is not

[1] Before 2013, the General Administration of Customs of China released official statistics on imports and exports only in terms of the US dollar, but not in China's own currency (except for annual data published in the *China Customs Statistics Yearbooks*).

involved in the trade, the use of the renminbi as a vehicle currency for trade invoicing would be only much less. In contrast, the US dollar as the primary vehicle currency accounts for a dominating share in the Asia-Pacific region and even in the euro area, and other established currencies also play nontrivial roles (Figures 2 and 3).

In short, the actual use of the renminbi as an invoicing currency remains very limited and seems to fall behind the overall progress in the internationalization of the renminbi. It is therefore important to understand prospects for the renminbi as a major invoicing currency, at least in the Asia-Pacific region, and the factors that could impede the realization of its potential.

Any research in this area is, however, constrained by the availability of data on invoicing behavior. Because of the lack of historical data on renminbi invoicing, we cannot make predictions based on its past trend. The best we can do is to use the experience of some major currencies to benchmark the potential role of the renminbi under comparable economic and institutional conditions.[2] We are able to construct two datasets that allow us to pursue this line of analysis.

We approach this problem from two angles. First, we focus on one country, namely Thailand, and investigate the determinants of the invoicing share of different currencies when it trades with its partner countries. Second, we focus on one currency, namely the euro, and investigate the determinants of its invoicing share in the aggregate trade of different countries. We use the empirical models estimated from these two types of regression analysis to gauge the extent to which the currency of interest, the renminbi, could be used to invoice international trade in the Asia-Pacific region, considering: (i) the potential invoicing share of the renminbi in the trade of Thailand with China and ASEAN economies, and (ii) the projected use of the renminbi in invoicing the trade of Asia-Pacific countries such as Australia, ASEAN economies, and South Korea.

The above two methods address different aspects of the question we ask, but the results are largely consistent with each other. The choice of Thailand is determined by the availability of the data as well as its relevance for the expansion of the cross-border use of the renminbi. As a typical Southeast Asian country, Thailand has close economic ties with China. China is now the largest trading partner of Thailand with a share of 12% and 15% in the total exports and imports respectively of Thailand in 2012. On the other hand, the choice of the euro is determined by the availability of the data as well as its similarities with the renminbi as it emerged as a competitor with the US dollar in Europe and its neighboring regions. Interested in finding whether there is any historical experience of a currency that resembles the circumstances of the renminbi today, we think that the euro may be a good example. The euro was a new currency that emerged in the late 1990s, just like the renminbi is an emerging currency today. The circumstances in which the euro found itself then was somewhat like those for the

[2] Ito and Chinn (2013) take a similar approach to study the potential of renminbi invoicing and the role of capital account liberalization in China.

renminbi today, i.e. aspiring to be a regional currency that challenges the incumbent currency, the US dollar. While the euro challenged the dominance of the dollar in Europe, the renminbi may challenge the dollar in Asia.

We emphasize that we are estimating the potential of the renminbi conditional on it having comparable conditions as the reference currencies. In particular, we develop a simple theory for the determination of trade invoicing, which implies a convex relationship between the invoicing share of a currency and the economic size of its issuing country. In our framework, it is the coalescing effect and thick market externalities that give rise to this convex relationship. We call this the "tipping phenomenon" in invoicing currency and argue that thick market externalities can be attributed to the degree of capital account openness and financial market maturity of the issuing country. Our analysis of the Thai data finds some evidence of the tipping phenomenon, and shows that the convexity between the invoicing share and the economic size is partly due to the size of thick market externalities, which is proxied by the ratio of the foreign exchange (FX) turnover share of a currency to the GDP share of the issuing country (hereafter referred to as the FX-share-GDP-share ratio). This ratio is very small for the renminbi relative to the established currencies, such as the US dollar, euro, Japanese yen, and pound sterling, reflecting the lack of capital account openness and immaturity of the financial sector in China. Our analysis of the euro data focuses only on one currency and hence cannot explicitly test the tipping phenomenon. Guided by our theory with the coalescing effect and thick market externalities, our empirical assessment of the renminbi's potential is conducted under the assumption of comparable capital mobility and well-functioning financial markets as in the euro area. To some extent, these estimates represent an upper bound of the renminbi's potential.

Taken together, our empirical estimates consistently suggest that the renminbi has the potential to become a major invoicing currency in the Asia-Pacific region. However, in order to arrive at the "tipping point," China has to establish a market thickness for the renminbi comparable to that of established currencies. In other words, China needs to sufficiently open up its capital account and liberalize its financial sector to fully materialize the potential of the renminbi as an international invoicing currency.

2. Some Background Literature

There is a rich economic literature on the factors that determine the emergence of international invoicing currency. Instead of carrying out a comprehensive survey, we provide a brief discussion on the two important forces behind our theoretical model in the context of the present paper.

Studying the currency denomination of international trade, Bacchetta and van Wincoop (2005) and Goldberg and Tille (2008) focus on the "unit of account" function of money. In particular, Goldberg and Tille (2008) argue that exporting firms have the incentive to mimic the choice of invoicing currency of

their competitors in the same market so as to minimize price volatility and maximize profits. They call this "coalescing effect" and use it to explain why there is one single vehicle currency used in the world to invoice homogeneous commodities such as oil.[3]

Another reason why countries converge to using one single currency for trade invoicing is network externalities. Matsuyama, Kiyotaki and Matsui (1993) and Rey (2001) focus on the "medium of exchange" function of money and conclude that "thick market externalities" are very important in the making of a vehicle currency. As firms have an incentive to adopt the currency used by a majority of firms, once a currency becomes sufficiently widely used, its role as a vehicle currency is self-justifying. Following Kindleberger (1981), Krugman (1984) draws an analogy between money and language. He argues that what makes English the world's *lingua franca* is not its simplicity or internal beauty, but its wide use. As a language becomes more widely used, it is more attractive for outsiders to use it as well, as they can use it to communicate with more people in the world. Likewise, a firm is more willing to use a currency for invoicing if other firms are already using it.

A currency with strong network externalities usually possesses a few competitive advantages over other currencies, such as lower transaction costs, higher degree of convertibility, more open financial asset transaction and accessible financial services offered. The network externalities become self-enforcing as more firms use that currency for invoicing. In other words, as more firms use that currency for invoicing, its network externalities increase, which, in turn, enhances the attractiveness of the currency as an invoicing currency.

The self-reinforcing mechanism may also be applied to the adoption of a reserve currency. Chinn and Frankel (2007) find that there is a statistically significant non-linear relationship between currency shares in official reserves and GDP shares of issuing countries. They call this the "tipping phenomenon:" "if one currency were to draw even and surpass another, the derivative of reserve currency use with respect to its determining variables (e.g., GDP share) would be higher in that range than in the vicinity of zero or in the range when the leading currency is unchallenged." This point is demonstrated in Figure 4, which is borrowed from Chen, Peng, and Shu (2009). In this figure, the panel data points of the reserve currency share are plotted against the GDP share of the issuing country, for the US dollar, euro, Japanese yen, and pound sterling for the period of 1999-2008. There is clearly a convex relationship between the two variables.

In this paper, we develop a simple model showing how the coalescing effect and thick market externalities work together to give rise to a convex relationship between the invoicing share of a currency and the economic size of the issuing country. Our empirical tests and evaluation of the renminbi's potential as a major invoicing currency in the Asia-Pacific region are carried out on the

[3] A vehicle currency is defined as a currency used for invoicing trade when the issuing country is not one of the trading partners.

basis of this theory.

3. A Simple Theory

3.1 Coalescing Effect without Thick Market Externalities

To begin, let us denote a country by capital letter (e.g., J) and its currency by the lower case (e.g., j). Suppose there are many firms in each country, each selling a good to many different countries. Each firm chooses an invoicing currency in each market so as to maximize its profits. We assume that the unit of account is also the medium of exchange so that the invoicing currency is also the settlement currency. A Nash equilibrium is then a set of invoicing strategies such that each firm has no incentive to change its invoicing currency in each market given the invoicing currencies chosen by its competitors in each market.

Due to the coalescing effect, a firm has an incentive to choose the same invoicing currency as its competitors to reduce output volatility and hence maximize profits. As a country grows larger relative to the rest of the world, firms have higher tendency to invoice in the country's currency so as to compete with local producers. As proved by Lai and Zhou (2012), the coalescing effect implies that the invoicing share of a currency increases at an increasing rate with the GDP share of the issuing country when the GDP share is sufficiently small.

Let η_j denote the global invoicing share of currency j and let X_J denote the GDP share of country J. Use function $\eta_j = h(X_J)$ to describe the relation between the two variables. Then, we have:

Proposition 1. *In the presence of the coalescing effect in invoicing behavior,* $h'(X_J) > 0$ *for any* $X_J \in [0,1]$*, and* $h''(X_J) > 0$ *when* X_J *is sufficiently small.*

The proof of Proposition 1 can be found in Lai and Zhou (2012). The proposition shows that the currency of a larger country has higher global invoicing share; moreover, the global invoicing share of a currency increases at an increasing rate with the GDP share of the country when the latter is small. In other words, there is a convex relationship between the GDP share of the issuing country and the aggregate invoicing share of its currency for emerging economies.

3.2 Coalescing Effect with Thick Market Externalities

We now introduce thick market externalities into our framework. Let T_j stand for the thickness of the market for currency j, which can be affected by many factors, such as the degree of convertibility of j and the depth and breadth of the financial markets of country J. We assume that thick market externalities enter into η_j as a multiplicative factor, i.e.,

$$\eta_j = h(X_J)T_j.$$

Therefore, as the market for a currency gets thicker, its invoicing share increases, holding other factors constant.

Further, let $\overrightarrow{\alpha_J}$ denote a vector that captures the degree of convertibility of j, the depth and breadth of the financial markets of country J, and all other factors that enhance the currency j's functioning as an international currency. When financial markets are allowed to operate more freely, all components of $\overrightarrow{\alpha_J}$ will be larger. For example, when there is relaxation of capital controls and financial market liberalization, components of $\overrightarrow{\alpha_J}$ become larger. We summarize this effect by assuming that

$$T_j = T_j(\overrightarrow{\alpha_J}) \quad \text{where} \quad \frac{\partial T_j}{\partial \overrightarrow{\alpha_J}} > 0.$$

In other words, the market thickness of currency j increases with capital account openness and the level of financial development of the issuing country. This assumption is in line with the view expressed by Krugman (1984). He argued that a currency with strong network externalities usually possesses a few competitive advantages over other currencies, such as lower transaction costs, higher degree of convertibility, more open financial asset transaction and accessible financial services.

In the setting outlined above, the positive effect of GDP share on invoicing share is reinforced by a thicker market for the currency. We can further show the following result:

Proposition 2. *In the presence of both the coalescing effect and thick market externalities in determining invoicing behavior,*

$$\eta_j = h(X_J)T_j(\overrightarrow{\alpha_J}),$$

where $h(X_J)$ *and* $T_j(\overrightarrow{\alpha_J})$ *capture the coalescing effect and thick market externalities, respectively. Then,* $\partial\eta_j/\partial X_J > 0$ *for any* $X_J \in [0,1]$*, and* $\partial^2\eta_j/\partial X_J^2 > 0$ *when* X_J *is small. Moreover, since* $\partial T_j/\partial\overrightarrow{\alpha_J} > 0$*,* $\partial^3\eta_j/\partial X_J^2\partial\overrightarrow{\alpha_J} > 0$*.*

The idea of Proposition 2 is illustrated in Figure 5. The solid curve shows the relationship between the invoicing share of an emerging currency j and the GDP share of its issuing country J when the vector $\overrightarrow{\alpha_J}$ is given, i.e. when the degree of financial development and capital account openness are given. The dotted curve shows how the solid curve shifts when financial development and capital account openness both increase.

3.3 Tipping Phenomenon

Empirically, we proxy thick market externalities T_j by the ratio of the FX turnover share of j to the GDP share of J. As shown in Table 1, we find that there is a positive correlation between this FX-share-GDP-share ratio and the GDP share of J. Our interpretation is that financial development, capital account liberalization, and the degree of currency convertibility all increase in the GDP share, i.e. $\partial\overrightarrow{\alpha_J}/\partial X_J > 0$. Moreover, this is consistent with historical experience: the financial development of the major economies of the world deepened as their global importance increased.

An important implication of Proposition 2 is that the presence of thick market externalities, coupled with the fact that financial development is positively correlated with the relative size of an economy (i.e., $\partial\overrightarrow{\alpha_J}/\partial X_J > 0$), leads to a convex relationship between invoicing share η_j and GDP share X_J. That is, we can see that $\partial^2\eta_j/\partial X_J^2 > 0$, even without controlling for $\overrightarrow{\alpha_J}$.

Back to Figure 5, $\partial\overrightarrow{\alpha_J}/\partial X_J > 0$ implies that as country J's GDP share increases, $\overrightarrow{\alpha_J}$ also increases and hence, its invoicing curve also shifts up. Suppose we start from the origin 0 of the diagram. Then, as X_J increases, η_j increases, not only because there is movement along the solid curve, but also because there is a shift of the curve. The first effect is the coalescing effect, while the second effect is the effect of thick market externalities.

The convexity of η_j in X_J is a manifestation of the tipping phenomenon. In Section 3.1, we argued that $\partial^2\eta_j/\partial X_J^2 > 0$ for small X_J when controlling for $\overrightarrow{\alpha_J}$, because of the coalescing effect. When thick market externalities are present, we expect the magnitude of $\partial^2\eta_j/\partial X_J^2$ to become larger, as $\partial T_j/\partial\overrightarrow{\alpha_J} > 0$, and $\partial^3\eta_j/\partial X_J^2\partial\overrightarrow{\alpha_J} > 0$. Thus, the tipping phenomenon can be due to both the coalescing effect and thick market externalities. How strong these effects are is an empirical question. In the empirical analysis below, we will show that the lack of thick market externalities can lead to rather serious under-use of a currency as an invoicing currency.

4. Empirical Evidence

In this section, we investigate the determinants of the use of invoicing currency guided by the model outlined above. For an empirical study of invoicing behavior, data limitation is a major constraint. We approach this problem from two perspectives: The first considers the determinants of the invoicing share of different currencies in a country's trade with its partners, while the second examines the determinants of the use of one currency in the trade of various countries. We use a dataset from the Bank of Thailand for the first set of analysis and a dataset on the euro for the second.

4.1 Fixing Country and Varying Currencies: Determinants of Invoicing Share of Currencies Used in Thailand's Trade

4.1.1 Data

For comparison across multiple invoicing currencies, we use a dataset from the Bank of Thailand that contains the distribution of settlement currencies for Thailand's exports to and imports from major trading partners between 1993 and 2011. This is a rare, publicly available dataset documenting the choice of market-determined settlement or invoicing currencies in a country over a reasonably long period of time. An obvious limitation of this dataset is that it only covers the trade of Thailand, but this can also be an advantage. With one partner of the trade controlled for, we obtain a check on the different influences of an international currency in different geographic areas.

As we suggested earlier, when the choice of settlement currency is market-determined, we can assume for practical purposes that the settlement currency is the invoicing currency as well. We will benchmark the potential of the renminbi as an invoicing currency on the basis of market-determined behavior. We are interested in the role of the renminbi in the Asia-Pacific region, and so Thailand, as a typical Southeast Asian country, is very relevant for our purposes.

Invoicing currencies in our sample include major international currencies (US dollar, euro, Japanese Yen, and pound sterling), regional currencies (Canadian dollar, Thai baht, Singapore dollar, and Malaysian ringgit), and historical currencies (German mark, French franc, and Italian lira). The set of trading partners consists of 29 countries from the ASEAN, EU, and NAFTA.

The main variable of interest is the invoicing share of a currency in Thailand's imports from or exports to a trading country. Explanatory variables include the characteristics of currencies (e.g., volatility of exchange rate), the characteristics of currency issuing countries (e.g., GDP share), as well as the characteristics of trading partners (e.g., amount of trade of the trading partner with issuing countries).

A more detailed description of currencies, partner countries, and the definition and measurement of the variables, as well as the descriptive statistics of the data can be found in Appendix A.

4.1.2 A Preliminary Look at the Data

Our theoretical analysis implies a nonlinear relationship between currency invoicing share and the issuing country's GDP share due to the coalescing effect and thick market externalities. Such tipping phenomenon seems to show up in Figure 6. In Thailand's trade with the rest of the world, the invoicing share of a currency jumps to a dominating level as the GDP share of the issuing country increases up to around 20%. Below the threshold, an increase of the GDP share does not have a large effect. In Thailand's trade with the EU, the nonlinearity seems to be quadratic, which partly

motivates our specification with a squared term of the issuing country's GDP share in our regression analysis below. However, in trade with ASEAN and NAFTA countries, such a quadratic relation does not seem to be visible. Thus we try an alternative specification using a logistic transformation of the invoicing share to capture nonlinearities.

Figure 7 displays the invoicing share of major currencies. It is clear that the US dollar plays a dominant role in Thailand's trade with NAFTA, ASEAN, and EU countries, in decreasing order of share. The local currency, the Thai baht, is used in trade with countries in different regions, which reflects the practice of producer currency pricing in exports and local currency pricing in imports. The euro is mainly used in trade with the EU, but at a non-trivial level. The Japanese yen actually plays a visible role not only in Thailand's trade with ASEAN countries but also in its trade with NAFTA countries, which reflects its international role as a vehicle currency. The pound sterling and German mark have non-trivial shares only in the Thailand-EU trade.

The US dollar plays a dominating role in invoicing Thailand's trade, regardless of whether the U.S. is the trading partner or not. As shown in Figure 8, this has not changed much in the past two decades. During the sample period, the invoicing share of the euro and Thai baht rose slowly. The share of the Japanese yen has been declining but remains to be the second most used currency for a typical ASEAN country like Thailand. Figure 9 further shows the use of the US dollar in trade with countries from different regions. Except in trade with EU countries, where the euro plays an important role, the share of US dollar invoicing remains above 75%. In trade with NAFTA countries, its share is consistently close to 1. The higher share of the US dollar in Thailand's exports to the EU relative to imports from the EU is consistent with the intuition behind Grassman's (1973) law that seller firms with more bargaining power will choose the home currency (the euro vs. Thai baht) to avoid exchange rate risk. In general, the data show that the pattern of trade invoicing is quite persistent over time.

4.1.3 Regression Analysis

We now use regression analysis to examine the determinants of the extent to which a currency is used in trade invoicing. Our baseline specification is given by

$$y_{it} = \alpha + \beta x_{it} + \varepsilon_{it},$$

where y_{it} is the currency invoicing share in Thailand's imports from or exports to partner country i at time t, x_{it} is a set of characteristics of the currency, and ε_{it} is the error term. Our focus is the effects of the factors underlying the invoicing behavior as captured by β.

In theory, the economic size of the issuing country will affect the international use of a currency in trade invoicing through multiple channels. For example, a larger economy usually trades more, and pricing in its currency is obviously convenient to foreign firms trading with that country. The bargaining

power of domestic firms tends to increase as their home country becomes relatively larger economically, and hence, the trade of that country is more likely to be invoiced in the home currency so that domestic firms can avoid exchange rate risks. The choice of the invoicing currency in bilateral trade depends on the trade patterns of the two trading partners. When the issuing country has a lot of trade with each of the trading partners, the currency tends to be used more because of the coalescing effect. Further, as argued in Engel (2006), the choice of invoicing currency is essentially an indexing problem: firms that set prices in advance choose to index their prices to the current exchange rate because of uncertainty about exchange rate movements. The extent to which the exchange rate of a currency co-moves with the exchange rate of the Thai baht and that of the trading partner's currency is important in the management of exchange rate risk, in addition to transaction costs and exchange rate volatility.

Table 2 presents the baseline OLS estimates of a simple linear model. In columns (1) and (2), we include only the GDP share of the issuing country and find evidence of its positive effects on the use of the currency in both Thailand's imports and exports. When we add the share of the issuing country in Thailand's and the partner's total trade to capture the pattern of trade, columns (3) and (4) show that the importance of the issuing country to the trading partners is positively associated with the use of the currency in the trade between two partners that are not the issuing country. This partly reflects the influences of vehicle currencies. Columns (5) and (6) introduce exchange rate variables. We find evidence for the positive role of exchange rate co-movement with the Thai baht, but not for the role of exchange rate co-movement with the trading partner's currency. Larger exchange rate volatility is associated with less use of the currency in trade invoicing. The coefficients on the bid-ask spread are not statistically significant, which may suggest that direct transaction costs are not as important as exchange rate risks.

The dependent variable y_{it} is bounded between 0 and 1, but from a technical point of view, the linear specification used above does not address this constraint. It is standard practice in this situation to take a logistic transformation of y_{it} but still impose the usual OLS assumptions. The formulation, which is given as follows, then has a logistic interpretation:

$$\ln\left(\frac{y_{it}}{1-y_{it}}\right) = \alpha + \beta x_{it} + \varepsilon_{it}.$$

As discussed by Chinn and Frankel (2007), this transformation can partially capture the persistence of the international use of a currency in this setting.

Table 3 shows the estimates of the log-transformed version of the same set of regressions as presented in Table 2. The main message from Table 2 follows here. In columns (5) and (6), the exchange rate bid-ask spread has a negative coefficient, but is only significant at the 10% and 5% level respectively. The other variables largely behave the same way as in the simple linear version.

As shown in Figure 6, the relationship between the invoicing share and the GDP share does not seem to be linear. Our theory presented in Section 3 also predicts that the coalescing effect and thick market externalities can lead to nonlinearity between the two variables. One way to capture this feature is to introduce a squared term of the GDP share into our linear specifications. Nonlinearity is of course embedded in the logistic specifications. In our empirical analysis, thick market externalities are proxied by the FX-share-GDP-share ratio. We argue that this variable is the driving force underlying the nonlinearity, which we will test with the data. Further, domestic financial development is potentially another fundamental condition of the wide use of a currency in international trade invoicing.

Table 4 presents evidence on the nonlinearity and the role of thick market externalities and financial development. Columns (1) and (2) re-estimate the linear model without exchange rate co-movement with partner's currency and the exchange rate bid-ask spread, which appears insignificant in Table 2. The estimates are largely unchanged. Columns (3) and (4) document that, after adding the squared term of the GDP share, the invoicing share of a currency is convex in the GDP share of the issuing country, in both the import and export regressions. The coefficient on the squared GDP share is statistically and economically significant. The specification with the squared GDP share also fits the data better. When we include the FX-share-GDP-share ratio, as displayed in columns (5) and (6), the invoicing share becomes less convex in the GDP share, although the convexity remains. This is consistent with our theory. The coefficients on the FX-share-GDP-share ratio are positive and significant, which demonstrates the influence of thick market externalities. When we add a variable for financial development in columns (7) and (8), proxied by the capital market depth of the issuing country, the coefficients on the squared GDP share become statistically insignificant. Thus, financial openness and development largely give rise to the convexity between the invoicing share and the GDP share. When we drop the squared term in columns (9) and (10), the effect of market externalities becomes stronger. In columns (11)-(12), the removal of the squared term does not lead to much change over the results in columns (7) and (8). Columns (13) and (14) further test the effects of financial development, without controlling for thick market externalities.

The estimates based on the log-transformed specification are reported in Table 5. Given the embedded nonlinearity, we do not include the squared term. However, our empirical evidence continues to support the importance of thick market externalities and financial development for the choice of invoicing currency. In addition to the fact that y_{it} is bounded between 0 and 1, we observe that a large proportion of trade activities is invoiced in the US dollar. With this skewed distribution, the OLS coefficient estimates are unbiased but no longer efficient, and in small samples, the standard errors may be biased. Fortunately, we have a relatively large sample, which can partially alleviate this concern. Taking the log-transformation, the sample distribution becomes much less skewed. From this perspective, the logistic version is our preferred specification. Thus, we draw implications for the

renminbi on the basis of the results in Table 5.[4]

Finally, our sample period covers two major financial crises, the Asian financial crisis and the recent global financial crisis. Does this fact affect our regression results? Figure 10 exhibits the trend of imports and exports of Thailand over time. The trade was not interrupted by the Asian financial crisis, at least at the aggregate level, but was somewhat affected by the recent crisis. As shown in Figure 8, the pattern of invoicing behavior has persisted through the financial crises. When we re-estimate the preferred logistic model using the subsample that excludes observations for 1997-1999 and 2008-2010, the regression results, presented in Table 6, are almost the same as before, both in terms of statistical significance and magnitude. In other words, our main empirical results are robust to the inclusion of years during economic crises. Since we are interested in the long-term potential of the renminbi that can withstand economic fluctuations and crises, we use the estimates based on the whole sample (without omitting the observations of crisis years), as the benchmark for counterfactual evaluation of the potential use of the renminbi for trade invoicing in a country similar to Thailand, such as other ASEAN countries.

4.2 Fixing Currency and Varying Countries: Determinants of Invoicing Share of the Euro across Countries

4.2.1 Data

To understand how the extent to which a currency is used for trade invoicing varies across countries, we focus on the experience of the euro. Our data is mainly from the report *The International Role of the Euro* (ECB, 2011), supplemented by reports from central banks of individual countries (e.g., U.K., Australia, and Thailand) and compiled by us. We have collected information on the annual use of the euro in trade invoicing at the country level. There are thirty-five countries covered in this data: nine euro-area countries (Belgium, France, Germany, Greece, Italy, Luxembourg, Netherlands, Portugal, and Spain), fourteen EU accession countries (Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, U.K., Slovakia, and Slovenia),[5] two EU candidate countries (Former Yugoslav Republic of Macedonia, and Turkey), one other European country (Ukraine), and nine countries outside Europe (Algeria, Australia, India, Indonesia, Pakistan, South Africa, Korea, Thailand, and Tunisia). The period of coverage is 1999-2010. The earliest observations we use are from 1999 when the euro is introduced, and the latest observations are in 2010 (unbalanced panel). As far as we know, this is one of the most comprehensive datasets on euro

[4] Having that said, the OLS estimates represent important baseline results, not only in illustrating the marginal effects of regressors on the invoicing share, but also in spelling out the intuition behind the tipping phenomenon.

[5] Cyprus, Estonia, Latvia, Slovakia, and Slovenia, adopted the euro as the official currency during 2007-2014. We repeat our test by adjusting for this and find the results almost unchanged.

invoicing across countries.[6]

In this part of our analysis, the dependent variable is the invoicing share of the euro in the annual imports or exports of a country at an aggregate level. We do not observe invoicing shares in bilateral trade as in the Thailand data. To explain variations in the use of the euro across country and over time, the independent variables mainly include the characteristics of relevant countries (e.g., EU membership, economic size) and the euro (e.g., bid-ask spread). Appendix B contains a more detailed description of our data.

4.2.2 A Preliminary Look at the Data

The use of the euro for trade invoicing is shown in Table 7, along with US dollar invoicing. The first (third) column shows the euro share in the invoicing of exports (imports), averaged across the available observations in the sample period for each country. Similarly, the second (fourth) column shows the dollar share in export (import) invoicing, for which we have constructed a comparable dataset for the role of the US dollar. For countries in the Eurozone, the euro is their local currency and typically amounts to a share over 50%. For other European countries (except Ukraine), EU member or not, the euro also plays a significant role, which is at least comparable to the role of the US dollar. However, the US dollar overwhelmingly dominates both export and import invoicing in all non-European countries with observations in our sample. The different pictures are partly captured by the EU dummy that is included in the regression analysis below. Overall, the US dollar is the prominent invoicing currency globally.

The role of the euro is further illustrated in Figure 11, which displays the euro invoicing share in a country's imports (exports) against the country's imports from (exports to) the Eurozone as a share of its total imports (exports). Following Goldberg and Tille (2008), all sample points would lie along the 45-degree line under the extreme case of complete euro invoicing of trade with the Eurozone and no vehicle currency role for the euro. For European countries, observations lie close to this reference line, with more than half of them lying above. In contrast, the use of the euro for trade invoicing in non-European countries is much smaller than what would be expected purely on the basis of direct trade flows with the Eurozone. For comparison, the role of the US dollar in trade invoicing across countries is shown in Figure 12. The use of the dollar is far more than the trade with the U.S. for all sampled countries. Taken together, Figures and 12 imply the tipping phenomenon in the sense that currency invoicing share is convex in the underlying conditions of the issuing country, such as economic size and trade share.

[6] Our dataset covers the data of Goldberg and Tille (2008) as a subset. There are only twenty-four countries for which they have invoicing information, with the latest observations being around 2003. For the details of data sources, please refer to Goldberg and Tille (2005) and Kamps (2006).

4.2.3 Regression Analysis

We focus on one specific currency, the euro, to understand its use for trade invoicing in different countries. Without variation across currencies, we cannot identify the tipping phenomenon, or test the convex relationship between the invoicing share of a currency and the GDP share of its issuing country, and neither is there such a need. In this context, our empirical analysis does not directly account for thick market externalities and underlying institutional factors. In fact we are dealing with a new question and therefore our model specification is different to the one used in Section 4.1.

Specifically, we estimate an equation that is modified from Goldberg and Tille (2008), who derive this aggregate invoicing function on the basis of a micro-founded model:

$$\beta_{eur,i}^{t} = \delta_0 + \delta_1 \gamma_{euz,i}^{t} + \delta_2 \gamma_{euz,i}^{t} \times \frac{Y_i^t}{Y_{euz}^t} + \delta_3 Heur_i^t + \delta_4 EU + \delta_5 year_{eur} + \delta_6 year_{eur} \times \frac{Y_i^t}{Y_{euz}^t} + \delta_7 pip_{eur-\$} + \mu_i^t.$$

The dependent variable $\beta_{eur,i}^{t}$ is the share of euro invoicing in the exports or imports of country i in year t. The variable $\gamma_{euz,i}^{t}$ is the share of the Eurozone in the total trade (exports and imports) of country i, Y_i^t/Y_{euz}^t is the economic size of country i relative to the Eurozone, EU is an indicator variable for the EU membership of country i, $year_{eur}$ is the number of years after the introduction of the euro, taking 1999 as the base year, and $pip_{eur-\$}$ is the difference in bid-ask spread between the euro and the US dollar in year t. $Heur_i^t$ is the currency preference for cost hedging as defined in Goldberg and Tille (2008): for country i, it equals 1 when the euro is the preferred hedging currency for transactions, 0 when the euro and the US dollar are equally preferred for hedging, and -1 when the US dollar is the preferred hedging currency. Finally, μ_i^t is an i.i.d. error term.

There are a number of points to note about this specification. First, as shown in Lai and Zhou (2012), countries that trade more with the Eurozone are more willing to use the emerging euro. This is an implication of the coalescing effect and captured by the coefficient δ_1 on $\gamma_{euz,i}^{t}$. The interaction term $\gamma_{euz,i}^{t} \times \frac{Y_i^t}{Y_{euz}^t}$ is intended to reflect the potential effect that a smaller country tends to be more reliant on trading with the Eurozone and more affected by the trade share with the Eurozone $\gamma_{euz,i}^{t}$. The weak influence of its own currency, home or abroad, would give way to the euro. Therefore, we may expect the sign of the coefficient δ_2 to be negative. Second, the time trend variable $year_{eur}$ is included because the growth in relative economic size of the issuing country leads to the emergence of its currency as a major invoicing currency. In the case of the euro, the economic size of the Eurozone jumped immediately when the euro was introduced and increased as more and more European countries adopted the euro as their official currency. In addition, this time variable also captures the inertia in adopting the euro for invoicing purposes. By an argument similar to the above, the

interaction term $year_{eur} \times \frac{Y_i^t}{Y_{euz}^t}$ allows for the potential effect that a smaller country tends to adopt the euro faster, and hence, the sign of its coefficient δ_6 is expected to be negative. Finally, term $pip_{eur-\$}$ captures the effect of the differential in transaction costs, which are calculated in a way that is standard in literature -- the median difference between the bid-ask spreads (pips) of the euro and the dollar on local currency each year.

Table 8 presents the results for euro invoicing in exports, with the explanatory variables added one by one. The share of the Eurozone in a country's total trade $\gamma_{euz,i}^t$ has strongly positive effect on the use of the euro in export invoicing by a country and it contributes to explaining more than 60% of the cross-country and intertemporal variation of the euro's share in export invoicing (adjusted R^2 is equal to 0.601 in column (1)). This supports distinguishing countries according to their trade relationship with the Eurozone. The negative and significant coefficient on $\gamma_{euz,i}^t \times \frac{Y_i^t}{Y_{euz}^t}$ shows that the euro is used less in exports by countries that are relatively large, when the share of trade with the Eurozone is controlled for. EU members use the euro more widely, as suggested by column (3). The time trend $year_{eur}$ enters with a significant and positive coefficient (column (4)). In general, the use of the euro increases over time, but the increase is contributed by smaller countries with a relatively larger degree, as signified by strongly negative coefficient on the interaction term $year_{eur} \times \frac{Y_i^t}{Y_{euz}^t}$ (column (5)). In particular, when this is introduced, the magnitude of the coefficient on the first interaction term $\gamma_{euz,i}^t \times \frac{Y_i^t}{Y_{euz}^t}$ drops by nearly half, because these two terms are partially correlated. The hedging motive seems not as important in magnitude, but is significant statistically, according to column (6). Consistent with Goldberg and Tille (2008), columns (7) shows that $pip_{eur-\$}$ is insignificant in explaining invoicing currency choice. Since missing observations in the data for transaction costs limit the number of observations that we can use, we report the results without these for import invoicing and in the counterfactual analysis for the renminbi.[7]

Table 9 reports the results for euro invoicing for imports, which share similar patterns with those for euro invoicing for exports. This is an extension of Goldberg and Tille (2008), who only examine export invoicing. Overall, both sets of our estimates are close to their findings, both qualitatively and quantitatively.

5. The Potential of the Renminbi as an Invoicing Currency

In this section, we evaluate the potential of the renminbi for trade invoicing in the Asia-Pacific region, based on the two sets of empirical evidence in Section 4. We continue to offer two different angles for

[7] However, when we repeat our analysis with it, the results are almost unaltered. For example, for import invoicing, the estimates on other variables with it being included are very close to those presented in column (6) of Table 9.

the assessment: the extent of renminbi invoicing in the bilateral trade between Thailand and other countries, and the extent of renminbi invoicing in the total trade of countries in the Asia-Pacific region.

5.1 The Implications of Cross-Currency Experience

To capture the effects of thick market externalities, our empirical analysis evaluates the impact of the normalized global FX turnover of a currency on the extent to which the currency is used as an invoicing currency. In 2013, the renminbi was the 9th most traded currency (BIS, 2013), but as shown in Table 10, its market share remained very limited, accounting for only about 1% of global FX turnover. Relative to China's GDP share, its turnover share is even smaller (no larger than, for example, the Thai baht). On the other hand, this means that the renminbi has a lot of potential in the development of its market thickness, which in turn can promote its use as an invoicing currency.

To make predictions about the potential of the renminbi, we rely on the empirical models reported in columns (3) and (4) of Table 5 for imports and exports, respectively. The estimates are based on our preferred logistic specification, which is robust across different regressor configurations. In particular, we consider two cases: (1) China is the trading partner of Thailand, and (2) an average ASEAN country is the trading partner of Thailand.

We use the 2010 data on China's share in Thailand's total trade, China's share in the partner's trade, exchange rate co-movement between the renminbi and Thai baht, renminbi exchange rate volatility. With these variables fixed at their values in 2010, we compute the required GDP share for the share of renminbi invoicing to reach certain level under different assumptions about market depth. In particular, we show how the required GDP share varies with the imposed ratio of FX turnover share to GDP share. Table 11 shows the Chinese data on the main explanatory variables in 2010, along with the US data for the same year. China is not comparable with the US either in economic size, thickness of its currency market, or capital market depth.

Table 12 presents the results for renminbi invoicing in the trade between Thailand and China. It shows that, at the current level of the renminbi's FX market thickness and China's GDP share, the renminbi could reach an invoicing share around 10% in Thailand's trade with China. Although there is no direct evidence on renminbi invoicing in the Thailand-China trade, the fact that China was the second largest trading partner of Thailand, accounting for 17% of Thailand's total trade in 2010, and that the renminbi was not visible in the currency distribution of Thailand's trade (the minimum observation is less than 0.5%) imply that the renminbi is still far from reaching its projected invoicing share in the bilateral trade.

Why is the renminbi so much under-used in the invoicing of trade? One possible reason is inertia in the adoption of an emerging currency. Although changes in fundamental conditions imply changes in the composition of invoicing currencies, there may be a substantial time lag in adjustment. As argued

by Krugman (1984), "the choice of a vehicle currency reflects both history and hysteresis." A similar argument applies for invoicing currencies, and might explain why the renminbi has not realized its potential yet. Another possible explanation is that the implied potential reflects only the average experience of different currencies, but idiosyncratic factors may contribute to the disparity between actual use and average potential.[8]

Moreover, it clear from Table 12 that when the renminbi's market thickness increases, the required GDP share for the emergence of the reminbi as a major invoicing currency becomes significantly smaller. This shows the importance of improving capital account openness and financial development.

Table 13 reports the predictions for the potential of the renminbi as a vehicle currency in invoicing trade between Thailand and ASEAN countries. When China is not involved in the trade, it requires a much higher GDP share of China for the renminbi to play an important role than the share required when China is the trading partner. However, if the FX-share-GDP-share ratio of the renminbi reaches a level comparable to that of more established currencies (e.g., 1 or 1.5), the renminbi could have an invoicing share of around 10% when China's GDP share reaches 13%-18%, which is likely to be achieved in the near future. The renminbi could even play a leading role (around 40-60% invoicing share) in the ASEAN region as a vehicle currency were China's GDP share to reach a level around 25%, which is roughly the GDP share of the U.S. in 2012, under the assumption of high capital account openness and financial development, and hence a thick market for the renminbi.

5.2 The Implications of the Euro's Experience

In 1999, the euro was introduced as a new currency, and offers a comparison for the path of the renminbi as an emerging currency today. The circumstances in which the euro found itself then were a bit like those in which the renminbi finds itself today, namely, aspiring to be a regional currency that challenges the incumbent currency, the US dollar. We use the estimation results for the euro presented in Section 4.2 to predict the potential path of the renminbi in trade invoicing.

We are using the euro's experience to estimate the potential use of the renminbi for trade invoicing. By potential, we mean the invoicing share of the renminbi conditional on China reaching the same degree of capital account openness and financial development as the Eurozone so that the renminbi has a market as thick as the euro. In carrying out the estimation, we assume that the empirical model estimated for the euro is applicable to the renminbi. The variables included in the model should behave in the same way. For example, the share of China in the total trade of a country should have the same marginal effect on the use of the renminbi as that of the Eurozone on euro invoicing measured by the estimate of coefficient δ_1. However, there are aspects for which we cannot draw

[8] Yet another possible reason is that the effect of the FX-share-to-GDP-share ratio on the left-hand-side variable is non-linear (i.e. convex). In that case, we over-estimate the potential of the renminbi when the ratio is small, but under-estimate it when the ratio is large.

parallels between the euro and the renminbi. For example, before the launch of the euro, the German mark had been used as an invoicing currency in continental Europe to a large extent. Once the euro was introduced, those who used the German mark likely switched to the euro immediately. Thus, the share of euro invoicing in some European countries was already nontrivial at the birth of the currency (Portes and Rey, 1998). This is certainly not true for the renminbi. From this perspective, it may be useful to consider our out-of-sample predictions based on the euro regressions as an upper bound for the potential use of the renminbi in trade invoicing.

Specifically, our predictions are based on the estimates contained in column (3) of Table 8 and 9 for export and import invoicing, respectively. This is because of there is no China-equivalent for $year_{eur}$, years after the introduction of the euro. It is still hard to assess the international use of the renminbi for cost hedging. There is thus no China-equivalent for $Heur_i^t$ either, the indicator for the euro as preferred hedging currency over the US dollar. Columns (3) account for the effect of EU membership. The equivalent "China-dummy" should be set to zero for all countries that we are considering. The actual Chinese data on all other variables is used to pin down the implied invoicing shares of the renminbi.

The results for both export invoicing and import invoicing are listed in Table 14. For example, based on the data of 2010, potential renminbi invoicing in Australia, Indonesia, South Korea, Malaysia, Philippines, and Singapore is in the range of between 8% and 12% of the country's total imports or exports, assuming the same level of capital account openness and financial development as the Eurozone. The implied potential use of the renminbi increases from 2008 to 2010, reflecting the growth in relative economic size of China in the global economy.

We present the predictions for Thailand (the last row of Table 14) to enable an indirect comparison with the results obtained from the Thailand data (Tables 12 and 13). Suppose that the FX-share-GDP-share ratio of the renminbi reached that of the euro, of 1.03 in 2010 (Table 10). Given that China's GDP share is 9.4% in 2010 and that the shares of China and ASEAN countries in Thailand's total imports are 13.3% and 16.6%, respectively, the potential invoicing share of the renminbi in Thailand's imports from China+ASEAN is 14.9%, based the cross-currency regression analysis for Thailand. Only a smaller renminbi invoicing share in Thailand's imports from the rest of the world, which cannot be directly estimated using this approach, is needed to reach the aggregate renminbi invoicing share of 11.7% as stated in Table 14. In light of the geo-economic factors, this is reasonable. A similar calculation follows for export invoicing. Therefore, our two sets of counterfactual predictions are consistent, or at least compatible, with each other, though we cannot directly compare the two sets of numbers.

As argued above, the assessment given in Table 14 should be treated as an upper bound for the potential of the renminbi as an invoicing currency as there are a number of factors favorable to the euro's use as an invoicing currency when it was launched not shared by the renminbi.

6. Conclusion

Trade invoicing reflects the function of an international currency as a unit of account. In this paper, we develop a simple model to show that a coalescing effect and thick market externalities lead to a convex relationship between the invoicing share of a currency and the economic size of its issuing country, which we call the “tipping phenomenon” of trade invoicing. Constrained by the availability of the data, there is sparse evidence on invoicing behavior. This paper contributes to the literature by providing new evidence on the determinants of the use of a currency in trade invoicing. Our empirical analysis provides evidence for a tipping phenomenon and the underlying role of thick market externalities, as proxied by the ratio of the FX turnover share of the currency to the GDP share of the issuing country. We argue that in order to arrive at this “tipping point,” the issuing country has to establish a sufficiently thick market for its currency.

Applying the empirical models to evaluate the potential of the renminbi, our quantitative thought experiments suggest that there is large scope for the use of the renminbi in trade invoicing in the Asia-Pacific region and beyond. We argue that China needs to have a more open capital account and a more liberalized financial sector to achieve the required thick market externalities for the renminbi to emerge as a major invoicing currency. Market-driven invoicing behavior may exhibit a good deal of inertia, but transformations of the global economic landscape will induce changes in the international currency system eventually. As China’s relative economic size increases, capital controls are gradually relaxed, and financial reforms are smoothly implemented, it seems inevitable that the renminbi will become a major invoicing currency in the Asia-Pacific region. The only question is when.

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Table 1. Correlation between GDP Share and Ratio of Foreign Exchange Turnover Share to GDP Share

	1998	2001	2004	2007	2010	2013
Correlation	0.261	0.280	0.301	0.312	0.294	0.429

Notes: The GDP data is not yet available for 2013 when we write this paper. Given that GDP share changes only slowly, we use 2012 GDP share as a proxy when computing the correlation in last column.

Data Source: BIS, World Bank.

Table 2. Determinants of Currency Invoicing Share in Thailand's Trade: Baseline Estimation with Simple Linear Model

Sample	Import	Export	Import	Export	Import	Export
	(1)	(2)	(3)	(4)	(5)	(6)
Issuer's GDP share	2.336***	2.444***	2.746***	3.045***	2.756***	2.980***
	(0.153)	(0.122)	(0.143)	(0.123)	(0.157)	(0.137)
Issuer's share in Thailand total			0.202***	0.231***	0.147***	0.185***
trade			(0.024)	(0.035)	(0.037)	(0.043)
Issuer's share in partner's total			0.225***	0.134**	0.222***	0.150**
trade			(0.041)	(0.065)	(0.044)	(0.056)
EX comovement with THB					0.079***	0.128***
					(0.015)	(0.010)
EX comovement with partner's					0.009	-0.023
currency					(0.024)	(0.018)
EX volatility					-0.134***	-0.226***
					(0.027)	(0.027)
EX bid-ask spread					-0.680	-0.785
					(0.806)	(0.704)
Constant	-0.019	-0.022	-0.154***	-0.172***	-0.110***	-0.093***
	(0.015)	(0.015)	(0.015)	(0.029)	(0.032)	(0.032)
R-square	0.627	0.622	0.730	0.743	0.751	0.783
# Observations	1901	1821	1901	1821	1251	1266

Notes: Standard errors, clustered within trading partners, are reported in parentheses. *** p <0.01, ** p < 0.05, * p < 0.1.

Table 3. Determinants of Currency Invoicing Share in Thailand's Trade: Baseline Estimation with Logistic Transformation

Sample	Import	Export	Import	Export	Import	Export
	(1)	(2)	(3)	(4)	(5)	(6)
Issuer's GDP share	20.337***	20.674***	25.424***	27.354***	24.130***	25.978***
	(1.269)	(1.017)	(1.055)	(1.145)	(1.339)	(1.519)
Issuer's share in Thailand total			3.213***	3.339***	2.148***	2.436***
trade			(0.243)	(0.343)	(0.332)	(0.437)
Issuer's share in partner's total			3.635***	2.775***	3.627***	2.949***
trade			(0.262)	(0.463)	(0.321)	0.405
EX comovement with THB					0.629***	0.969***
					(0.172)	(0.068)
EX comovement with partner's					-0.011	-0.297
currency					(0.235)	(0.176)
EX volatility					-1.115***	-1.995***
					(0.288)	(0.316)
EX bid-ask spread					-14.252*	-17.056**
					(7.508)	(7.725)
Constant	-4.818***	-4.800***	-6.996***	-7.128***	-6.170***	-5.991***
	(0.183)	(0.143)	(0.166)	(0.304)	(0.381)	(0.519)
R-square	0.546	0.546	0.716	0.694	0.726	0.736
# Observations	1893	1820	1722	1649	1247	1265

Notes: Standard errors, clustered within trading partners, are reported in parentheses. *** p <0.01, ** p < 0.05, * p < 0.1.

Table 4. Determinants of Currency Invoicing Share in Thailand's Trade: Inclusion of Thick Market Externalities in the Linear Model

Sample	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export	Import	Export
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
Issuer's GDP share	2.641***	2.918***	1.163***	0.620**	1.424***	0.999**	2.061***	2.162***	2.492***	2.625***	2.213***	2.206***	2.439***	2.615***
	(0.139)	(0.118)	(0.407)	(0.344)	(0.429)	(0.427)	(0.331)	(0.291)	(0.146)	(0.134)	(0.143)	(0.128)	(0.131)	(0.111)
Issuer's GDP share squared			4.880***	7.664***	3.484**	5.358***	0.537	0.159						
			(1.506)	(1.183)	(1.493)	(1.291)	(1.102)	(0.851)						
Issuer's share in Thailand total trade	0.167***	0.185***	0.115***	0.109***	0.351***	0.430***	0.426***	0.563***	0.399***	0.505***	0.434***	0.565***	0.207***	0.267***
	(0.023)	(0.031)	(0.030)	(0.036)	(0.060)	(0.081)	(0.061)	(0.057)	(0.060)	(0.086)	(0.057)	(0.054)	(0.022)	(0.032)
Issuer's share in partner's total trade	0.228***	0.140**	0.222***	0.130**	0.246***	0.230***	0.252***	0.250***	0.254***	0.245***	0.254***	0.250***	0.233***	0.155***
	(0.041)	(0.055)	(0.044)	(0.051)	(0.056)	(0.066)	(0.052)	(0.059)	(0.054)	(0.066)	(0.051)	(0.058)	(0.044)	(0.050)
EX comovement with THB	0.066***	0.110***	0.061***	0.092***	0.009	0.014	0.019	0.037***	0.013	0.024	0.020	0.037***	0.076***	0.120***
	(0.012)	(0.010)	(0.009)	(0.007)	(0.012)	(0.013)	(0.014)	(0.012)	(0.014)	(0.016)	(0.014)	(0.013)	(0.013)	(0.009)
EX volatility	-0.123***	-0.203***	-0.089***	-0.136***	-0.061***	-0.111***	-0.011	-0.026	-0.084***	-0.157***	-0.011	-0.026	-0.064***	-0.097***
	(0.021)	(0.024)	(0.013)	(0.015)	(0.012)	(0.022)	(0.018)	(0.019)	(0.017)	(0.034)	(0.018)	(0.019)	(0.014)	(0.018)
Ratio of FX turnover share to GDP share					0.143***	0.189***	0.111***	0.130***	0.150***	0.203***	0.110***	0.130***		
					(0.035)	(0.048)	(0.028)	(0.038)	(0.036)	(0.053)	(0.028)	(0.038)		
Issuer's capital market depth							0.111*	0.194***			0.117***	0.196***	0.077***	0.132***
							(0.040)	(0.021)			(0.041)	(0.022)	(0.027)	(0.018)
Constant	-0.113***	-0.117***	-0.067***	-0.048**	-0.289***	-0.335***	-0.470***	-0.660***	-0.335***	-0.406***	-0.484***	-0.664***	-0.248***	-0.358***
	(0.015)	(0.026)	(0.020)	(0.023)	(0.060)	(0.097)	(0.095)	(0.069)	(0.061)	(0.105)	(0.090)	(0.065)	(0.048)	(0.038)
R-square	0.742	0.775	0.750	0.793	0.746	0.809	0.754	0.833	0.741	0.799	0.754	0.833	0.750	0.798
# Observations	1712	1650	1712	1650	1219	1190	1219	1190	1219	1190	1219	1190	1712	1650

Notes: Standard errors, clustered within trading partners, are reported in parentheses. *** p <0.01, ** p < 0.05, * p < 0.1.

Table 5. Determinants of Currency Invoicing Share in Thailand's Trade: Inclusion of Thick Market Externalities in the Logistic Model

Sample	Import	Export	Import	Export	Import	Export	Import	Export
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Issuer's GDP share	24.441***	26.088***	23.755***	23.356***	21.891***	21.066***	23.130***	24.323***
	(1.087)	(1.133)	(1.157)	(1.308)	(1.313)	(1.492)	(1.122)	(1.272)
Issuer's share in Thailand total trade	2.881***	2.975***	5.006***	6.022***	5.245***	6.351***	3.144***	3.454***
	(0.242)	(0.315)	(0.528)	(0.538)	(0.497)	(0.429)	(0.260)	(0.341)
Issuer's share in partner's total trade	3.668***	2.830***	3.783***	3.566***	3.779***	3.596***	3.698***	2.915***
	(0.252)	(0.386)	(0.321)	(0.432)	(0.314)	(0.427)	(0.263)	(0.356)
EX comovement with THB	0.608***	0.858***	0.222	0.167	0.264*	0.240**	0.669***	0.918***
	(0.115)	(0.066)	(0.137)	(0.119)	(0.137)	(0.101)	(0.129)	(0.072)
EX volatility	-1.129***	-1.923***	-0.930***	-1.570***	-0.443**	-0.852***	-0.744***	-1.307***
	(0.213)	(0.247)	(0.192)	(0.239)	(0.211)	(0.209)	(0.197)	(0.199)
Ratio of FX turnover share to GDP share			1.191***	1.826***	0.923***	1.425***		
			(0.291)	(0.356)	(0.225)	(0.270)		
Issuer's capital market depth					0.784**	1.069***	0.504**	0.772***
					(0.343)	(0.198)	(0.239)	(0.181)
Constant	-6.615***	-6.489***	-8.47***	-9.042***	-9.472***	-10.456***	-7.495***	-7.901***
	(0.224)	(0.318)	(0.507)	(0.533)	(0.741)	(0.463)	(0.486)	(0.354)
R-square	0.727	0.726	0.750	0.789	0.757	0.802	0.732	0.735
# Observations	1704	1649	1215	1190	1215	1190	1704	1649

Notes: Standard errors, clustered within trading partners, are reported in parentheses. *** p <0.01, ** p < 0.05, * p < 0.1.

Table 6. Re-Estimation of the Logistic Model with Thick Market Externalities Excluding Financial Crises

Sample	Import	Export	Import	Export	Import	Export	Import	Export
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Issuer's GDP share	24.114***	25.159***	23.579***	22.518***	21.670***	20.627***	23.289***	24.240***
	(1.131)	(1.220)	(1.187)	(1.409)	(1.323)	(1.562)	(1.163)	(1.259)
Issuer's share in Thailand total trade	2.767***	2.624***	5.045***	6.177***	5.154***	6.433***	3.074***	3.103***
	(0.268)	(0.354)	(0.647)	(0.638)	(0.544)	(0.478)	(0.263)	(0.377)
Issuer's share in partner's total trade	3.675***	2.776***	3.755***	3.557***	3.712***	3.575***	3.700***	2.837***
	(0.251)	(0.372)	(0.320)	(0.472)	(0.307)	(0.462)	(0.260)	(0.358)
EX comovement with THB	0.693***	1.110***	0.054	0.026	0.267*	0.240**	0.793***	1.235***
	(0.145)	(0.095)	(0.129)	(0.113)	(0.146)	(0.107)	(0.165)	(0.124)
EX volatility	-1.433**	-2.789***	-1.335**	-1.908***	-0.424	-0.745***	-0.673	-1.696***
	(0.623)	(0.596)	(0.540)	(0.448)	(0.290)	(0.210)	(0.413)	(0.554)
Ratio of FX turnover share to GDP share			1.069***	1.898***	0.564**	1.338***		
			(0.381)	(0.454)	(0.276)	(0.331)		
Issuer's capital market depth					1.007***	1.163***	0.471**	0.644***
					(0.362)	(0.238)	(0.205)	(0.192)
Constant	-6.607***	-6.247***	-8.171***	-8.982***	-9.500***	-10.681***	-7.698***	-7.815***
	(0.372)	(0.482)	(0.721)	(0.785)	(0.775)	(0.591)	(0.417)	(0.566)
R-square	0.719	0.714	0.741	0.785	0.752	0.800	0.722	0.720
# Observations	1158	1124	778	765	778	765	1158	1124

Notes: Observations for 1997-1999 and 2008-2010 are excluded. Standard errors, clustered within trading partners, are reported in parentheses. *** p <0.01, ** p < 0.05, * p < 0.1.

Table 7. Use of the Euro and the US Dollar for Invoicing in Exports and Imports of Different Countries

	Export		Import	
	Euro Share (%)	USD Share (%)	Euro Share (%)	USD Share (%)
European countries				
Belgium	53.630	30.967	53.730	34.200
Bulgaria	53.200	50.186	58.369	42.886
Croatia	69.192	31.057	73.917	22.214
Cyprus	18.550		9.950	
Czech Republic	71.642	13.633	68.208	19.217
Denmark	32.883	21.950	33.900	20.450
Estonia	60.925	9.200	58.388	21.950
France	50.325	37.940	43.142	48.680
Germany	61.717	26.600	54.833	34.767
Greece	37.930	54.350	35.960	57.150
Hungary	78.643	16.400	69.857	21.343
Italy	61.609	24.800	45.664	34.300
Latvia	50.709	39.600	56.536	35.660
Lithuania	46.342	50.029	49.092	47.700
Luxembourg	52.691	29.000	43.664	40.233
Macedonia, FYR	68.167	35.800	67.242	33.714
Netherlands	49.560	35.940	41.900	47.000
Poland	62.942	31.829	58.250	30.571
Portugal	54.118	31.725	53.609	34.725
Romania	63.425	36.357	67.167	30.914
Slovakia	74.663	25.400	78.800	
Slovenia	83.230	9.580	74.870	14.860
Spain	57.869	35.614	54.223	41.714
Turkey	47.767	43.467	36.522	55.600
U.K.	21.000	27.750	22.000	34.750
Ukraine	6.086	76.275	16.417	74.767
Non-European countries				
Algeria	0.530	99.000	49.400	
Australia	0.942	71.167	8.467	51.117
India	7.100		8.100	
Indonesia	1.667	92.586	4.858	80.429
Pakistan	4.000	91.433	6.500	83.867
South Africa	17.000	52.000		
South Korea	4.925	85.900	4.350	80.375
Thailand	2.242	86.667	3.925	78.333
Tunisia	50.775			

Data Source: ECB, authors' compilation.

Table 8. Determinants of Euro's Share in a Country's Export Invoicing

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Eurozone's share in exporter's total trade	1.273***	1.319***	1.144***	1.223***	1.184***	1.215***	1.298***
	(0.072)	(0.069)	(0.078)	(0.072)	(0.074)	(0.075)	(0.076)
Eurozone' share in exporter's total trade × ratio of exporter's size to Eurozone		-3.675***	-3.889***	-3.356***	-1.980**	-1.371	-1.712**
		(0.759)	(0.732)	(0.670)	(0.932)	(0.979)	(0.749)
EU dummy (exporter = EU member)			0.117***	0.084***	0.069***	0.063**	0.082***
			(0.028)	(0.026)	(0.026)	(0.026)	(0.028)
# years after introduction of Euro				0.021***	0.0249***	0.025***	0.031***
				(0.003)	(0.004)	(0.004)	(0.003)
# years after introduction of Euro × ratio of exporter's size to Eurozone					-0.212**	-0.208**	-0.247***
					(0.101)	(0.100)	(0.077)
Preferred hedging currency						-0.062*	-0.040
						(0.032)	(0.032)
Diff. in bid-ask spread btw euro and USD							-0.564
							(1.722)
Constant	-0.0348	-0.0287	-0.0271	-0.163***	-0.149***	-0.171***	-0.224***
	(0.030)	(0.029)	(0.028)	(0.032)	(0.033)	(0.035)	(0.033)
R-square adjusted	.601	.639	.666	.725	.729	0.733	0.877
# Observations	210	210	210	210	210	210	144

Notes: Standard errors are reported in parentheses. *** p <0.01, ** p < 0.05, * p < 0.1.

Table 9. Determinants of Euro's Share in a Country's Import Invoicing

	(1)	(2)	(3)	(4)	(5)	(6)
Eurozone's share in importer's total trade	1.238***	1.301***	1.219***	1.248***	1.202***	1.202***
	(0.063)	(0.058)	(0.071)	(0.068)	(0.070)	(0.071)
Eurozone' share in importer's total trade × ratio of importer's size to Eurozone		-4.190***	-4.248***	-3.918***	-2.393***	-2.394***
		(0.607)	(0.603)	(0.585)	(0.812)	(0.862)
EU dummy (importer = EU member)			0.048*	0.0328	0.0169	0.017
			(0.025)	(0.024)	(0.024)	(0.025)
# years after introduction of Euro				0.0116***	0.0158***	0.016***
				(0.003)	(0.003)	(0.003)
# years after introduction of Euro × ratio of exporter's size to Eurozone					-0.233***	-0.233***
					(0.087)	(0.087)
Preferred hedging currency						0.000
						(0.028)
Constant	-0.00664	-0.00218	0.00102	-0.0717**	-0.056*	-0.056*
	(0.026)	(0.023)	(0.023)	(0.028)	(0.029)	(0.031)
R-square adjusted	.659	.725	.729	.749	.757	0.756
# Observations	199	199	199	199	199	199

Notes: Standard errors are reported in parentheses. *** p <0.01, ** p < 0.05, * p < 0.1.

Table 10. Global FX Turnover Share and GDP Share

	1998	2001	2004	2007	2010	2013
			Global FX Turnover Share (%)			
USD	43.401	44.932	44.004	42.798	42.430	43.523
EUR	--	18.956	18.705	18.518	19.526	16.706
GBP	5.508	6.523	8.249	7.433	6.440	5.905
JPY	10.862	11.767	10.415	8.625	9.496	11.519
CAD	1.763	2.244	2.100	2.145	2.642	2.284
SGD	0.553	0.527	0.453	0.584	0.709	0.698
THB	0.071	0.076	0.100	0.098	0.096	0.160
RMB	0.007	0.004	0.048	0.226	0.431	1.119
			Ratio of FX Turnover Share to GDP Share			
USD	1.500	1.411	1.577	1.711	1.869	1.996
EUR	--	0.960	0.809	0.836	1.027	0.985
GBP	1.138	1.428	1.588	1.469	1.813	1.744
JPY	0.838	0.909	0.946	1.105	1.097	1.390
CAD	0.863	1.008	0.895	0.841	1.064	0.902
SGD	1.744	1.859	1.751	1.935	2.073	1.827
THB	0.193	0.210	0.262	0.221	0.192	0.314
RMB	0.002	0.001	0.011	0.036	0.046	0.096

Notes: The GDP data is not yet available for 2013 when we write this paper. We use 2012 GDP share as a proxy when computing the ratio of foreign exchange turnover share to GDP share in the last column of the lower panel.

Data Source: BIS, World Bank.

Table 11. Values of Main Variables for China and the U.S. in 2010

Main Variables	China (RMB)	U.S. (USD)
Dependent variables		
Currency share in Thailand import from issuer	--	0.935
Currency share in Thailand export to issuer	--	0.945
Currency Share in Thailand import from ASEAN	--	0.869
Currency Share in Thailand export to ASEAN	--	0.796
Independent variables		
Issuer's GDP share	0.094	0.227
Issuer's share in Thailand total trade	0.121	0.079
Issuer's share in ASEAN's total trade	0.173	0.107
Exchange rate comovement with Baht	0.782	0.735
Exchange rate volatility	0.358	0.313
Ratio of FX turnover share to issuer's GDP share	0.046	1.869
Issuer's capital market depth	1.052	1.947

Data Source: Bank of Thailand, BIS, World Bank.

Table 12. Required GDP Share of China (%) to Achieve Given Renminbi Invoicing Share in the Thailand-China Trade

		Ratio of FX Turnover Share to GDP Share		
RMB Invoicing Share in Thailand's Imports	0.046 (as of 2010)	0.5	1.00	1.50
10%	8.371	6.095	3.588	1.081
20%	11.785	9.509	7.002	4.495
25%	12.996	10.720	8.213	5.706
30%	14.054	11.778	9.271	6.764
40%	15.914	13.637	11.131	8.624
50%	17.620	15.344	12.838	10.331
RMB Invoicing Share in Thailand's Exports	0.046 (as of 2010)	0.5	1.00	1.50
10%	12.405	8.856	8.856	1.038
20%	15.877	12.328	12.328	4.510
25%	17.109	13.560	13.560	5.742
30%	18.185	14.636	14.636	6.818
40%	20.077	16.528	16.528	8.710
50%	21.813	18.264	18.264	10.446

Notes: Calculations are based on the empirical models with logistic transformation, as reported in columns (3) and (4) of Table 5. It is assumed that all independent variables other than GDP share and FX turnover share will remain at their current levels.

Table 13. Required GDP Share of China (%) to Achieve Given Renminbi Invoicing Share in the Thailand-ASEAN Trade

		Ratio of FX Turnover Share to GDP Share		
RMB Invoicing Share in Thailand's Imports	0.046 (as of 2010)	0.5	1.00	1.50
10%	21.541	19.265	16.758	14.251
20%	24.955	22.678	20.172	17.665
25%	26.166	23.890	21.383	18.876
30%	27.223	24.947	22.441	19.934
40%	29.083	26.807	24.301	21.794
50%	30.790	28.514	26.007	23.501
RMB Invoicing Share in Thailand's Exports	0.046 (as of 2010)	0.5	1.00	1.50
10%	25.032	21.483	17.574	13.665
20%	28.504	24.955	21.046	17.137
25%	29.736	26.186	22.277	18.368
30%	30.812	27.262	23.353	19.444
40%	32.703	29.154	25.245	21.336
50%	34.439	30.890	26.981	23.072

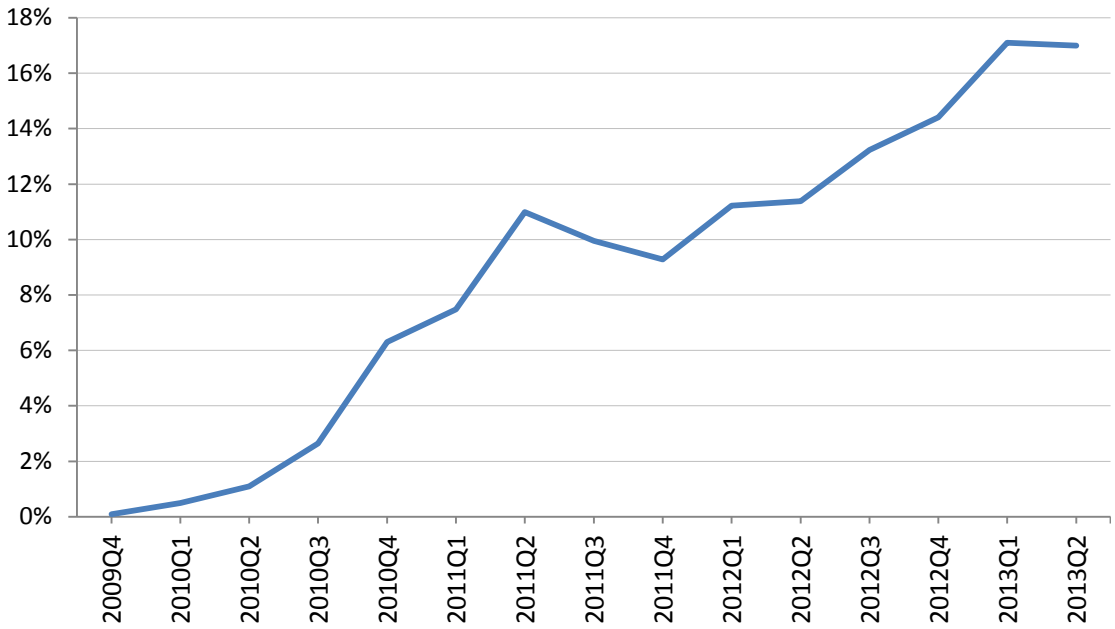
Notes: Calculations are based on the empirical models with logistic transformation, as reported in columns (3) and (4) of Table 5. It is assumed that all independent variables other than GDP share and FX turnover share will remain at their current levels.

Table 14. The Potential Invoicing Share of the RMB in the Trade of Some Asia-Pacific Countries, Based on Projection from the Euro's Experience

	Export		Import	
	2008 Data	2010 Data	2008 Data	2010 Data
Australia	3.8	8.3	3.6	8.5
Indonesia	7.1	8.2	7.4	8.6
Korea	6.7	10.2	6.7	10.5
Malaysia	10.3	12.6	10.9	13.4
Philippines	9.2	9.9	9.8	10.6
Singapore	9.8	10.7	10.4	11.3
Thailand	9.1	11.1	9.6	11.7

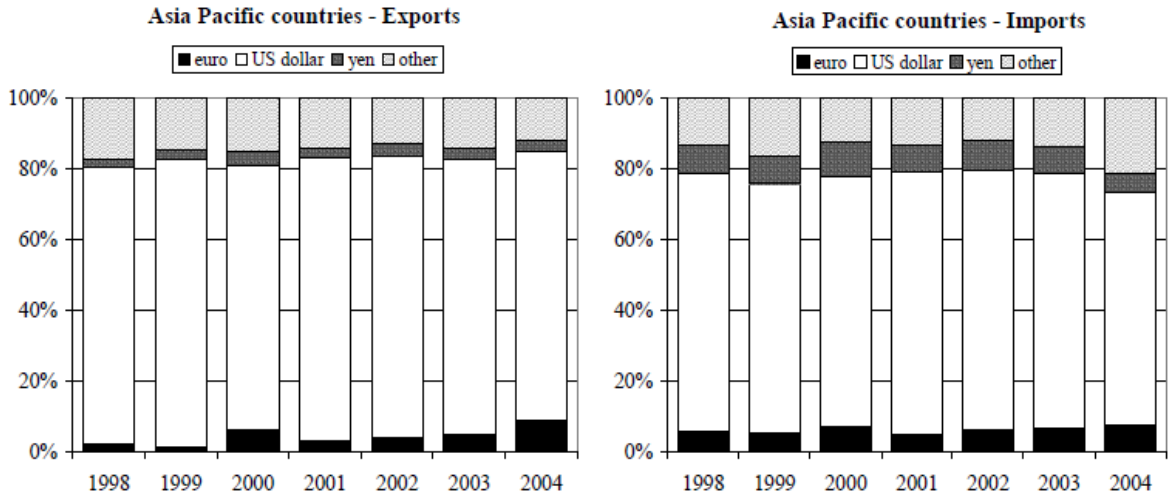
Notes: Calculations are based on the empirical models reported in Column (3) of Tables 8 and 9. The projections using the 2008 and 2010 data of China-equivalent of the independent variables are reported.

Figure 1. Share of Renminbi Settlement in China's Cross-Border Trade



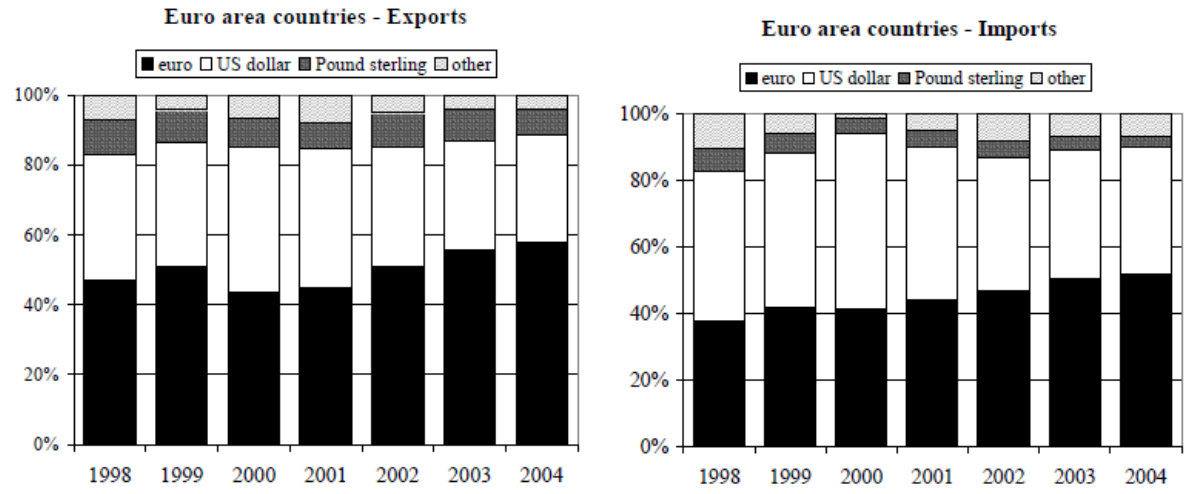
Data Source: People's Bank of China.

Figure 2. Invoicing Currency Distribution: Asia-Pacific



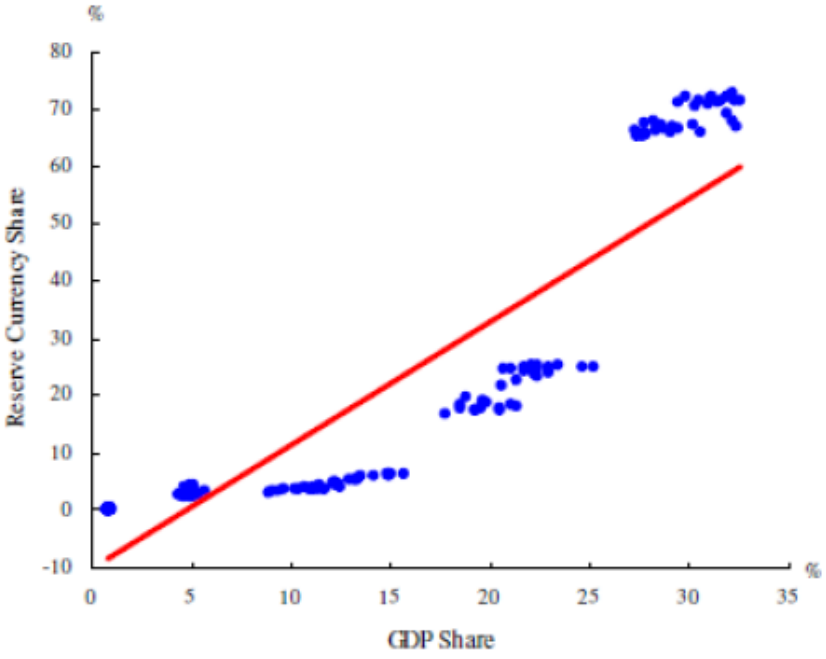
Source: Kamps (2006).

Figure 3. Invoicing Currency Distribution: Eurozone



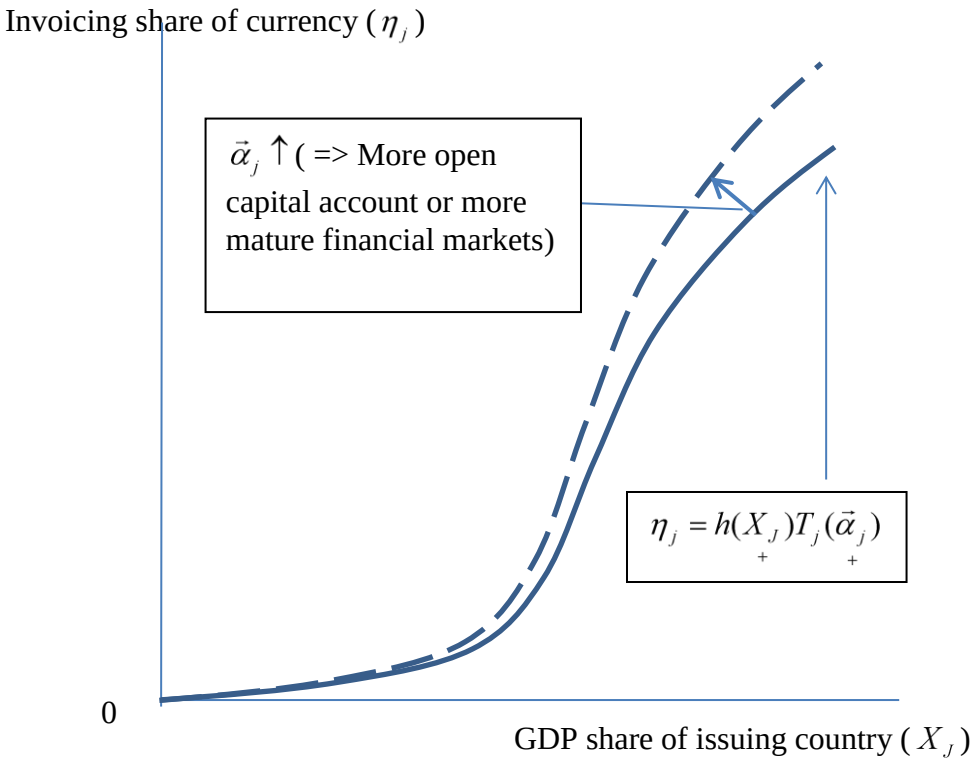
Source: Kamps (2006).

Figure 4. Reserve Currency Share vs. GDP Share



Source: Chen, Peng, and Shu (2009).

Figure 5. Thick Market Externalities, Coalescing Effect, and Tipping Phenomenon



$h(X_J)$ represents coalescing effect

$T_i(\vec{\alpha}_i)$ represents thick market externalities.

Figure 6. Currency Invoicing Share and GDP Share

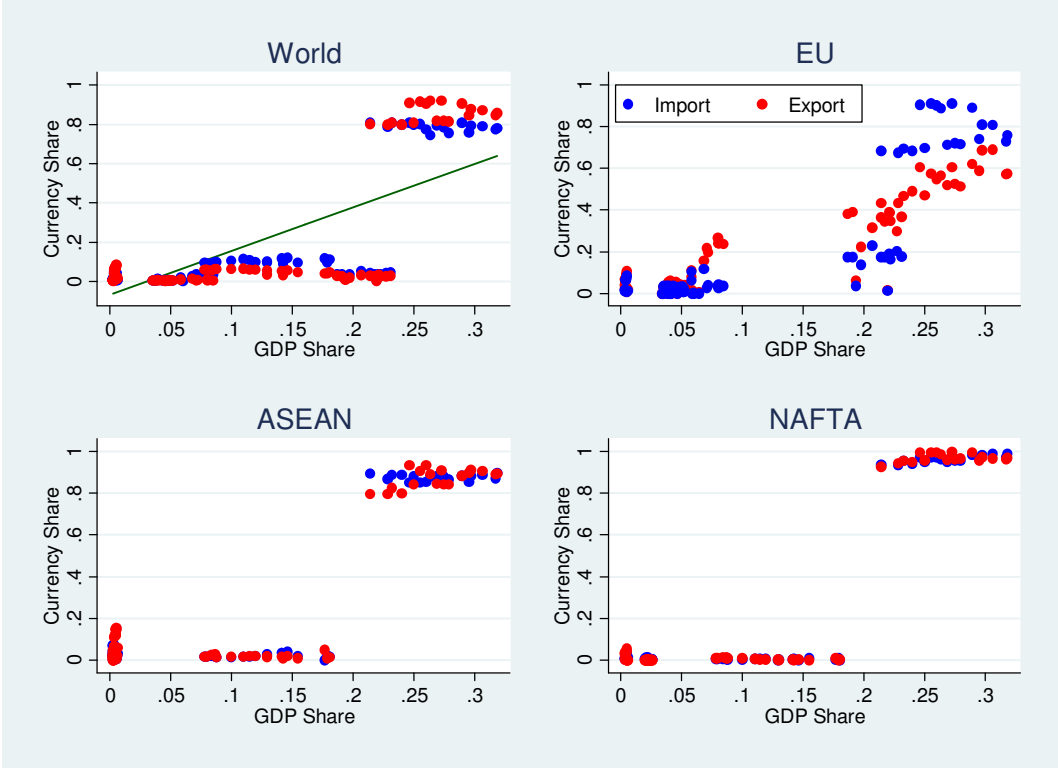


Figure 7. Major Invoicing Currencies in Thailand's Trade

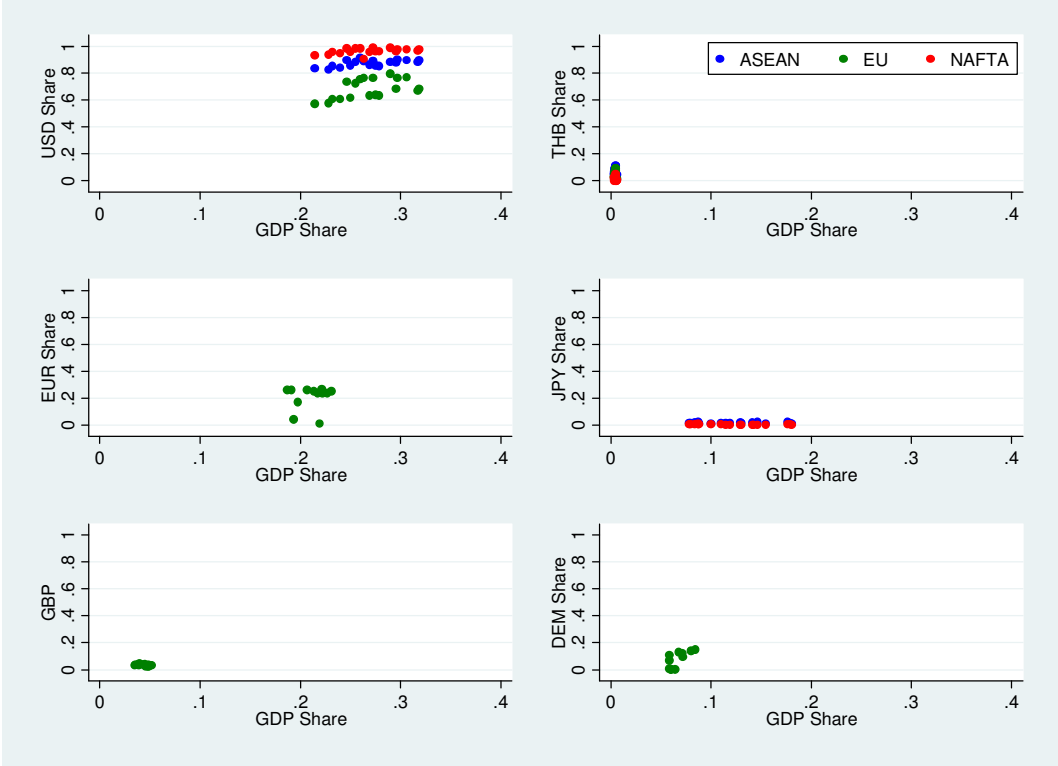


Figure 8. Major Invoicing Currencies in Thailand's Trade over Time

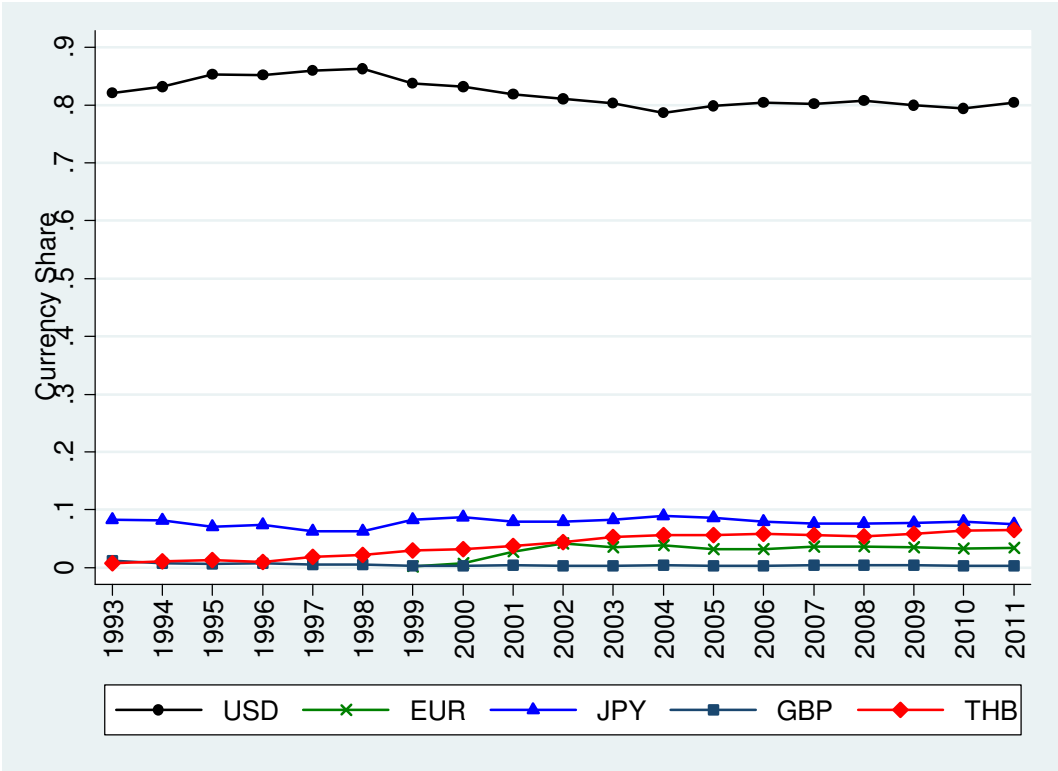


Figure 9. The US Dollar as Invoicing Currency in Thailand's Trade

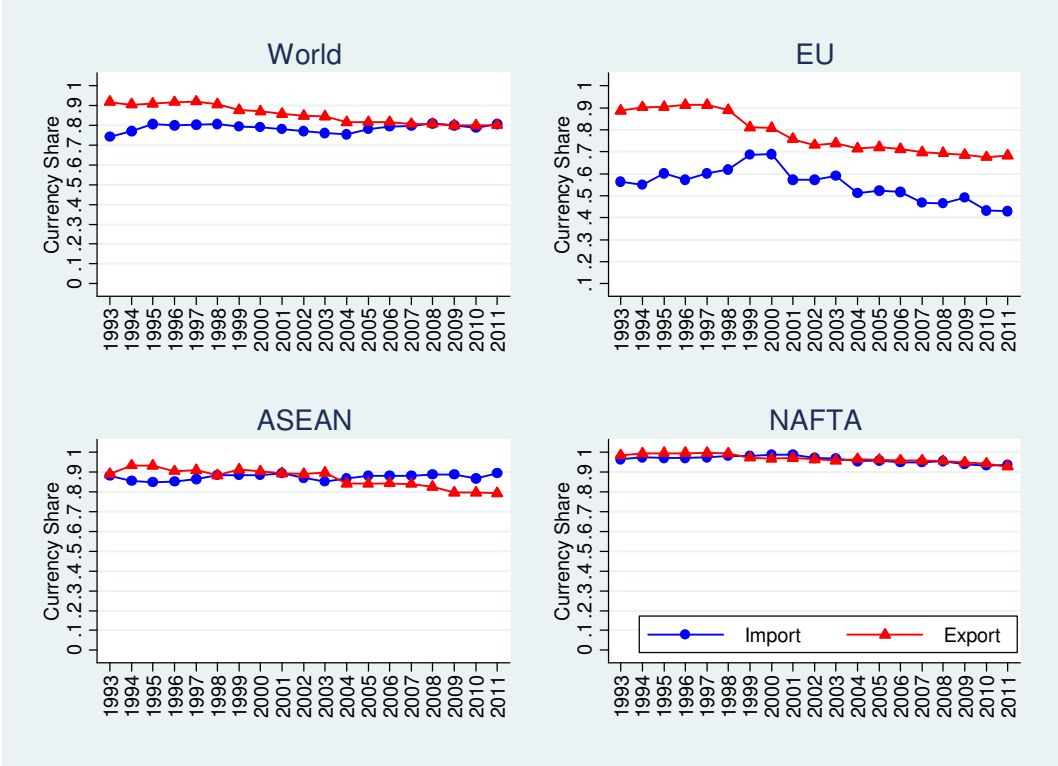
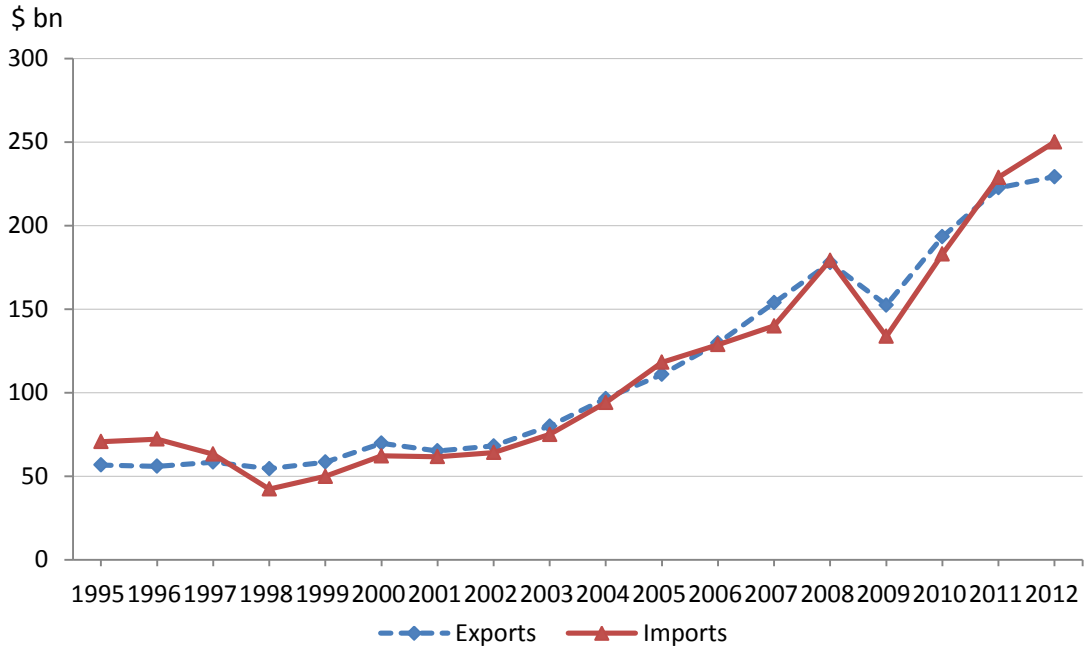
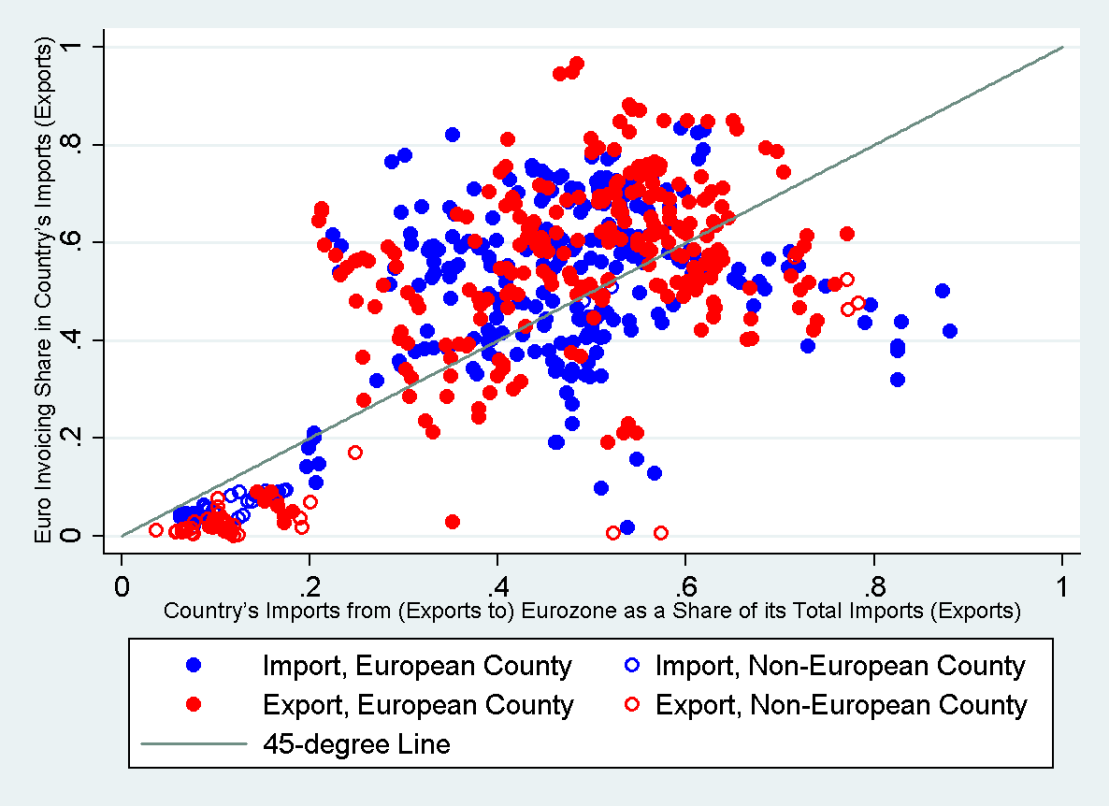


Figure 10. International Trade of Thailand from 1995 to 2012



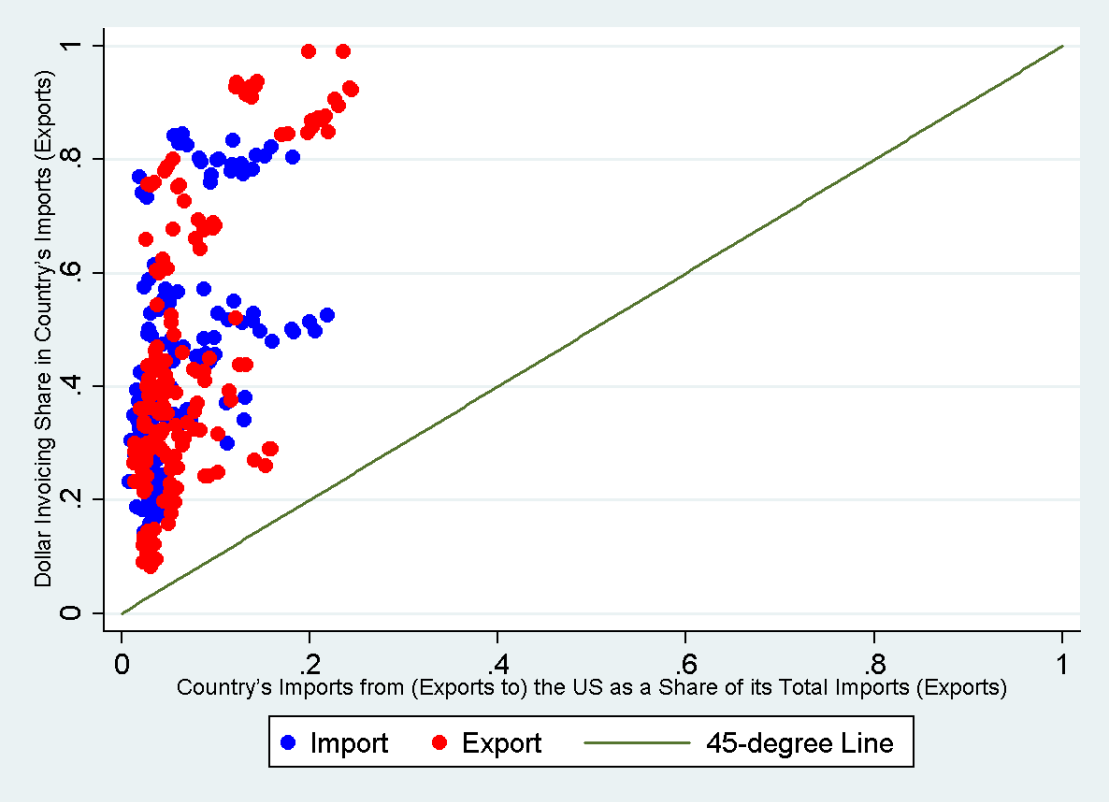
Data Source: Bank of Thailand.

Figure 11. Use of the Euro for Trade Invoicing across Countries



Data Source: ECB, authors' compilation.

Figure 12. Use of the US Dollar for Trade Invoicing across Countries



Data Source: Authors' compilation.

Appendix A. Description of the Thailand Data

A.1 Variables and Data Sources

In this section, we give detailed definition of the variables used in Section 4.1 and provide information on data sources.

Dependent variables

Currency invoicing share in Thailand exports to partner country: the share of exports using the specified currency as receipts in the total exports from Thailand to the specified partner country. Source: Bank of Thailand.

Currency invoicing share in Thailand imports from partner country: the share of imports using the specified currency as payment in the total imports to Thailand from the specified partner country. Source: Bank of Thailand.

The shares are calculated from trade values in the US dollar. For the euro, whose history begins in 1999, invoicing shares are unobservable before 1999. Similarly, for the German mark, French franc, and Italian lira, invoicing shares are unobservable after 2002.

Independent variables

Issuer's GDP share: the ratio of the currency issuing country's GDP to the world GDP in a given year. All GDP are evaluated at market exchange rates. Source: World Bank.

Issuer's share in Thailand total trade: the share of Thailand's trade (imports + exports) with the currency issuing country in the total trade of Thailand with the rest of the world, evaluated in the US dollar. Since the issuing country of Thai baht is Thailand itself, the shares are then normalized to be 1. Source: Bank of Thailand.

Issuer's share in partner's total trade: the share of the currency issuing country's trade with the partner country in the total trade of the partner country with the rest of the world. All trade values are in the US dollar. If the partner country and the currency issuing country are the same, the share is normalized to be 1. Source: UN Comtrade.

EX comovement with THB: measured as the correlation coefficients between the exchange rate of Thai baht against Swiss franc and exchange rate of invoicing currency against Swiss franc. For Thai baht, EX comovement with THB is always 1. Source: Bloomberg.

EX comovement with partner's currency: measured as the correlation coefficients between the exchange rate of the partner country against Swiss franc and exchange rate of invoicing currency against Swiss franc. If partner country's currency is the invoicing currency, EX comovement with partner's currency is 1. Source: Bloomberg.

EX volatility: standard deviation of daily percentage change of the exchange rate of invoicing currency against SDR. Source: Bloomberg.

EX bid-ask spread: measured as the ratio of the difference between bid and ask exchange rates to the average of bid and ask rates of the invoicing currency against Thai baht. All bid and ask prices are monthly-end data. The bid-ask spreads are 0 for Thai baht. Source: Bank of Thailand.

FX turnover share: the share of the transactions involving the invoicing currency in total foreign exchange turnover of the world. The data for 1998, 2001, 2004, 2007, and 2010 is available from the Bank of International Settlements. For other years between 1998 and 2010 are interpolated using the log linear model. Source: Bank of International Settlements.

Issuer's capital market depth: the ratio of stock market capitalization plus outstanding domestic private debt securities to GDP of the currency issuing country. Source: World Bank.

A.2. Descriptive Statistics

To provide more information on the structure of the Thailand data, the following three tables contain descriptive statistics on currencies, trading partners, and variables.

Table A1. Some Statistics about the Currencies in the Thailand Data

Currency	# Observations	Percentage of Total	Currency	# Observations	Percentage of Total
USD	505	24.12	SGD	119	5.68
THB	486	23.21	FRF	62	2.96
GBP	231	11.03	MYR	60	2.87
JPY	208	9.93	ITL	33	1.58
EUR	194	9.26	CAD	25	1.19
DEM	171	8.17			

Table A2. Some Statistics about Trading Partners in the Thailand Data

Partner	# Observations	Percentage of Total	Partner	# Observations	Percentage of Total
Austria	75	3.58	Laos	38	1.81
Belgium	89	4.25	Luxembourg	67	3.2
Brunei Darussalam	77	3.68	Malaysia	95	4.54
Cambodia	43	2.05	Mexico	49	2.34
Canada	72	3.44	Myanmar	62	2.96
Denmark	81	3.87	Netherlands	88	4.2
Finland	75	3.58	Philippines	77	3.68
France	85	4.06	Portugal	73	3.49
Germany	91	4.35	Singapore	90	4.3
Greece	73	3.49	Spain	95	4.54
Indonesia	81	3.87	Sweden	77	3.68
Ireland	86	4.11	United Kingdom	93	4.44
Italy	95	4.54	United States	62	2.96
Japan	57	2.72	Vietnam	48	2.29

Table A3. Descriptive Statistics for the Thailand Data

Variable	Mean	Standard Deviation	Min	Max	# Observations
Dependent Variable					
Invoicing share in import	0.255	0.327	0.001	1.000	1901
Invoicing share in export	0.271	0.350	0.001	1.000	1821
Independent Variable					
Issuer’s GDP share	0.110	0.109	0.002	0.318	2094
Issuer’s share in Thailand total trade	0.300	0.389	0.006	1.000	2094
Issuer’s share in partner's total trade	0.174	0.266	0.000	1.000	1918
EX commovement with THB	0.667	0.366	-0.473	1.000	2076
EX comovement with partner's currency	0.676	0.397	-0.822	1.000	1599
EX volatility	0.529	0.258	0.193	1.848	2094
EX bid-ask spread	0.011	0.010	0.000	0.081	2011
Ratio of FX turnover share to GDP share	1.058	0.635	0.079	2.285	1488
Issuer’s capital market depth	1.325	0.656	0.322	3.030	2094
Year			1993	2011	

Appendix B. Description of the Euro Data

B.1. Variables and Data Sources

We provide more details on the definition of the variables and the source of the data used in Section 4.2 below.

Dependent variables

EUR's share in export invoicing of a country: the share of exports using the Euro as receipts in the total exports of the specified country. Source: ECB, central banks of individual countries.

EUR's share in import invoicing of a country: the share of imports using the Euro as payment in the total imports of the specified country. Source: ECB, central banks of individual countries.

The shares are calculated from trade values in the US dollar if not directly available from the original source.

Independent variables

Eurozone's share in country's total export: the share of the country's exports to the Eurozone in the country's total exports to the rest of the world, evaluated in the US dollar. Source: WTO.

Eurozone's share in country's total import: the share of the country's imports from the Eurozone in the country's total imports from the rest of the world, evaluated in the US dollar. Source: WTO.

Ratio of country's GDP to Eurozone's GDP: the ratio of the specified country's GDP to the aggregated GDP of the Eurozone in a given year. All GDP are evaluated at market exchange rates. Source: World Bank.

EUR as preferred hedging currency: a dummy variable, with variable equals 1 when the euro is the preferred hedging currency for transactions and 0 otherwise. A preferred hedging currency is defined in Goldberg and Tille (2008). Source: Goldberg and Tille (2008).

EU dummy: an indicator variable for the EU membership of a country. It equals 1 when the country is a member of EU and 0 otherwise. Source: authors' compilation.

Number of years after introduction of EUR: the number of years after the introduction of the euro. Source: authors' compilation.

Bid-ask spread against EUR: the ratio of the difference between bid and ask exchange rates to the average of bid and ask rates of the country's currency against the euro. All bid and ask prices are monthly-end data. Source: Bloomberg.

Bid-ask spread against USD: the ratio of the difference between bid and ask exchange rates to the average of bid and ask rates of the country's currency against the US dollar. All bid and ask prices are monthly-end data. Source: Bloomberg.

B.2. Descriptive Statistics

As indicated in Section 4.2.1, the euro dataset covers 35 countries from 1999-2010. The panel is not balanced. Table B1 contains more information on observations by country.

Table B1. Some Statistics about Countries in the Euro Data

Country	# Observations	Percentage of Total	Country	# Observations	Percentage of Total
Algeria	2	0.67	Luxembourg	11	3.68
Australia	12	4.01	Macedonia, FYR	12	4.01
Belgium	10	3.34	Netherlands	5	1.67
Bulgaria	13	4.35	Pakistan	3	1.00
Croatia	12	4.01	Poland	12	4.01
Cyprus	4	1.34	Portugal	11	3.68
Czech Republic	12	4.01	Romania	12	4.01
Denmark	6	2.01	Slovakia	8	2.68
Estonia	8	2.68	Slovenia	10	3.34
France	12	4.01	South Africa	1	0.33
Germany	6	2.01	South Korea	4	1.34
Greece	10	3.34	Spain	13	4.35
Hungary	7	2.34	Thailand	12	4.01
India	1	0.33	Tunisia	4	1.34
Indonesia	12	4.01	Turkey	9	3.01
Italy	11	3.68	U.K.	4	1.34
Latvia	11	3.68	Ukraine	7	2.34
Lithuania	12	4.01			

Table B2 provides a set of descriptive statistics on the variables used for the regression analysis in Section 4.2.3.

Table B2. Descriptive Statistics for the Euro Data

Variable	Mean	Standard Deviation	Min	Max	# Observations
Dependent variables					
EUR's share in export invoicing	0.474	0.251	0.000	0.965	299
EUR's share in import invoicing	0.461	0.224	0.017	0.833	288
Independent variables					
Eurozone's share in country's total exports	0.434	0.190	0.037	0.783	299
Eurozone's share in country's total imports	0.426	0.177	0.062	0.881	299
Ratio of country's GDP to Eurozone's GDP	0.043	0.067	0.001	0.293	299
EUR as preferred hedging currency	0.064	0.244	0.000	1.000	299
Bid-ask spread against EUR	0.001	0.004	-0.056	0.017	240
Bid-ask spread against USD	0.001	0.003	0.000	0.032	262
Year			1998	2010	299