Currency choice in international trade: a new monetarist approach and firm-level evidence

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Currency Choice in International Trade: A New Monetarist Approach and Firm-level Evidence *

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Abstract

Financial market imperfections severely restrict currency use in international trade. We develop a unified search-based framework with financial frictions to address the determinants for currency choice, emphasizing the roles of trade finance and financial market development, as well as macro, micro factors and firm-level bargaining power. In an open economy monetary search model with financial intermediation, the usage of a particular currency will emerge endogenously and strategic complementaries among exporters, importers and financial intermediation reinforce the status of international currency. With highly disaggregated data from Colombia, we provide firm-level evidence that financial factors significantly affect the patterns of currency usage. We show that exporters prefers the currency with a more developed financial market, especially for small firms in financially vulnerable sectors. In particular, a developing country with medium-level of financial development could enhance its currency usage by more than 10% if they further develop their financial market. Meanwhile, bad monetary policy and low bargaining power of exporters will also hurt the popularity of currency, although empirically firm-level bargaining power only has a secondary effect. These results provide important policy implications for developing countries that seek to improve the international role of its own currency but suffer from financial market underdevelopment, unstable monetary policy and inferior bargaining position of firms, emphasizing the role of financial market development and macroeconomic stability.

Keywords: Invoicing Currency; Trade Finance; Financial Intermediation; Financial Development; Monetary Search.

JEL Classification Numbers: F1, F31, F41

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1 Introduction

The currency chosen by exporters to set price is one of the most important and interesting questions in international macroeconomics. Basically, an exporter can choose its own currency (PCP), the destination country's currency (LCP) or a third country's currency (VCP). This "invoicing currency" choice problem attracted substantial attention among academic researchers and policy makers. First, the currency denomination of international trade has real effects on the macroeconomy. It will directly affect how balance of payment and domestic prices react to exchange rate fluctuation when price is sticky.[1] Secondly, invoicing currency choice has important policy implications for the effectiveness of monetary policy and the choice of exchange rate regimes (Devereux and Engel, 2002; Corsetti and Pesenti, 2005). Thirdly, as a starting point, the currency denomination in international trade is usually the first stage of currency internationalization (McKinnon, 1969). What determines the currency choice? What are the roles played by financial intermediaries, or more generally financial market? How would the financial, macro, micro and firm-level strategic factors work together to reinforce each other and what are the relative magnitude of their effects? These are the main questions that this paper is to address.

Trade finance and financial market development have long been recognized as one of the crucial characteristics in currency choices of international trade but formal modeling has been illusive. On one hand, the theory that links trade finance and financial market development to invoicing currency choice is sparse.[2] As Gopinath (2015) observed "...It is often suggested that currency invoicing choices in trade transactions are related to the depth of financial markets in currencies, particularly in the provision of trade credit...While this is plausible there is very little formal analysis of this linkage." On the other hand, historical experience clearly shows the essential role played by trade finance and financial markets in currency internationalization.[3] Recently, trade finance still plays an important role in facilitating international trade,

[1]The degree of exchange rate pass-through effects is closely linked to invoicing currency choice as documented in Engel (2006) and Goldberg and Tille (2008).

[2]Previous studies in invoicing currency choices either emphasized macroeconomic factors such as economy size and openness, or focused solely on the industrial or firm level factors. However, the importance of trade finance and financial market development is largely left not considered or modeled.

[3]US GDP surpassed Great Britain in 1870s, and U.S. share of world export surged to 22.1% in 1913, but the international role of USD was essentially zero, while Sterling still invoiced over 60% of world trade in early 1900s (Broz, 1997). The establishment of FED is believed to speed up the rise of USD, with its favorable policy towards developing financial market and providing trade credit(Eichengreen, 2011).

especially for developing countries like Colombia and China.[4] The key innovation in this paper is to explicitly consider the link between financial market efficiency and endogenous invoicing currency choice.[5]

By integrating trade finance and financial intermediation to the currency choice in international trade, our paper provides a novel, tractable, and unified framework to study how financial, macro, micro and firm-level strategic factors jointly affect firm's currency choice.[6] Furthermore, we discipline our theory with empirical evidence using a proprietary and rich dataset of Colombia's trade from 2007 to 2013. With multinomial logit model, we are able to estimate and rank the effects from various factors in invoicing currency choice decision. Based on these rankings, we argue it gives useful policy implications for the governments trying to promote the usage of their own currency in international trade.

In terms of model characteristics and theoretical predictions, we develop a unified micro-founded framework based on the open economy monetary search model (Lagos and Wright, 2005, Zhang, 2014) to incorporate various determinants of currency choice, especially trade finance and financial development. Goods are assumed to be delivered one period after contract, and the lack of commitment calls for financial intermediation (also called banker) to provide liquidity to the exporters, and bankers would later get paid by the importers. Financial intermediation operates at a fixed cost, and exporter receives liquidity at discount, so he would choose the currency with a higher level of profit. Consequently, a currency is never used in international trade if the issuing country does not have a liquid and efficient financial market. The theory features the explicit consideration of time-to-ship friction and the essential role played by trade finance. Strategic complementaries among exporters, importers and bankers illustrate how financial, macro and bargaining factors reinforce status of international currency. In this sense, our paper studies currency choices using the New Monetarist approach as summarized in Williamson et al. (2010).

The theoretic model formulates four testable hypothesis regarding the financial, macro, micro and firm-level strategic factors respectively. First, the currency issued

[4]As reported in BIS report, US$6.58 trillion of bank-intermediated trade finance was provided during 2011, supporting around 1/3 of international trade. Higher share for emerging markets.

[5]Despite the relevance of trade finance and financial intermediaries in international currency choice, theoretical work on its implications for invoicing currency choice remains sparse. See Ahn et al. (2011), Schmidt-Eisenlohr (2013) for trade finance related works.

[6]Recently there has been a growing literature on endogenous currency choice and its linkage to exchange rate pass-through (Devereux et al., 2004; Engel, 2006; Goldberg and Tille, 2008; Gopinath et al., 2010; Chung, 2016; Goldberg and Tille, 2016).

by the destination country with better financial market development is more likely to be used, especially for firms more reliant on trade finance. This prediction is novel and has not been identified in previous literature. The second prediction is that bad monetary policy, which gives rise to high inflation and high exchange rate volatility, would make the currency unattractive for international trades. This is consistent with the theoretic work in Devereux et al. (2004), Engel (2006) and the empirical work in Wilander (2006), Goldberg and Tille (2008) and Chung (2016). The third hypothesis is that exporters with higher bargaining power would be more likely to use their home currency. It is consistent with the recent empirical work by Goldberg and Tille (2016). The fourth forecast is that when we consider PCP, LCP and VCP in a three-country model, homogeneous goods tend to rely more on the VCP, consistent with the "coalescing effect" as firstly identified in Goldberg and Tille (2008).

Furthermore, we test our theory's predictions using a novel and rich dataset of the Colombia's international trade from 2007 to 2013. Colombia is best described as a developing country heavily relying on trade finance. The dataset covers 6.4 million individual export transactions for more than ten thousands Colombia firms. Such a detailed transaction-level dataset has not been used to study invoicing currency choice before. The richness of trade information allows us to design empirical strategies to better identify the effects of trade finance and financial market development, as well as other important determinants. Specifically, in the firm-level empirical tests we construct a new proxy for firm's trade finance dependence based on industry code following Manova (2013), and interact this proxy with financial market development. In the transaction-level tests, we construct a similar proxy for each transaction's trade finance dependence based on transportation mode following Ahn et al. (2011), and interact this measure with financial market development. In this way, we are able to provide the first empirical evidence on how trade finance and financial market development affect invoicing currency choices.

We start the empirical analysis by documenting substantial variations in invoicing currency choice among destination countries, industries and different periods, even though unsurprisingly the US dollar strongly dominates among the currencies. For example, when exporting to the similar regional countries, say China, South Korea and Japan, Colombia firms use 0.00%, 0.02% and 1.36% LCP respectively while use 8.55%, 0.03% and 0.00% PCP respectively. For different industries, currency dominations are significantly different. For mineral products, 15.87% are in PCP while in food industry the share of PCP drops to zero. From the perspective of time dimension, the usage of US dollar was very high and stable before 2008 but started to declined after the financial crisis in the second half of 2008. In the meantime, share of Euro and Colombia Peso started to picked momentum. In total, there are 24 different

currencies that are used as invoicing currencies for Colombia firms.

Guided by our theoretical framework, a thorough econometric test is performed on the highly disaggregated Colombia dataset.[7] We find strong support for our theory that financial factors significantly affect the patterns of currency usage. The empirical results show that exporters tend to use the currency with a more developed and efficient financial market, especially for small firms in financially vulnerable sectors, after controlling for macro, micro, firm's bargaining power and industry-year-geographic fixed effects. In particular, a median developing country like Colombia or China could enhance their home currency usage by more than 10% if they could further develop their financial markets up to the top level as Japan. Furthermore, bad monetary policy, such as high inflation and exchange rate volatility, would severely hurt the usage of a currency. Specifically, one standard-deviation increase in inflation and the coefficient of variation in FX rate will decrease the likelihood of using that currency by 6.8% and 3.8% respectively. We also find that low bargaining power of exporters will restrict the popularity of a currency but the effect is relatevely small. In terms of micro factor, our empirical results confirms that homogeneous goods are more likely than differentiated goods to be invoiced in VCP relative to PCP.

Our study has important policy implications for less developed countries that seek to expand its currency usage in international trade but suffer from backward financial development, volatile monetary policy, and inferior bargaining position of its exporters. The results highlighted the importance of a deep, liquid and efficient (more developed) financial market. Equally importantly, a stable monetary policy will also help to significantly increase the use of one currency. In the counter-factual experiment, we finds that if China further develop its economy and financial market to the level of Japan, Chinese Yuan will be promoted by around 20% in international trades.

The rest of this paper is organized as follows. In section 1.1 we briefly review the related literature. In section 2, we develop an open-economy monetary search model featuring financial frictions. This unified framework is tractable, micro-founded and readied to be extended to show how financial, macro, micro and strategic factors affect the choices among PCP, LCP and VCP. In section 3, we describe the dataset, show the substantial variations in currency choices, and present preliminary empirical evidence among various key factors. A formal econometric methodology and firm-level empirical evidence are discussed in section 4, together with a bunch of robustness

[7]For a long time little was known beyond several broad stylized facts based mainly on aggregate data. Recently there are a few firm-level studies on Canadian (Goldberg and Tille, 2016) and British (Chung, 2016), but they did not consider financial factors.

check. The empirical results, both the firm-level and transaction-level, strongly support the main predictions of the theory. Section 5 concludes with discussions of policy implications.

1.1 Related Literature

This paper contributes to the existing theoretical studies on the endogenous invoicing currency choice. Our unified open-economy monetary search framework is closely related to Zhang (2014) which itself is based on the model of Lagos and Wright (2005) and Lester et al. (2012) in monetary economics. Zhang (2014) provides the important insights that strategic complementarity in portfolio choices between buyer and seller, as well as information acquisition decisions of sellers, generates multiple equilibria with different international currency regimes. The main departure we make is to introduce trade finance and financial intermediation.[8] Monetary search models are particularly suitable for the issue of currency choice, since they explicitly discuss the role of fiat money and allow agents to choose different currencies rather than make exogenous assumptions[9]. Moreover, the tractability of search-theoretic models enables us to comprehensively evaluate the effect of macro, micro, strategic and financial factors.

For empirical part, our results contribute to the firm-level analysis on invoicing currency choice.[10] Recently, improved access to custom data allows for more systematic analysis at firm or transaction level. For Canadian import, Goldberg and Tille (2016) synthesized the macro, micro and strategic factors for currency choice, and documented that larger transaction size helps promote LCP. Devereux et al. (2017) also adopted Canadian dataset to show the non-monotone relationship between mar-

[8]Search theory has a long history of modeling the rise of international currency (e.g. Matsuyama et al., 1993; Trejos et al., 1996), but suffers from the indivisibility of money and the inability to reach equilibrium. With the breakthrough in Lagos and Wright (2005), such models are now widely applied to provide new insight into topics of international economics (e.g. Lester et al., 2012; Geromichalos and Simonovska, 2014; Jung and Pyun, 2016; Zhang, 2014).

[9]The classical New Open Economy Macroeconomics literature mostly assume PCP (e.g. Obstfeld and Rogoff, 1995). To remove this assumption, some literature, such as Bacchetta and Van Wincoop (2005), Engel (2006), and Goldberg and Tille (2008), allowed exporters to choose currency and preset price to hedge exchange rate risk. Fully appreciating the importance of short-term fluctuation, we consider our model complementary to the previous study by considering other relevant factors such as financial development.

[10]Empirical studies with country-level also proved fruitful in many ways, and the leading research includes Kamps (2006), Goldberg and Tille (2008), Ito and Chinn (2014), and Ito and Kawai (2016) The lack of heterogeneity and variation at micro level, however, limits the significance of their results and makes us prefer firm-level analysis.

ket share and invoicing currency choice. Our empirical methodology is most close to Chung (2016) that employed UK data in 2011 and found that firms relying more on foreign currency-denominated input are less likely to invoice their export by home currency. This paper adds new firm-level evidence to the empirical literature, with a particular focus on the trade finance and financial factors in determining invoicing currency choices and quantify the relative economic importance of various factors. Furthermore, while the existing empirical literature are mainly for industrial countries, firm-level analysis for developing countries is quite rare, and that distinguished our paper from others.[11]

This paper is also related with a vast literature discussing the impact of financial frictions on international trade. Amiti and Weinstein (2011) highlighted the collapse of trade finance as an important reason for Japanese financial crisis in 1990s. Feenstra et al. (2014) used Chinese firm data to show that exporters faced a tighter credit constraint than purely domestic firms. The heterogeneous-firm model in Manova (2013) and Chaney (2016) also proved that financial frictions affected both the intensive and extensive margin of international trade. The credit constraint in these works normally refers to working capital loan, which is made before production and mostly in home currency. In our model, however, the trade credit provided by bank is made after production and could be in various currencies.

Our work complemented the relevant studies that focused on the pattern of payment method in trade finance but ignored firm's currency choice in this process. Schmidt-Eisenlohr (2013) built a model of contract choice and the equilibrium is determined by financial efficiency and contract environment. The empirical evidence in Schmidt-Eisenlohr and Niepmann (2015) showed that Letter of Credit is mostly employed with intermediate contract environment and riskier destination country. Ahn (2015) took advantage of Colombian and Chilean dataset to document the dominance of post-shipment payment, and explained it in a model featured by account-receivable financing. Although our model assumed trade finance by bank, the implication for invoicing currency choice remains robust with alternative payment methods.

[11]The conventional wisdom in classical literature, such as Grassman (1973) and McKinnon (1969), casually observes that developing countries' home currency is seldom used for international trade, because of either their small economic influence, or the large share of homogeneous goods in export. Whether this observation still holds today is open to question. For example, Reiss (2015) convincingly showed that the main exports denominated in Brazilian real are homogeneous goods.

2 Theoretical framework

In this section, we develop a theory that relates invoicing currency choice to financial, macro, micro and firm-level strategic factors. We mainly follow the endogenous choice of international currency in Zhang (2014), and add trade finance to enrich the literature. In international trade, financial restrictions have a large impact, especially for developing countries like Colombia, so the addition of financial intermediary is realistic and reasonable. Different from the information theory in Zhang (2014), our model features time-to-ship friction and emphasizes financial development as an important determinant of invoicing currency choice[12]. The time-to-ship friction is both empirically relevant and theoretically important. In reality, international trade normally takes longer time and involves larger volume than domestic trade, so participants face more risk and uncertainty (Manova, 2013). In theory, the time-to-ship friction has dual effects on our model structure. First, The timing mismatch between shipment and payment, combined with the lack of commitment between exporter and importer, necessitates the existence of financial intermediation to facilitate trade. Second, since exporters need immediate liquidity from bankers, who would get paid by importer only in the next period, so the payment received by exporter would be discounted by nominal interest rate, therefore making a channel for monetary policy to directly influence international trade.

Several papers already noticed this kind of financial friction and tried to incorporate it into monetary search model. For example, Wright et al. (2016) modeled different channels to finance trade credit, both internal and external, and had in-depth discussion on its relationship with monetary policy and banking sector regulation. Our paper, however, diverges from previous literature by focusing on trade finance rather than trade credit. As discussed in Amiti and Weinstein (2011), trade credit is more of an accounting concept, referring to the accounts receivable in balance sheet, regardless of whether it's domestic or international trade. Trade finance, on the other hand, is exclusively for international trade, denoting the loans extended to exporters so that their production cost could be covered in time. Our model is greatly simplified by focusing on trade finance by banks, exporters and importers wouldn't worry about default. Meanwhile, the model's implication for international currency choice would remain robust for other types of payment method like open account or cash in advance.

[12]Here we focus on a partial equilibrium setup for exporter's currency choice. Interested reader could refer to Liu (2016) for the version of general equilibrium.

2.1 Environment

The following monetary search model is based on Lagos and Wright (2005) and extends the two-country model in Zhang (2014) and Liu (2016). The two-country framework is presented first and then extended to incorporate three-country and VCP. Time is discrete and infinite. There are two countries in the world, 1 and 2, each populated with a unit measure of buyer, seller, and banker, who live forever with a discount factor of $\beta \in (0, 1)$. Their identity is fixed over time and their respective population in country $i \in \{1, 2\}$ is σ_i, σ_i, and $(1 - 2\sigma_i)$. Sellers always stay at home while buyers and bankers could go abroad. Each period is divided into three rounds of centralized market (CM), decentralized market (DM), and financial market (FM). For DM transaction, if buyer and seller are from different countries, we would call them importer and exporter. There is divisible and storable fiat money circulating in each country, and its total supply evolves according to $\hat{M}_i = (1 + \mu_i)M_i$, where M_i is the stock of country i's fiat money in current period, and variable with a hat is the level in next period. The growth rate of money supply μ_i is under the control of central bank. To feature scale of economy in financial sector, we assume a fixed total cost for banking industry. To avoid indeterminacy, bankers are further assumed to be specialized in home-currency business.[13]

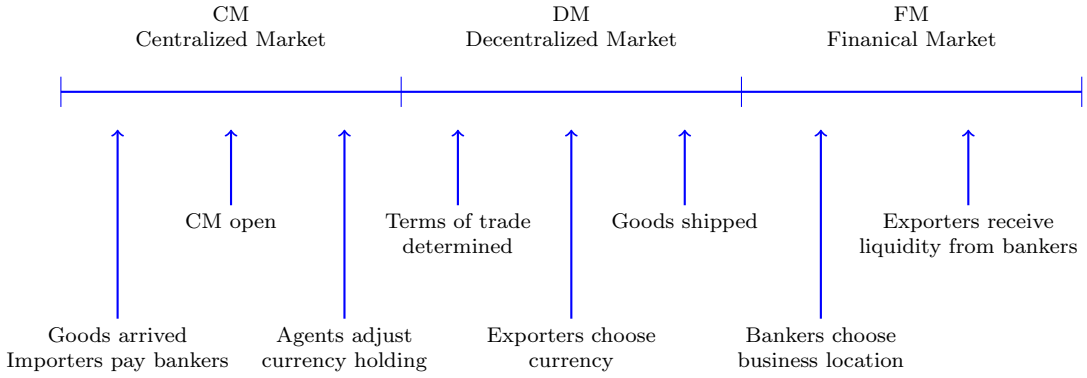
Here we start with a brief introduction on model, and detailed formulation follows. In DM, sellers are specialized in the production of a perishable differentiated good q but unable to consume it, while buyers are able to consume but couldn't produce. The lack of commitment and double coincidence requires fiat money as medium of exchange. Importantly, q is delivered only at the beginning of next period. For domestic trade, we assume it's always settled by home currency after delivery, and there's no role for banker. Our model is focused on international trade, where agents from different countries don't trust each other. Exporters want to get paid immediately after shipment, but importers promise to pay only after the delivery of goods in the next period. In this case, bankers could facilitate trade by providing financial intermediation: exporters get liquidity from banker at a discount, and importers pay bankers later to get goods. The currency choice is made by exporters, whose profit function depends on gains from trade, monetary policy, and financial efficiency. Goods would be shipped afterwards.

In FM, bankers first select the location of their business based on exporter's currency choice. If country 1 exporters choose home currency to settle international

[13]This assumption is strong but not unreasonable. It just implies that domestic banks are efficient financial intermediaries in their home currency, as discussed in McKinnon (1979) and Eichengreen (2011)

trade, country 1 bankers would pay a fixed total cost to setup financial industry in country 1. On the other hand, if country 1 exporters choose foreign currency, country 2 bankers would enter the market. After the establishment of financial industry, exporters show the proof of shipment and get liquidity from bankers at a discount. At the beginning of next period, goods are delivered, and importers pay bankers to get them. In the following CM, buyer, seller, and banker engage in the production and consumption of numéraire good X and adjust their holdings of fiat money based on the pattern of currency usage in the last period[14]. This CM functions as a frictionless FX market, which is certainly not without loss of generality as discussed in Geromichalos and Jung (2017), but we hold this assumption to simplify the model and focus on financial frictions. The model timing for international trade is depicted in figure 1.

Figure 1: Model timing



2.2 Model Setup

Now we will begin to formalize the physical environment. For tractability, assume the instantaneous utility function is $U^B = u(q) + U(X) - H$ for buyer, $U^S = -c(q) + U(X) - H$ for seller, and $U^I = U(X) - H$ for banker, where q, X, and H capture the amount of differentiated good, numéraire good, and working hour. Although every agent could produce numéraire good with a linear technology of $X = H$, only sellers could produce differentiated good with the cost function of $c(q)$. We further assume that the optimal consumption in CM is X^*, such that $U'(X^*) = 1$. The

[14]To match the model timing, we assume numéraire good is perished at the end of each period, and differentiated good is perished at the beginning of each period.

conventional assumption on function form also holds, so $u(0) = c(0) = 0, u'(0) = +\infty, c'(0) = 0, u' > 0, u'' < 0, c' > 0, c'' > 0$. For notations below, $i, j = \{1, 2\}$, $i \neq j$. The real value of country i's fiat money in terms of numéraire good is ϕ_i. This model is focused on stationary monetary equilibrium where the aggregate real balance is constant, therefore $1 + \mu_i = \frac{\phi_i}{\hat{\phi}_i}$. Central banks adjust home currency supply through lump-sum transfer to domestic agent when CM opens.

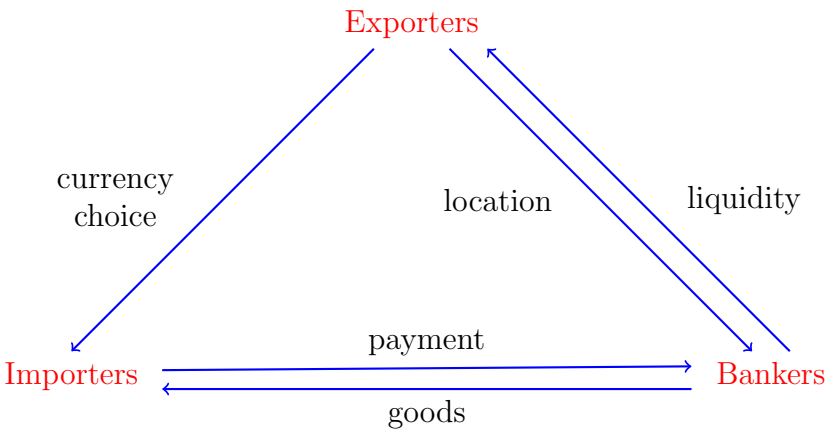
There is separate DM in each country. Buyers could go abroad with a probability of $(1 - \alpha)$ while sellers always stay at home. Buyer and seller meet pairwise and at random, with a matching function of $N_i = N(B_i, S_i)$, where the number of successful matching N_i is a function of buyer and seller's number in country i's DM. From this matching function, the number of meeting between country i buyer and country j seller (n_{ij}), as well as the probability for country i buyer to meet country j seller (p_{ij}) are determined[15]. Banking industry is perfect competitive and specialized in home-currency business. The total cost for country i banking industry to operate in country j is F_{ij}, assumed to be fixed over time. The value of F_{ij} reflects both financial efficiency and openness. If a country's banking sector could operate with low cost and foreign branching is supported or subsidized by government policy, F_{ij} will stay at a low level.

CM is open to buyer, seller, and banker from both countries. This Walrasian market allows agents to freely adjust their holding of currency, so it's similar to a frictionless foreign exchange market.[16] In our model, the decision by different types of agents is public information, which incorporates the elements of strategic complementarity. For exporter, his expectation of ultimate profit from DM trade is based on the decision of banker and importer. For banker, his business location is based on exporter's currency choice, and his currency choice is linked to importer's choice in CM. For importer, his optimal decision is tightly related with exporter's currency choice. The strategic complementarity among different types of agents is depicted in the figure 2. The decision of a certain type of agent affects other's choice, and that would reinforce the status of international currency.

[15]Here we are not explicit about the matching function, since any $N(B, S) \geq \min(B, S)$ would work. Another reason for ignoring the function form is that our model focused on bargaining power rather than searching friction in exporter's currency choice. Interested reader could refer to Liu (2016) for the importance of searching friction on global imbalance.

[16]In the real world, the foreign exchange market is OTC market with bid-ask spreads, and monetary search models are already widely applied in this field. See Lu (2016) for FX market in China.

Figure 2: Strategic complementarity



2.3 Optimal choice for agents

2.3.1 CM Value function

Agent's CM value function differs according to his type. Buyers want to hold money at the end of CM to buy differentiated good in the next period, therefore the CM maximization problem for country i buyer is

$$W_i^B(\phi_i m_i^i, \phi_j m_j^i) = \max_{\hat{m}_i^i, \hat{m}_j^i, H, X} U(X) - H + \mathbb{E}[V_i^B(\hat{\phi}_i \hat{m}_i^i, \hat{\phi}_j \hat{m}_j^i)]$$
$$\text{s.t.} \quad \phi_i \hat{m}_i^i + \phi_j \hat{m}_j^i + X \leq H + \phi_i m_i^i + \phi_j m_j^i + T_i$$

where m_j^i is country i buyer's holding of country j currency; $V_i^B(\cdot)$ is country i buyer's value function for DM trade; T_i is the lump-sum transfer from country i central bank. Buyer's expectation of DM value function is based on the pattern of currency usage in the last period. With the observation that buyer's value function is linear in his holding of money, this value function could be simplified into

$$W_i^B(\phi_i m_i^i, \phi_j m_j^i) = W_i^B(0,0) + \phi_i m_i^i + \phi_j m_j^i \tag{1}$$

Sellers don't have any incentive to hold money in CM since the liquidity he would get from bank is irrelevant with his money holding. His value function is therefore omitted. For country i banker, the CM value function is

$$W_i^I(\phi_i z_i) = \max_{\hat{z}_i, H, X} U(X) - H + \mathbb{E}\big[V_i^I(\hat{\phi}_i \hat{z}_i)\big]$$
$$\text{s.t.} \quad \phi_i \hat{z}_i + X \leq H + \phi_i z_i + T_i$$

where $V_i^I(\cdot)$ is the value function for banker in financial market, related with his holding of home currency ($\hat{z}_i$). Similarly, this value function could be transformed into

$$W_i^I(\phi_i z_i) = W_i^I(0) + \phi_i z_i \tag{2}$$

2.3.2 Terms of trade in DM

Buyer and seller make a proportional bargaining in DM to determine terms of trade. Buyer's utility maximization problem is

$$\max_{q,d(m)} \{u(q) - \phi d(m)\}$$

$$\text{s.t.} \quad \frac{u(q)-\phi d(m)}{\phi d(m)-\frac{c(q)}{\beta}} = \frac{\theta}{1-\theta}$$

$$d(m) \leq m$$

where q is the amount of differentiated good; $d(m)$ is the amount of fiat money buyers pay; θ and $(1-\theta)$ represent the bargaining power of buyer and seller. Since buyers make payment only when q is delivered at the beginning of next period, seller's cost function is adjusted by discount factor. The solution is

$$d(m) = \begin{cases} m^* & \text{if } \ \phi m \geq (1-\theta)u(q^*) + \theta c(q^*)/\beta \\ m & \text{otherwise} \end{cases}$$

where q^* is the level of consumption that would maximize total surplus such that $\beta u'(q^*) = c'(q^*)$; m^* is buyer's payment when total surplus is maximized, so $\phi m^* = (1-\theta)u(q^*) + \theta\frac{c(q^*)}{\beta}$. It will become clear later that buyer's holding of fiat money would never exceed m^*, because additional money doesn't increase his gains from trade, but incurs a loss from inflation. Therefore, buyer's payment to seller is

$$\phi m = (1-\theta)u(q) + \theta\frac{c(q)}{\beta} \tag{3}$$

with $q \leq q^*,\ \beta u'(q^*) = c'(q^*)$.

2.3.3 Financial constraint and exporter's currency choice

The time-to-ship friction imposed financial constraint on equilibrium. Without trade finance, country i exporter's profit in DM trade with country j importer is simply

$$\phi_i m_i^j - c(q_i^j) \tag{4}$$

where q_i^j is country j buyer's purchase of differentiated good settled in country i currency.

Now with financial friction, the immediate liquidity provided by bank must be able to cover exporter's DM cost. Given a perfect competitive banking sector, zero profit condition holds, so the immediate liquidity is equal to the proceedings from importer's future payment, net of banking sector's fixed cost. Here we assume the fund is equally split among exporters, whose actual profit therefore depends on the ratio between banker's fund available and importer's payment in the next period.

Consider country i exporter's profit for trade settled in his home currency. The total fund of banking industry after CM, net of the fixed total cost, is $[(1-2\sigma_i)\phi_i z_{ii} - F_{ii}]$. Here z_{ij} is country i banker's fund allocated to country j. From banker's optimal currency holding derived later, the rate of return in banking sector should be able to compensate the loss from inflation, so that, in this special case,

$$R_i = \frac{n_{ji}\phi_i m_i^j}{(1-2\sigma_i)\phi_i z_{ii}} - 1$$

where $R_i \equiv \frac{1+\mu_i}{\beta} - 1$ is the nominal interest rate of country i.[17] With the equations above, it's possible to simplify the ratio between the liquidity provided by bank and the payment from importer

$$\frac{(1-2\sigma_i)\phi_i z_{ii} - F_{ii}}{n_{ji}\phi_i m_i^j} = \frac{(1-2\sigma_i)\phi_i z_{ii} - F_{ii}}{(1+R_i)[(1-2\sigma_i)\phi_i z_{ii}]} = \left\{1 - \frac{F_{ii}}{(1-2\sigma_i)\phi_i z_{ii}}\right\}\left(\frac{1}{1+R_i}\right)$$

So country i exporter's profit from international trade settled in home currency is

$$\pi_i \equiv \underbrace{\left[1 - \frac{F_{ii}}{(1-2\sigma_i)\phi_i z_{ii}}\right]}_{\text{financial development}} \underbrace{\left(\frac{1}{1+R_i}\right)}_{\text{discount}} \underbrace{\phi_i m_i^j - c(q_i^j)}_{\text{gain from trade}} \tag{5}$$

This profit function could be decomposed into three parts. First and foremost, financial development is negatively related with the fixed cost in banking sector (F_{ii}), and positive in banker's total funding in country i (z_{ii}). Second, the discount factor affected by central bank's monetary policy. Lastly, exporter's gain from trade after the bargaining game with importer. For trade settled in foreign currency, we further

[17] This nominal interest rate is derived from Fisher equation. In this model, the real interest rate is approximated by $1/\beta$, and inflation rate is $1+\mu$. So $1+R = (1+\mu)/\beta$ according to Fisher equation.

assume that exporters suffer additional loss from transaction cost (τ), such as the costs for hedging, which is assumed to be an increasing function of importer's real payment ($\phi_j m_j^j$), so the profit function using foreign currency becomes

$$\pi_i^* \equiv \left[1 - \tau(\phi_j m_j^j)\right]\left[1 - \frac{F_{ji}}{(1-2\sigma_j)\phi_j z_{ji}}\right]\left(\frac{1}{1+R_j}\right)\phi_j m_j^j - c(q_j^j) \tag{6}$$

With these in mind, country i sellers choose settlement currency to maximize profit.

$$\forall i = 1,2 \quad \begin{cases} \text{autarky} & \text{if } \max\{\pi_i, \pi_i^*\} < 0 \\ s_i = 1 & \text{if } \max\{\pi_i, \pi_i^*\} \geq 0,\ \pi_i \geq \pi_i^* \\ s_i = 0 & \text{if } \max\{\pi_i, \pi_i^*\} \geq 0,\ \pi_i < \pi_i^* \end{cases} \tag{7}$$

where s_i is country i exporter's currency choice, equal to 1 when his home currency settles international trade.

2.3.4 Banker's optimal choice in financial market

If exporters find international trade profitable and choose a certain currency for settlement, bankers need to setup business accordingly. Since banking industry is perfect competitive, zero profit condition implies the following optimal choice for country i bankers.

$$\forall i,j = 1,2, i \neq j \quad \begin{cases} R_i = \frac{n_{ji}\phi_i m_i^j}{(1-2\sigma_i)\phi_i z_{ii}} - 1 & \text{if } \ s_i = 1 \\ R_i = \frac{n_{ij}\phi_i m_i^i}{(1-2\sigma_i)\phi_i z_{ij}} - 1 & \text{if } \ s_j = 0 \\ z_i = z_{ii} = z_{ij} = 0 & \text{otherwise} \end{cases} \tag{8}$$

Here z_{ij} is the country i banker's fund allocated to country j, and $z_i = z_{ii} + z_{ij}$. The first condition states that, if country i exporters choose home currency, country i banker would setup business there and allocate z_{ii} to exporters, so that the nominal return in banking industry is equal to the nominal interest rate, which is the marginal cost of holding fiat money. Similarly, if foreign exporters choose country i currency, the banker would provide liquidity with the amount of z_{ij}, also making the rate of return equal to nominal interest rate. If country i currency remained national, i.e. $s_i = 0$ and $s_j = 1$, country i banker wouldn't hold any currency, as stated in the third condition above.

2.3.5 Optimal choice for buyer

For buyer, the optimal holding of real balance is available after combining CM and DM value function. For country i buyer, his DM value function is

$$V_i^B(\phi_i m_i^i, \phi_j m_j^i) = \beta\big(p_{ii}+(1-s_j)p_{ij}\big)\big(u(q_i^i)-\phi_i m_i^i\big)+\beta p_{ij}s_j\big(u(q_j^i)-\phi_j m_j^i\big)+\beta W_i^B(\hat{\phi_i}\hat{m_i^i}, \hat{\phi_j}\hat{m_j^i})$$

where $(p_{ii} + (1 - s_j)p_{ij})\big(u(q_i^i) - \phi_i m_i^i\big)$ is country i buyer's expected surplus for DM trade settled in country i currency, and $p_{ij}s_j\big(u(q_j^i) - \phi_j m_j^i\big)$ is his expected surplus for trade settled in country j currency.

Substitute this into the expression of buyer's CM value function, then his maximization problem becomes

$$\max_{\hat{m}_i^i, \hat{m}_j^i} \Bigg\{ (\beta\hat{\phi}_i - \phi_i)\hat{m}_i^i + \beta\big(p_{ii} + (1 - s_j)p_{ij}\big)\theta\left[u(\hat{q}_i^i) - \frac{c(\hat{q}_i^i)}{\beta}\right]$$

$$+(\beta\hat{\phi}_j - \phi_j)\hat{m}_j^i + \beta s_j p_{ij}\theta\left[u(\hat{q}_j^i) - \frac{c(\hat{q}_j^i)}{\beta}\right]\Bigg\}$$

Several conventional observation in monetary search model would also apply here. For example, the solution for maximization problem requires $\beta\hat{\phi}_i - \phi_i < 0$ and $m < m^*$. The first order condition for home currency is

$$R_i = (p_{ii} + (1 - s_j)p_{ij})\left[\frac{\theta(u'(q_i^i) - c'(q_i^i)/\beta)}{(1-\theta)u'(q_i^i) + \theta c'(q_i^i)/\beta}\right] \tag{9}$$

This condition states that buyer's marginal cost of holding money (R_i) must be equal to the expected marginal benefit. Notice that buyer's demand for home currency is always positive since his meeting with domestic sellers would always use home currency as medium of exchange. This is not true for foreign currency, which crucially depends on foreign seller's decision.

$$\forall i, j = 1, 2, i \neq j \quad \begin{cases} q_j^i = 0 & \text{if } \ s_j = 0 \\ R_j = p_{ij}\left[\frac{\theta(u'(q_j^i) - c'(q_j^i)/\beta)}{(1-\theta)u'(q_j^i) + \theta c'(q_j^i)/\beta}\right] & \text{if } \ s_j = 1 \end{cases} \tag{10}$$

With agent's optimal choice and money market clearing condition, it's possible to define a general equilibrium allowing for international currency. The formal definition is relegated to appendix.

2.4 Three-country model and VCP

The model could be easily extended into three-country case to account for the emergence of international vehicle currency (IVC). Related details and equilibrium conditions are derived in appendix. The currency choice is similar to two-country model with the following profit function for exporters.

$$\pi_{ij}^k = \left(1-\tau_j(\phi_k m_k^i)\right)\left(1-\frac{F_{kj}}{(1-2\sigma_k)\phi_k z_{kj}}\right)\left(\frac{1}{1+R_k}\right)\phi_k m_k^i - c_j(q_k^i),\ \forall i,j,k \in \{1,2,3\} \tag{11}$$

In this profit function, π_{ij}^k stands for country j seller's profit with country i buyer if trade is settled by country k currency, and other notations follow the two-country model above. The determinants of currency choice still include financial development, discount factor, and gains from trade. This profit function provides one explanation for the wide use of USD in international trade: stable monetary policy and supreme financial efficiency make USD attractive even for trade not involving United States. By the same token, if the issuing country of a currency has a highly developed financial market, the invoicing currency of its international trade would have a better chance to deviate from VCP.

Another main finding from three-country model is that homogeneous goods tend to rely more on VCP. This is from the observation that sellers are mainly distinguished by their gains from trade, i.e., the financial development and discount factor in profit function are less relevant with seller's nationality. For homogeneous goods with standard exchange, sellers are very similar in bargaining power, so their choice is focused more on the financial premium of a currency, which leads to the rise of a single IVC to invoice international trade. Therefore, the model predicts that homogeneous goods use more of USD due to its financial supremacy, which is consistent with the empirical finding in Goldberg and Tille (2008).

2.5 Currency choice determinants and testable hypotheses

Through the above discussions, we focus on partial equilibrium analysis for exporter's currency choice and summarize the theoretical results in Proposition 1-4.

For international trade settled by home currency, exporter's profit function is

$$\pi = \underbrace{\left[1-\frac{F}{(1-2\sigma)\phi z}\right]}_{\text{financial development}}\underbrace{\left(\frac{1}{1+R}\right)}_{\text{discount}}\underbrace{\phi m - c(q)}_{\text{gain from trade}} \tag{12}$$

where F stands for the total fixed cost of home banking sector, $(1-2\sigma)\phi z$ for the liquidity provided by bankers, ϕm for importer's real payment, and R for the nominal interest rate of home currency, controlled by central bank through the growth rate of money supply, $R = \frac{1+\mu}{\beta} - 1$. On the other hand, if international trade is settled by foreign currency, exporter's profit function is

$$\pi^* = \left(1 - \tau(\phi^* m^*)\right)\left[1 - \frac{F^*}{(1-2\sigma)\phi^* z^*}\right]\left(\frac{1}{1+R^*}\right)\phi^* m^* - c(q^*) \tag{13}$$

where asterisk denotes foreign variables. Exporters choose the settlement currency that brings him a higher level of profit. With these in mind, there are four main determinants of currency choice.

First, a higher level of financial market development makes a currency more attractive. This observation is straightforward from the profit function decreasing in the fixed cost of banking sector (F) and increasing in the financial market liquidity $(1-2\sigma)\phi z$.

Second, currency with lower level of inflation is preferred. This intuitive result is also obvious from the profit function decreasing in nominal interest rate (R). Similarly, if we consider monetary policy uncertainty, the currency with higher foreign exchange rate volatility will be less likely to be used. In our model, the effect of monetary policy works both directly and indirectly on exporter's profit function. Directly, nominal interest rate would affect discount rate, which arises due to time-to-ship friction and the lag between payment and shipment. Indirectly, the growth rate of money supply and nominal interest rate would influence the currency holding by banker and buyer, as explicitly shown in equation 8, 9, and 10.

Thirdly, the bargaining power between exporter and importer affects currency choice. Here we take advantage of partial equilibrium analysis and propose that exporters with higher bargaining power prefer home currency under very general assumptions. The formal proof on the part of inflation, foreign exchange rate volatility and bargaining power is relegated to appendix.

Fourthly, as argued in the previous subsection, the model predicts that homogeneous goods are more likely to use VCP. Given these results from theoretical models, we have four testable hypotheses and would verify them with the dataset from Colombia exporters in the next section.

Proposition 1: Finance The currency issued by a country with better development in financial market is more likely to be used for international trade.

Proposition 2a: Macro (Inflation) Bad monetary policies, such as high inflation and currency depreciation, and exchange rate volatility, would make the currency

unattractive for international trade.

Proposition 2b: Macro (Foreign Exchange Rate) Macroeconomic uncertainty, as measured by exchange rate volatility, would make the currency unattractive for international trade.

Proposition 3: Strategic (Bargaining Power) Exporters with higher bargaining power would prefer to use their home currency in trade.

Proposition 4: Micro (Goods Characteristics) Exporters with higher bargaining power would prefer to use their home currency in trade.

3 Data, Facts and Determinants of Invoicing Currency Choices

In this section, we start by describing the dataset used for the empirical analysis. First, we describe the Colombia dataset in details and show various firm-level descriptive statistics. *The key message is: in the Colombia dataset, there are a large number of exporting firms that are selling to a large number of destination countries in a variety of industries and products, using many invoicing currencies.* Next, we demonstrate that there are substantial variations in invoicing currency choices in Colombia export, among destination countries and different industries. These cross-sectional and time-series variations in invoicing currency choices are crucial for econometric analysis in the next section. Following the descriptive statistics on invoicing currency choices, we provide a broad preliminary assessment of the various factors behind invoicing currency choice for Colombia exporters, highlighting the key financial, macro, micro and strategic forces that are emphasized in the theoretic model in previous section. We end up this section with discussion on the advantages and limitation of Colombia dataset. In the next section, we implement systematic econometric study on these various factors using a multinomial logit model.

3.1 Data Source and Descriptive Statistics

Our primary data source covers daily import transactions from the Colombian Customs Office for the 20072013 period.[18] This novel database covers 6.4 million individual export transactions for Colombia exporters, from January 2007 to December 2013. Each transaction is recorded in a custom invoice containing information on the date, exporter name, exporter ID, country of destination, currency of invoicing, industry and product code (up to HS10), transportation method (by sea, by air, by railway, etc.), FOB value in US dollar, quantity, and gross weight. We complement the export data with a detailed import data. [19]

Table 1: Summary Statistics: Colombia's Export (2013)

Number of exporters	9898
Number of HS6 digit code exported	3582
Number of destination country	137
Number of Currency	24
Number of transactions	907153
Percent of transactions shipped by sea	43.4%
Average shippment value	60327
Median shippment value	2375.2
Colombia Export Value (000s US$)	54700000

Table 1 gives a snapshot of Colombia's exports in 2013. Other years are similar. Colombia firms export to more than 130 countries and there are around 10000 exporters. In total, 24 different currencies are used. The total transaction number is 907153, among which 43.4% were shipped by sea. There are 3582 varieties of HS6-digit products in 2013. Overall, there are very large number of exporters are selling a large variety of products to different countries using many invoicing currencies.

Table 9, 10 and 11 in the appendix take a further step to look at distribution over destinations, industries and destination-industry pairs respectively. Table 9 shows per exporter distribution of the number of HS 4/6-digit product exported, the number of transactions, the number of destination countries, the number of currencies and total export value. In 2013, in terms of HS 6-digit products, the median firm exports 1 product while the top one percent exporters sell 44 products. Similarly, if we focus

[18]The data is obtained from Datamyne, a company that specializes in documenting import and export transactions in the Americas. For more detail please see www.datamyne.com.

[19]Although the import data is much richer than export, it does not have invoicing currency information.

Table 2: Colombia Exports Distribution across industries and regions (2007-2013)

	Region share (by count)					Industry share	
Industry Category	North America	Latin America	Eurozone	Asia	Other	Count	Value
Animal Products	27.15%	35.35%	14.71%	14.05%	8.74%	0.93%	1.26%
Vegetable Products	56.01%	3.43%	17.61%	3.82%	19.13%	19.52%	9.71%
Foodstuffs	17.37%	56.62%	6.30%	1.36%	18.34%	6.37%	2.99%
Mineral Products	19.34%	53.27%	6.53%	6.83%	14.03%	1.41%	57.85%
Chemicals	1.92%	85.19%	1.08%	0.36%	11.45%	18.95%	4.24%
Plastics/Rubbers	8.84%	76.63%	3.26%	0.58%	10.68%	7.74%	3.30%
Leathers/Furs/Hides	30.96%	43.20%	8.58%	6.07%	11.19%	1.58%	0.63%
Wood Products	8.53%	75.76%	2.23%	1.37%	12.11%	5.80%	1.63%
Textiles	15.46%	73.19%	3.99%	0.49%	6.86%	16.67%	3.04%
Footwear/Headgear	11.93%	76.54%	3.92%	0.16%	7.45%	0.95%	0.23%
Stone/Glass	27.53%	57.72%	3.07%	0.94%	10.75%	4.90%	5.91%
Metals	15.85%	59.51%	4.43%	9.89%	10.31%	5.10%	4.46%
Machinery/Electrical	12.95%	77.01%	2.95%	0.91%	6.17%	5.19%	2.07%
Transportation	9.17%	86.13%	1.01%	0.51%	3.18%	1.20%	1.82%
Miscellaneous	13.33%	68.30%	6.21%	2.52%	9.64%	0.63%	0.18%
Service	14.45%	70.62%	4.09%	0.47%	10.37%	3.03%	0.69%
Region total	20.75%	58.92%	6.20%	2.07%	12.06%		

on destination country, the median firm exports to 1 country while the top one percent exporters sell products to more than 22 countries. Most of the firms are using one currency for trade invoicing while some of them are using more than 2 different currencies. This skewed distribution is typical in the international trade data. Table 10 shows the per HS 4-digit product distributions of total exports, and the number of exporters, destination countries, currencies and transactions. More than 25% of the industries use more than 2 currencies while 10% use more than 3 currencies. Again, these distributions are skewed, with the median number of exporters and destination countries being much smaller. Table 11 shows distributions over exporter-HS4-digit Industry pairs, which are particularly skewed so that the vast majority involves an exporter selling a given product to a single country in small dollar amounts. For more than 50% of the export-product pairs, however, the exporter sells the same HS 4-digit product to multiple countries and in large dollar amounts. More importantly, for each exporter-HS4 industry pair, only one single currency will be used in most of the cases.

The broad composition of exports to 16 different industries and 5 different regions in the worlds is present in Table 2. We find that the geographical composition is

Table 3: Invoicing currency by destination countries

	Count share			Value share		
	PCP	LCP	VCP	PCP	LCP	VCP
United States	0.25%	99.73%	0.03%	0.37%	99.62%	0.00%
France	0.79%	13.52%	85.70%	0.03%	2.99%	96.97%
Spain	1.02%	12.25%	86.73%	2.30%	2.26%	95.44%
Netherlands	0.37%	6.79%	92.84%	0.05%	0.72%	99.23%
Germany	0.03%	9.27%	90.71%	0.01%	2.40%	97.58%
UK	0.03%	1.60%	98.37%	0.05%	0.23%	99.72%
Canada	0.03%	0.07%	99.90%	0.16%	0.01%	99.83%
Venezuela	0.14%	1.85%	98.01%	0.52%	2.56%	96.92%
Peru	0.19%	0.00%	99.81%	0.56%	0.01%	99.43%
Mexico	0.23%	0.24%	99.53%	1.75%	0.18%	98.07%
China	8.55%	0.00%	91.45%	0.47%	0.00%	99.53%
Korea	0.03%	0.02%	99.95%	0.00%	0.03%	99.97%
Japan	0.00%	1.36%	98.64%	0.00%	1.11%	98.89%
Australia	0.02%	0.06%	99.92%	0.04%	0.10%	99.86%

dominated by the Latin America countries, which account for 58.9% by counts. The North America (United States and Canada) accounts for 20.75% by counts. It is important to notice that while US is still a major trading partner of Colombia and account for 18.1% by counts, it doesn't play as dominant as a role in the previous studies on Canadian data (58.9% for Canadian imports) by Goldberg and Tille (2016) and UK data (29%) by Chung (2016). Some industries account for a large share of Colombia exports. In terms of counts, Vegetable Products, Chemicals and Textiles accounts for a large share of exports. In terms of value, mineral products accounts for half of the total exports value. Given that Colombia is a developing country rich in natural resources, this is not surprising.

3.2 Characteristics of Invoicing Currency Choices

Next we report some patterns related to currency choice for Colombia exporters. We will discuss the cross-sectional variation of currency choices in Table 3 and 4. Then we look at the time series variation in Figure 3, 4, 5 and 6 in the appendix.

Table 3 displays the currency distribution (PCP, LCP, VCP) over major trade partners. The US dollar has a dominant role in exports to Unites States. While the

Table 4: Invoicing currency by industry

	Count share			Value share		
	PCP	LCP	VCP	PCP	LCP	VCP
Animal Products	0.02%	25.67%	74.31%	0.36%	6.53%	93.11%
Vegetable Products	0.01%	52.76%	47.24%	0.04%	46.28%	53.69%
Foodstuffs	0.00%	19.82%	80.17%	0.01%	18.77%	81.22%
Mineral Products	15.87%	17.43%	66.70%	0.67%	45.74%	53.59%
Chemicals	0.06%	4.56%	95.38%	0.14%	5.95%	93.92%
Plastics/Rubbers	0.04%	11.53%	88.43%	0.01%	11.67%	88.33%
Leathers/Furs/Hides	0.10%	33.62%	66.28%	0.04%	21.53%	78.43%
Wood Products	0.03%	12.39%	87.58%	0.02%	7.48%	92.50%
Texiles	0.02%	17.25%	82.74%	0.01%	20.35%	79.63%
Footwear/Headgear	0.05%	13.54%	86.42%	0.01%	5.97%	94.02%
Stone/Glass	0.03%	29.48%	70.50%	0.00%	60.37%	39.63%
Metals	0.04%	18.92%	81.04%	0.01%	13.07%	86.91%
Machinery/Electrical	0.06%	13.76%	86.18%	0.15%	16.46%	83.39%
Transportation	0.04%	9.56%	90.40%	0.01%	7.21%	92.78%
Miscellaneous	0.51%	14.27%	85.23%	0.39%	20.08%	79.53%
Service	0.07%	16.66%	83.27%	0.23%	17.27%	82.50%

PCP and LCP are low compared to VCP, there are substantial variations. Take Euro area for example, they have a substantial shares of LCP (which are Euro) while individual countries has significantly different shares. France has 13.52% of transactions are invoiced in LCP while Netherlands has only 6.79%. This variation is also obvious when we look at other regions such as Asia. In China, when Colombia exporting firms are dealing with the customers from China, 8.55% of the transactions are invoiced by Colombia Peso and none of them are settled using Chinese currency. When Colombia firms are exporting to Japan, 1.36% of the transactions are denominated in Japanese Yen and none of them are settled in Colombia Peso. In the case of South Korea, it is in the middle. Table 4 shows the variations in currency choices exist in industry level. The share of PCP is relatively high (15.87%) in mineral products whereas the share of PCP falls to almost zero in food industry.

There are also substantial variations over time as shown in Figure 3, 4, 5 and 6 in the appendix. Before the 2008 global financial crisis, the usage of US dollar is very high and stable. During 2008, its share started to decline and the share of Euro and Colombia Peso started to increase. This could partially reflect that during the great

trade collapse, USD-based trade finance was disturbed and exporters in Colombia started to look for alternative currencies for international trade. After August 2011, the share of US dollar further decreased and other currencies' share gained more ground. This could potentially be due to the downgrading of US government rating in August 2011.

3.3 Broad assessment of the currency choices of Colombia Trade

We start a broad assessment of currency choices and show how it is related to financial, macro, micro and strategic factors. The major financial factor we consider is financial development. For macroeconomic factors we focus on inflation rate and FX volatility. For microeconomic factors we focus on exporter's firm-level bargaining power and importing countries' market share. All related graphs are present in the appendix. Note that United States is not included in these graphs.

Financial Factor

For financial factors, we consider financial market development as a key measure. The theory predicts that if the destination country has a higher level of financial development, its currency will be more likely to be used.

Figure 7, 8 and 9 in appendix show these patterns. The countries with a higher financial development level will be more likely to have its own currency used. At the same time, Colombia's Peso will be less likely to be used. The vehicle currency will be less likely to be used if the destination country has a higher level of financial development.

Macro Factor

Inflation and foreign exchange rate volatility are among the two most important macro factors for invoicing currency choices. Figure 10, 11 and 12 in the appendix show the relationship between CPI and currency choice. If the country has a higher inflation, its currency will be less likely to be used. At the same time, the vehicle currency will be more likely to be used. Figure 13, 14 and 15 in the appendix show the relationship between foreign exchange volatility and currency choice. If the country has a higher foreign exchange volatility against Colombia Peso, its currency will be less likely to be used. At the same time, the vehicle currency will be more likely to

Table 5: Currency Choices and Product Differentiation

	Heterogeneous Goods	Homogeneous Goods
VCP	73.62%	82.33%
LCP	26.06%	17.52%
PCP	0.32%	0.14%

Table 6: Invoicing Currency by Firm Size and External Finance Dependence

	Firm Size (Top 10 Percentile)			Firm Size (Other Percentile)		
External Finance Dependence	PCP	LCP	VCP	PCP	LCP	VCP
Low	0.00%	12.4%	82.5%	0.00%	17.4%	87.6%
Medium	0.0%	35.7%	64.3%	0.02%	28.2%	71.7%
High	1.4%	41.4%	57.1%	0.1%	20.9%	79.0%

be used.

Micro Factor

For micro factor, we consider the differentiated goods vs homogenous goods as categorized by Rauch (1999). Table 5 shows that homogeneous goods are more likely to use VCP while differentiated goods use more of PCP. This stylized facts are consistent with Goldberg and Tille (2008).

Strategic Factor

We also consider the strategic factor when there is bargaining between exporters and importers. As emphasized by Goldberg and Tille (2013), the firm size is a key measure of bargaining power. Chung (2016) use Top 10 percentile of exporter's size as a dummy for big size exporting firms. Table 6 shows the relationship between currency choices, firm sizes and financial dependence. We can see that larger firms will tend to have a lower share of VCP compared to small firms.

3.4 Advantages and limitation of Colombia Data

Through the above discussions, our dataset has four advantages when compared with the recent firm-level/transaction-level study as in Chung (2016) and Goldberg

and Tille (2013):

The first advantage is the diversity in trading partners and industries. Through 2007 to 2013, the total number of trading partners (destination countries) was more than 130 for exporters. The US accounts for 18.1% of exports and the second (Ecuador) and third (Venezuela) largest partner account for 15.3% and 13.2% respectively. The share of US is less dominant than the case of Canada and UK. The industries are also very rich, in both HS4 and HS6. So this dataset represents a small open economy exposed to a large number of partners.

The second advantage is in terms of data quality: our detailed transaction contains Colombia exporter/importer firm ID so we can do both firm-level and transaction-level analysis. We could also identify importing and non-importing exporters. More importantly, our data document a lot of detailed dimensions of each international trade transaction, such as transportation mode which has never been used in previous study. This information can help us to proxy the dependence on trade finance used in Ahn et al. (2011).

The third advantage is the time frame of our dataset, which includes the period both before and after the financial crisis (thus great trade collapse and trade finance collapse). Therefore it enables us to identify how financial market turmoil and trade finance collapse affect currency choices. The previous studies used either a single year such as 2011 in Chung (2016) or several years before financial crisis as in Goldberg and Tille (2016).

The last advantage is from a developing country's point of view. Colombia dataset is instructive as a developing country relies heavily on trade finance. This provide a unique opportunity to study how trade finance and financial market development affect exporters' currency choice. While the previous literature mostly focused on the industrial countries' firm-level dataset, this is the first study on a developing country more dependent on trade finance, which would affect the invoicing currency choice.

This dataset also has its own limitations. First, we do not have currency choices information for Colombia import. Second, we do not directly have the trade finance information such as whether the exporters get trade credit or not. In the subsequent section, we use various measures to proxy the trade finance dependence of firms.

To summarize, we provide the descriptive statistics of Colombia export/import dataset and currency denomination of the exports. We report substantial cross-sectional and time series variations in invoicing currency choices. We also assess

the pairwise link between invoicing currency choices and various drivers, including financial, macro, micro and strategic drivers. While Colombia dataset has obvious limitations, it provides a unique opportunity to study the invoicing currency choice for a small open economy which heavily relies on trade finance. Next, guided by our theory, we formally conduct an econometric exercise to study various invoicing currency drivers.

4 Empirical Evidence

In this section we use several multinomial logit models to estimate the effects of different factors and gauge the economic significance. We first introduce the econometric model specification and the construction of variables. Then we present the main empirical results. We also perform a series of robustness checks, including the complementary transaction-level tests.

4.1 Econometric Model and Construction of Variables

We take the entire sample of Colombia exports to all the destination countries (6.4 million transactions) and reduce it to the firm-product-destination level (0.55 million observations). As in Chung (2016) the dimension that is eliminated is the frequency of shipping for each exporter (at the product-destination level) within a year. We denote the exporter by superscript i, the product (at the HS6 level) by superscript j, and the specific destination (country) by superscript e. Furthermore we use k to denote industry in HS4 level.

We study the exporter's choice between local consumer's currency (LCP), producer's currency (PCP) or vehicle currency (VCP). The categorical dependent variable is an indicator variable L_t^{ije} taking into account all pricing strategies, specifically a vehicle currency, or producer's currency (Colombia Peso), or the destination currency. If using producer's currency, we assign $L_t^{ije} = 0$; while if using destination country's currency, we assign $L_t^{ije} = 1$; if using a vehicle currency, we assign $L_t^{ije} = 2$. As the three invoicing alternatives are mutually exclusive and exhaustive (for each firm-product-destination observation), we can use a multinomial logit (MNL) model to analyse the choice probability between the three options. We take PCP as the baseline option. Thus the MNL estimations yield two sets of results: LCP versus PCP and VCP versus PCP. Statistical significance in these estimations shows the direction in which the independent variables shift the likelihood of LCP (VCP) away

from the baseline option of PCP. The baseline specification is:

$$L_t^{i,j,e} = \text{MNL}(FD_t^e, FD_t^e \times TFD_t^{i,k}, FirmTop10^{i,k}, CountryShare_t^{i,e}, CPI_t^e, FXcov_t^e, \delta_e, \delta_k) \tag{14}$$

where the superscripts i, j, e, k denote firm, product, destination country and industry. δ_e, δ_k denote geographic fixed effect and industry fixed effects respectively. We add geographic fixed effect for Latin America, Euro Area, Asia, North America and others. The industry fixed effects are set at HS4 level. The empirical analysis is mainly focused on financial, macro and strategic factors. They require the following key ingredients: measures of destination countries' financial development, inflation and FX volatility in destination's currency and bargaining power between exporters and importers.

The first explanatory variable FD_t^i measures the destination country's financial development relative to Colombia. It is from the world bank and is calculated as the amount of financial resources provided to private sector by financial intermediary as a share of GDP. This measure has been used extensively in the finance and growth literature, as well as in international trade. Financial development varies significantly in the panel. The bottom three countries are Congo, Equatorial Guinea and Iraq, while the top three countries are Japan, Iceland and Denmark. We expect the more developed the country's financial system is, the less it will use dollar for invoicing and settlement. At the same time, its own currency will be more likely to be used.

To further identify the effect of financial development, we consider the industry's external dependence on finance. Specifically, we use $ExtFian_j$ to identify which industry is more relied on external finance (including trade finance) as in Manova (2013), which constructed this measure based on data for all publicly listed US-based companies from Compustat's annual industrial files.[20] External finance dependence is the share of capital expenditures not financed with cash flows from operations. Most of the external finance are from banks in a variety of ways, including short term credit

[20]Manova also consider asset tangibility as another measure of financial vulnerability. Asset tangibility records the share of net property, plant and equipment in total book-value asset. We use this alternative measure in the robustness check and find our results are robust.

like letter of credit and trade credit[21]. We do not observe the firm-level trade finance dependence, so we build a firm-level index based on Manova's measure as a proxy for firm-level trade finance dependence (TFD). It is constructed as the following:

$$TFD_t^{i,k} = ExtFina^k \times (-Firm_{Size}^i)$$

We interact External finance dependence from Manova with the negative of firm size in terms of export value. It is plausible that when the firm size is smaller and when it is operating in an industry which depends more on external finance, it will be more likely to rely on trade finance. If the index TFD_t is higher, it signifies more dependence on trade finance. From the theory, we expected that if the firm is more dependent on trade finance, and when the destnational country's financial development is higher, it will tend to use more VCP (LCP) compared to PCP.

For strategic factors, we construct a firm-level measure for bargaining power of exporters. (since we do not observe the importer's firm level information, we can not construct a similar measure for importers.) Following (Chung, 2016) we use the firm size in export value and focus on the top 10 percentile in HS4 industry. Denote $FirmSizeTop10$ as 1 if the firm size is in the top 10 percentile and as 0 otherwise. For the importer's bargaining power, we use the market share of the importing country in HS4 industry as used in Goldberg and Tille (2016) and denote as $CountryShare$. We expect that if the exporting firm has more bargaining power it will be more likely to use its own currency.

For the macroeconomic variables, we look at the inflation rate in the destination country CPI_t^i. It is from the world bank. Our theory predicts that currency of a country with higher inflation is unappealing to exporters. We also look at exchange rate volatility which might be influenced by the monetary policy in the destination country. $FXcov_t^e$ is the exchange rate volatility involving the destination country's currency against Colombia's Peso. Our theory, as well as the existing traditional theory(Devereux et al. (2004), Engel (2006)), predicts a currency with more volatile exchange rate is less likely to be chosen. We also add the real GDP per capita to control for the size of the economy.

[21] As stated in Manova et al. (2015) constructing the industry measures from US data is motivated by three considerations. First the US has one of the most advanced and sophisticated financial systems in the world. The behavior of US firms thus plausibly approximates their optimal asset structure and use of external finance. Second, using US as the reference country is convenient because of limited data for many other countries, but it also ensures that the measures are not endogenous to financial development. Finally, identification does not require that sectors have the same financial sensitivity as US but rather that their ranking remains relatively stable across countries.

All the related key variables and its sources are summarized in Table 12 in the appendix.

4.2 Main empirical findings

In table 7 and 8, we summarize the baseline multinomial logit regression with the key explanatory variables. We hereby report the estimation results for LCP vs PCP and VCP vs PCP respectively in table 7 and 8. Remember in Columns (1) to (6) the estimates from MNL regressions are odd ratios rather than marginal effects and we should avoid comparing the coefficient value directly. Therefore, the signs of the coefficients should only be interpreted as the direction of deviation from the baseline options. We will compute and discuss the average marginal effects (AME) in a later section. Also notice that in Column (5) and (6) we run the same regression for all countries and non-US countries respectively.

Column (1) and (2) in Table 7 and 8 include only financial factors. The positive and significant coefficient of FD_t^e in LCP vs PCP (Table 7) implies that if the destination country's financial development is higher than Colombia, it will make Colombia firms more likely to use the destination country's currency. Similarly, the negative and significant coefficient of FD_t^e in VCP vs PCP (Table 8) implies that if the destination country's financial development is higher than Colombia, it will make Colombia firms less likely to use the vehicle currency. Conversely, the lower the destination country's financial development, the more likely exporters will choose its own currency. (Colombia's financial development might be higher than destination county) This support Proposition 1.

The interaction of FD and firm-level trade finance dependence proxy TFD further identify the effects of financial market development on the trades that are more likely to be dependent on trade finance. The negative and significant coefficient of TFD in LCP vs PCP (Table 7) implies if the trades are more likely to be dependent on trade finance it will be more likely to use Colombia's Peso. But when it is exporting to a destination with higher financial market development, it will be more likely to use destination country's currency LCP or the vehicle currency. This shows that trade finance and financial market development is an important channel for invoicing currency choices as argued in our theory. In sum, it demonstrates that exporters tend to use the currency with a more developed and efficient financial market, especially for small firms in financially vulnerable sectors. It confirms the effects of financial market development.

In column (3) we add strategic factors. For the exporter's bargaining power, we use $FirmSizeTop10$ and for the importer's bargaining power, we use $CountryShare$. The negative and significant coefficient of $FirmSizeTop10$ implied that bigger firms will tend to shift the currency choices away from LCP (VCP) towards PCP. This supports the Proposition 3. In some of the specifications, import countries share has a statistically significant impacts on currency choices but its effects are not robust.

In column (4) we further add macroeconomic factors, namely the inflation and foreign exchange rate volatility. The estimated coefficient of CPI_t^e is significantly negative in table 7, which suggests that if the firm is exporting to a destination with high inflation (bad monetary policy) they are more likely to shift from LCP to PCP. In terms of VCP in table 8, when it is exporting to high inflation country, it tends to use more VCP relative to PCP. This confirms the Proposition 2.

Regarding to foreign exchange rate volatility, the estimated coefficient of $FXcov$ is significantly negative in table 7, which suggests that if the firm is exporting to a destination with high inflation (bad monetary policy) they are more likely to shift from LCP to PCP. In terms of VCP in table 8, when it is exporting to high inflation country, it tends to use more VCP relative to PCP. This confirms the Proposition 2(b).

We also control for real GDP per capita of destination country in model (5) and (6). The effects from financial development are still statistically significant and all the other key explanatory variables still have the expected effects.

Overall, these results strongly support the model's predictions. For both estimations, we add time fixed effects at a yearly level and industry fixed effects at the SITC-1 digit level. We also add geographic fixed effects which represent different continentals.

4.3 Robustness

We consider two sets of robustness tests: including other explanatory variables that have been considered in the literature as additional controls, performing the transaction level tests as did in Goldberg and Tille (2016).

4.3.1 Additional Controls

In table 14 and 15 we check whether the main results from the baseline empirical specification still hold when we add more control variables. These control variables include macro, micro and strategic factors which have been considered in the previous literature. The key conclusion from this robustness check is that the main results regarding to financial, macro and bargaining factors still holds. While CPI has robust and significant effects on the LCP vs PCP, the $FXcov$ has robust and significant effects on the VCP vs PCP.

Macro Factors

In addition to the real GDP, we add two dummy variables to capture exchange rate regimes. $Dpeg$ and $Epeg$ denote the dollar peg and euro peg respectively. This is the variable considered in both Goldberg and Tille (2016) and Chung (2016).

The results are present in Column (1) in table 14 and 15. The exporter are more likely to use LCP when the destination countries use exchange rate pegs. They are less likely to use vehicle currency when the destination countries are euro peggers. Notice that for LCP vs PCP, exchange rate regime considerations absorb most of the effect from exchange rate volatility and make the effect from $FXcov$ not statistically significant. Importantly, the key explanatory variables from the baseline empirical model still have the expected and significant results.

Micro Factors

First, we consider $Rauch^j$ to capture goods characteristics. We use Rauch (1999) measure to the trade data. We divide the SITC4 level into three categories: reference-priced or exchange traded, Walrasian, or differentiated goods. The first two categories include goods that highly substitutable with each other, while differentiated products, including the bulk of manufacturing, have more limited substitutability. This dummy variable will take values of 1 if goods are reference-priced or Walrasian (respectively) and zero otherwise, so that differentiated goods are the reference category. Exporters of reference-priced and Walrasian goods are expected to place a relatively high weight in limiting fluctuations of their price relative to that of their competitors, leading invoicing to coalesce around a central currency which is US dollar, as illustrated in the model as well as in Goldberg and Tille (2008).

We also consider a firm level characteristics: some firms are importing exporters and others are pure exporters. Chung (2016) finds that their invoicing currency

choices are significantly different from each other. So the dummy *Importing* is equal to 1 if the firm is exporting and importing at the same period of time.

The results are present in Column (2) in table 14 and 15. The exporter are more likely to use LCP (VCP) when the goods are homogeneous goods. For the differentiated goods, they are more likely to be used in PCP. For importing exporters, they are more likely to use LCP (VCP) relative to PCP. Again, the key explanatory variables from the baseline empirical model still have the expected and significant results.

Strategic Factors

Next we consider a bunch of strategic factors that have been considered and used before. We construct another firm-level bargaining power for the exporters $Herfindal^{i,e}$ that measures the degree of firm competition at the industry (HS4 code)-country level. The higher the index, the more bargaining power the firms have in that industry and in that country. This method is used in Sokolova (2015).

We also use the absolute export value as firm's size to supplement with the previous firm size measured with quantiles. We use the total FOB value in a year to measure its size. This variable is considered in Goldberg and Tille (2016).

The results are present in Column (3) in table 14 and 15. Compared to the firm size measured in Top 10 percentile, both the absolute firm size and firm's Herfindal index do not have a robust effect.

All Controls: All Countries and Non-US Countries

Column (5) and (6) consider all the control variables for the whole sample and non-US destinations respectively. The main results still hold. We also could notice that CPI has robust and significant effects on the LCP vs PCP, the $FXcov$ has robust and significant effects on the VCP vs PCP when we add all controls.

4.3.2 Transaction-level Tests

In this section we look at the transactional-level data and run the similar multinomial logit regression as in the previous section.

For each transaction, we create a trade size dummy following Chung (2016) and Goldberg and Tille (2016). We use the Top 5th percentile by size and distinguish

between big vs small intensive margin, denoted as $trade_{size}$.

Similar to the firm-level trade finace dependence, we use an alternative proxy for trade finance dependence for the transaction level data. First, notice that $trans_t$ is the transportation mode for each transaction which is used to proxy how the transaction are dependent on trade finance. We assign $trans_t = 1$ if it is shipped by sea, while $trans_t = 0$ if use other transportation modes. This is motivated by Ahn et al. (2011) that although we can not observe the trade finance dependence on each transaction, the goods that are shipped by sea will need a longer time to deliver and will tends to use more trade finance. Second, we also assume that smaller firms will tend to be more likely to rely on trade finance. Thus, we construct the new transaction level trade finance dependence proxy as followings:

$$TFD_t = trans_t \times (-Firm^i_{Size})$$

We also consider a financial crisis dummy *crisis* which will be equal to 1 if the transaction happen between 06/2008 and 06/2009 as used in Ahn et al. (2011). We interaction the crisis dummy with transaction mode dummy to see the effect of great trade finance collapse and its effects on currency choices.

The transaction-level empirical test is present in table 16 where we report three different specifications. The model (1) consider all the main explanatory variables plus a trade size dummy. Model (2) consider the interaction between financial development and transaction-level trade finance dependence. Model (3) consider the crisis dummy and test how great trade collapse affect the currency choices.

The results in model (1) shows the main results still hold in transaction level data. We find that when the transaction size is large, it tends to shift toward PCP. We consider the transaction-level trade finance dependence in model (2) and the results show that trades that are more dependent on trade finance will be more likely to be used in VCP. Results in model (3) shows that during the financial crisis when the trade finance in dollar was disrupted, the currency choice shifts away from VCP toward PCP and LCP.

4.4 Economic Significance

As in MNL models, the coefficients can not be compared directly and we need to calculate average marginal effects (AME). Table 17 shows the result. We calculate the average marginal effect for the baseline model as one standard-deviation increases

in the key independent variable. In this way we can quantify the effects of various factors. We find that the two most important factors influencing invoicing currency choices are monetary policy and financial development. Specifically, if there is one standard deviation increase in inflation in destination country, it will decrease its currency usage by more than 6.8%. On the other hand, if there is one standard deviation increase in financial development of destination country relative to home country, it will shift the choice probability to LCP by around 3.4%. If a country with medium-level financial market development like Colombia or China further develop their financial market to the top level like Japan (3 standard deviation increase), their own currency usage in international trades will be promoted by more than 10%. If there is a one standard deviation increase in destination country's exchange rate volatility, it will tend to shift the choice probability away from LCP by 3.8%. GDP per capital also has a very significant effect: if there is one-standard deviation increase in real GDP per capita, the destination country's currency will be 1.9% more likely to be used. The firm-level bargaining power has a statistically significant but smaller effects. Take China to do some counterfactual experiment: if China further develop its domestic financial market to the highest level and its GDP per capital further increase to a developed country level, its currency will be promoted by around 20%.

5 Conclusion

This paper focuses on financial market's influences on international currency use in trades. We discussed currency choice at firm level. First of all, we build a unified framework with financial frictions to address the determinants of currency choice, emphasizing the roles of financial market development, as well as monetary policy and firm's bargaining power. In an open economy monetary search model, the usage of a particular currency will emerge endogenously and strategic complementaries among exporters, importers and bankers reinforce the status of international currency. Secondly, with highly disaggregated data from Colombia exporters, we provide firm-level evidence that financial factors significantly affect the patterns of currency usage. We show that exporters tend to use the currency with a more developed and efficient financial market, especially for small firms in financially vulnerable sectors. In particular, a median developing country could enhance its home currency usage by more than 10% through financial market development. Furthermore, bad monetary policy and low bargaining power of exporters will severely restrict the popularity of a currency. These results have important policy implication for currency internationalization in developing countries.

Although it is the first step to add financial intermediary in the open-economy monetary search model to study endogenous currency choices, an interesting future work is to endogenize financial intermediary. Also, it would also be very interesting to test the model's predictions using China's data and see whether our empirical results carry over to other developing countries. Another interesting route is to implement structural estimation on our model.

Table 7: Baseline empirical results for invoicing currency choice (LCP vs PCP)

LCP vs PCP	(1) All	(2) All	(3) All	(4) All	(5) All	(6) Non-US
Financial Development	5.15***	4.86***	3.82***	1.94***	1.19***	0.47***
	(0.33)	(0.4)	(0.23)	(0.16)	(0.17)	(0.11)
Firm TFD		-4.47***	-3.83***	-5.05***	-5.16***	-3.08*
		(1.28)	(1.17)	(1.37)	(1.47)	(1.80)
FD × Firm TFD		2.84***	2.32***	3.37***	3.54***	-0.07
		(0.92)	(0.85)	(1.00)	(1.11)	(1.60)
Firm Size Dummy			-1.36***	-1.33***	-1.22***	-1.15***
			(0.35)	(0.35)	(0.36)	(0.08)
Importer Country Share in HS4			3.66***	2.16***	1.98***	0.05
			(0.63)	(0.52)	(0.56)	(0.35)
Inflation				-0.38***	-0.30***	-0.21***
				(0.04)	(0.05)	(0.01)
Exchange Rate Volatility				-74.28***	-49.2***	-8.84***
				(5.09)	(5.22)	(1.70)
GDP per capita					0.39***	0.18***
					(0.05)	(0.02)
Observations	545,022	545,022	545,022	545,022	545,022	474,258
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Observations are at the firm-product-destination level. The default option is PCP and estimates of LCP versus PCP are reported. Column (1) to Column (5) consider all samples while Column (6) consider non-US destinations. Fixed effects: δ_e are destinations at geographic level including North America, Latin America, Euro Area, Asia and others; δ_k are industries defined at the SITC-1-digit level. Standard errors are clustered at the HS4 level (1098 clusters) and are reported in parenthesis.
*** for 1% level.
** for 5%.
* for 10%.

Table 8: Baseline empirical results for invoicing currency choice (VCP vs PCP)

	(1)	(2)	(3)	(4)	(5)	(6)
VCP vs PCP	All	All	All	All	All	Non-US
Financial Development	-0.81***	-0.74***	-0.81***	-0.57***	-0.73***	-0.46***
	(0.10)	(0.10)	(0.12)	(0.09)	(0.09)	(0.05)
Firm TFD		-0.28***	-0.28***	-0.27***	-0.26***	0.03
		(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
FD × Firm TFD		0.22***	0.23***	0.23***	0.23***	0.58***
		(0.09)	(0.09)	(0.09)	(0.09)	(0.17)
Firm Size Dummy			-1.15***	-1.20***	-1.19***	-1.15***
			(0.34)	(0.35)	(0.33)	(0.07)
Importer Country Share in HS4			-0.81***	-1.07***	-0.2	0.50
			(0.39)	(0.36)	(0.4)	(0.31)
Inflation				0.05***	0.06***	0.02***
				(0.01)	(0.01)	(0.007)
Exchange Rate Volatility				13.73***	23.9***	6.25***
				(4.33)	(4.78)	(1.66)
GDP per capita					-0.16***	-0.12***
					(0.04)	(0.02)
Observations	545,022	545,022	545,022	545,022	545,022	474,258
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Observations are at the firm-product-destination level. The default option is PCP and estimates of VCP versus PCP are reported. Column (1) to Column (5) consider all samples while Column (6) consider non-US destinations. Fixed effects: δ_e are destinations at geographic level including North America, Latin America, Euro Area, Asia and others; δ_k are industries defined at the SITC-1-digit level. Standard errors are clustered at the HS4 level (1098 clusters) and are reported in parenthesis.
*** for 1% level.
** for 5%.
* for 10%.

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Table

Table 9: Distribution over Exporters (2013)

	p25	p50	p75	p90	p99	mean
Number of HS4 exported	1	1	3	7	30	3.331
Number of HS6 exported	1	1	4	9	44	4.446
Number of Transactions	1	4	21	117	1,421	91.65
Number of Destinations	1	1	2	6	22	2.746
Number of Currency	1	1	1	1	2	1.05
Export value (thousand USD)	6	36	269,738	1,796	50,910	5,529

Table 10: Distribution over HS-4 Industry (2013)

	p25	p50	p75	p90	p99	mean
Number of Exporters	4	11	32	73	311	30.73
Number of HS6 exported	1	2	4	7	14	3.338
Number of Transactions	12	69	363	1,427	10,273	845.4
Number of Destinations	4	10	21	34	68	14.59
Number of Currency	1	1	2	3	5	1.5
Export value (thousand USD)	90	868	5,839	29,550	447,500	51,000

Table 11: Distribution over Exporter and HS-4 Industry Pairs (2013)

	p25	p50	p75	p90	p99	mean
Number of HS6 exported	1	1	1	2	5	1.335
Number of Transactions	1	2	7	28	434	27.52
Number of Destinations	1	1	2	4	15	2.076
Number of Currency	1	1	1	1	2	1.02
Export Value (thousand USD)	0.7	5.5	40	280	11,010	1,660

Table 12: Variables and Data Source

Name	Description	Source
FD (financial development)	Private credit over GDP relative to Colombia level	World Bank
Inflation	Import country's YOY change of CPI	IMF
FX volatility	Coefficient of variation for monthly bilateral exchange rate in a year	IMF
Real GDP	Import country's real GDP, in log	World Bank
EFD (external finance dependence)	Share of capital expenditures not financed by cash	Manova (2013)
Firm Size	FOB value of firm's total export in a year, in absolute value	Colombia Export Database
TFD (trade finance dependence)	TFD=EFD×(-Firm size)	Author's calculation
Firm size dummy	Equal to 1 if firm size is at top 10% of HS4 industry	Colombia Export Database
Country share	Market share of import country in HS4 industry	Colombia Export Database
Peg	Equal to 1 if import country's currency is pegged to USD or EUR	IMF
Homogeneous good	Equal to 1 if reference-priced or has standard exchange	Rauch (1999)
Importing exporters	Equal to 1 if export firm is also importing in the same year	Colombia Export Database
Herfindal (Industry)	Index for Firm share in HS4 industry (measure competitiveness)	Colombia Export Database
Herfindal (Country)	Import country share in HS4 industry (measure competitiveness)	Colombia Export Database
Trade size dummy	Equal to 1 if transaction size is at 5% of total transaction in a year	Colombia Export Database
Transportation mode	Equal to 1 if transported by sea	Colombia Export Database
TFD (transaction level)	TFD (transaction level)=Transportation mode ×(-Firm size)	Author's calculation
Crisis	Equal to 1 if transaction happens between June 2008 and June 2009	Ahn et al. (2011)

Table 13: Baseline empirical results for invoicing currency choice (VCP vs LCP)

VCP vs LCP	(1) Model 1	(2) Model 2	(3) Model 3	(4) Model 4	(5) Model 5
Financial Development	-5.96***	-4.86***	-4.73***	-2.5***	-1.99***
	(0.32)	(0.40)	(0.19)	(0.17)	(0.17)
Firm TFD		4.47***	3.33***	4.35***	4.78***
		(1.28)	(1.12)	(1.16)	(1.45)
FD × Firm TFD		-2.84***	-2.0**	-2.8***	-3.22***
		(0.92)	(0.80)	(0.81)	(1.07)
Firm Size Dummy			0.25**	0.13	0.03
			(0.11)	(0.12)	(0.11)
Importer Country Share in HS4			-4.5***	-2.97***	-2.1
			(0.6)	(0.48)	(0.46)
Inflation				0.52***	0.39***
				(0.04)	(0.05)
Exchange Rate Volatility				70.25***	67.9***
				(3.2)	(3.7)
GDP per capita					-1.5***
					(0.05)
Observations	545,022	545,022	545,022	545,022	545,022
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes

Notes: Observations are at the firm-product-destination level. The default option is PCP and estimates of VCP versus LCP are reported. Column (1) to Column (5) consider all samples while Column (6) consider non-US destinations. Fixed effects: δ_e are destinations at geographic level including North America, Latin America, Euro Area, Asia and others; δ_k are industries defined at the SITC-1-digit level. Standard errors are clustered at the HS4 level (1098 clusters) and are reported in parenthesis.
*** for 1% level.
** for 5%.
* for 10%.

Table 14: Robustness with additional controls (LCP vs PCP)

LCP vs PCP	(1) Macro	(2) Micro	(3) Strategic	(4) All Controls	(5) Non-US
Financial Development	0.81***	4.40***	1.88***	0.62***	0.76***
	(0.18)	(0.09)	(0.09)	(0.16)	(0.11)
FD × Firm TFD	0.26*	3.20***	2.85*	3.67**	3.93**
	(1.55)	(0.78)	(1.46)	(1.53)	(1.74)
Firm Size Dummy	-0.94***	-1.67***	-1.40***	-1.20***	-1.22***
	(0.42)	(0.07)	(0.08)	(0.12)	(0.40)
Inflation	-0.30***	-0.04***	-0.38***	-0.31***	-0.32***
	(0.06)	(0.01)	(0.01)	(0.04)	(0.05)
Exchange Rate Volatility	-7.2	-83.72***	-73.19***	-6.70	6.67
	(17.2)	(2.32)	(2.30)	(17.2)	(13.8)
GDP per capita	0.6***			1.10***	1.09***
	(0.09)			(0.10)	(0.10)
Dollar Peg	4.96***			5.05***	5.19***
	(0.40)			(0.30)	(0.39)
Euro Peg	0.86*			0.89*	0.79*
	(0.46)			(0.46)	(0.44)
Heterogeneous vs Homogeneous goods		0.34***		0.32***	0.36***
		(0.06)		(0.10)	(0.10)
Non-importing vs Importing Exporters		0.31***		0.74***	0.81***
		(0.07)		(0.11)	(0.17)
Firm Herfindal Index in HS4			-0.28	0.13	0.05
			(0.22)	(0.25)	(0.26)
Firm Size (Absolute Value)			0.65	-0.04	-0.07
			(0.82)	(0.06)	(0.06)
Importer Country Share in HS4			2.13***	1.33**	1.57**
			(0.52)	(0.60)	(0.73)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes

Notes: Observations are at the firm-product-destination level. The default option is PCP and estimates of LCP versus PCP are reported. Column (1) to Column (5) consider all samples while Column (6) consider non-US destinations. Fixed effects: δ_e are destinations at geographic level including North America, Latin America, Euro Area, Asia and others; δ_k are industries defined at the SITC-1-digit level. Standard errors are clustered at the HS4 level (1098 clusters) and are reported in parenthesis.
*** for 1% level.
** for 5%.
* for 10%.

Table 15: Robustness with additional controls (VCP vs PCP)

VCP vs PCP	(1) Macro	(2) Micro	(3) Strategic	(4) All Controls	(5) Non-US
Financial Development	-0.83***	-0.60***	-0.62***	-0.86***	-0.82***
	(0.18)	(0.08)	(0.08)	(0.17)	(0.14)
FD × Firm TFD	0.47**	0.53***	-0.01	0.38*	0.40**
	(0.18)	(0.17)	(0.94)	(0.22)	(0.16)
Firm Size Dummy	-0.96**	-1.33***	-1.25***	-1.16***	-1.17***
	(0.34)	(0.32)	(0.33)	(0.36)	(0.10)
Inflation	0.018	0.03***	0.05***	0.02	0.002
	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)
Exchange Rate Volatility	29.03***	14.80***	14.77***	29.5***	26.77***
	(10.07)	(4.04)	(4.09)	(9.9)	(5.8)
GDP per capita	-0.42***			-0.41***	-0.31***
	(0.07)			(0.07)	(0.06)
Dollar Peg	-0.15			-0.12	0.16
	(0.23)			(0.24)	(0.20)
Euro Peg	-1.48***			-1.52***	-1.50*
	(0.41)			(0.41)	(0.24)
Heterogeneous vs Homogeneous goods		0.30***		0.34***	0.37***
		(0.07)		(0.08)	(0.10)
Non-importing vs Importing Exporters		0.33***		0.69***	0.76***
		(0.07)		(0.15)	(0.10)
Firm Herfindal Index in HS4			-0.11	-0.69**	-0.79***
			(0.21)	(0.25)	(0.25)
Firm Size (Absolute Value)			0.62	0.07	0.06
			(0.81)	(0.06)	(0.05)
Importer Country Share in HS4			-1.10***	0.41	0.17
			(0.36)	(0.53)	(0.46)
Year FE	Yes	Yes	Yes	Yes	Yes
Industry FE	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes

Notes: Observations are at the firm-product-destination level. The default option is PCP and estimates of VCP versus PCP are reported. Column (1) to Column (5) consider all samples while Column (6) consider non-US destinations. Fixed effects: δ_e are destinations at geographic level including North America, Latin America, Euro Area, Asia and others; δ_k are industries defined at the SITC-1-digit level. Standard errors are clustered at the HS4 level (1098 clusters) and are reported in parenthesis.
*** for 1% level.
** for 5%.
* for 10%.

Table 16: Transaction Level Tests

	(1)		(2)		(3)	
Variables	LCP	VCP	LCP	VCP	LCP	VCP
FD	2.8***	-1.1***	3.4***	-0.7***	4.1***	-0.7***
$FirmSizeDummy$	-3.7***	-3.0***	-5.3***	-4.7***	-5.4***	-4.3***
CPI	-0.69***		-0.65***		-0.24***	
$FXcov$		23.6***		15.3**		14.4***
$Trans_{size}$	-1.4**	-0.5***				
$FD \times TFD$			4.5	9.4***		
$Trans_{mode} \times Crisis$					-1.12*	-1.06***
Observations	4,490,473	4,490,473	4,490,473	4,490,473	4,490,473	4,490,473
Year FE	Yes	Yes	Yes	Yes	No	No
Industry FE	Yes	Yes	Yes	Yes	Yes	Yes
Geographic FE	Yes	Yes	Yes	Yes	Yes	Yes

Table 17: Average Marginal Effect (AME)

	FD	CPI	FXcov	Firm Size	CountryMarketShare	GDP per capita
LCP vs PCP	+3.4%	−6.8%	−3.8%	−0.1%	+0.9%	+1.9%
VCP vs PCP	−3.5%	+6.8%	+3.9%	−0.4%	−0.9%	−2.0%

Figure

Figure 3: Share of Currency: US Dollar

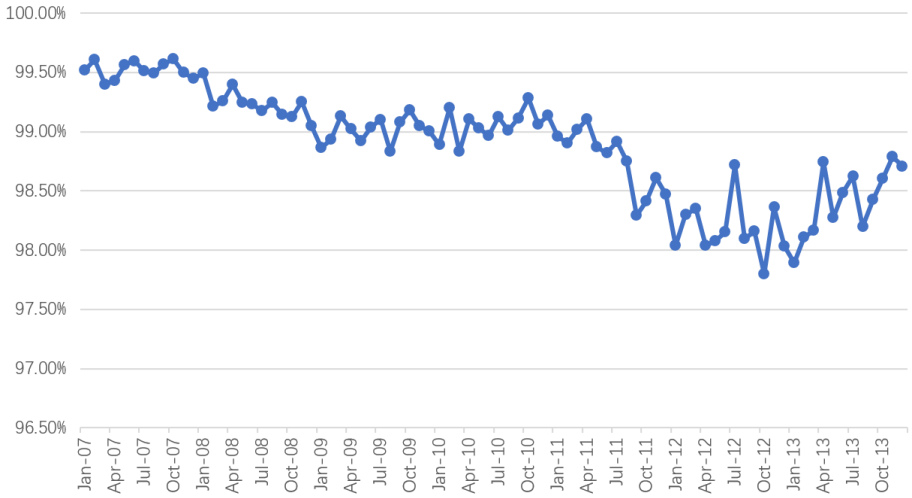


Figure 4: Share of Currency: Euro

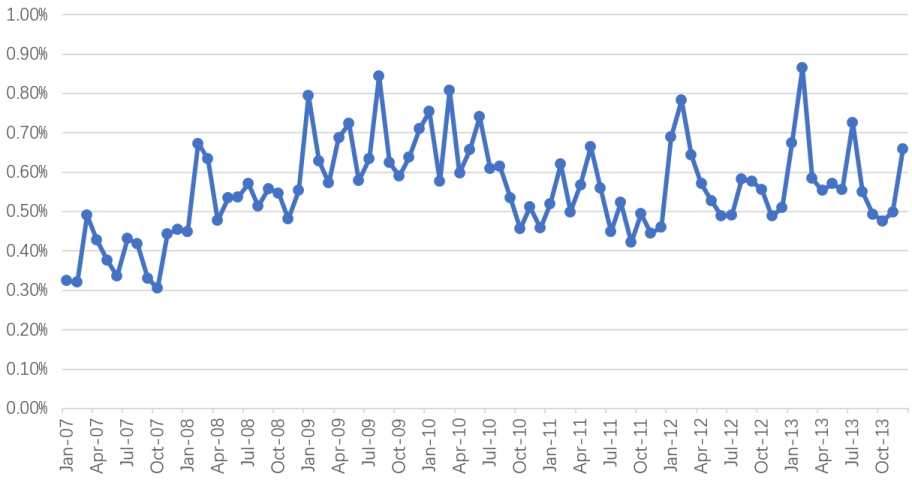


Figure 5: Share of Currency: Colombia Peso

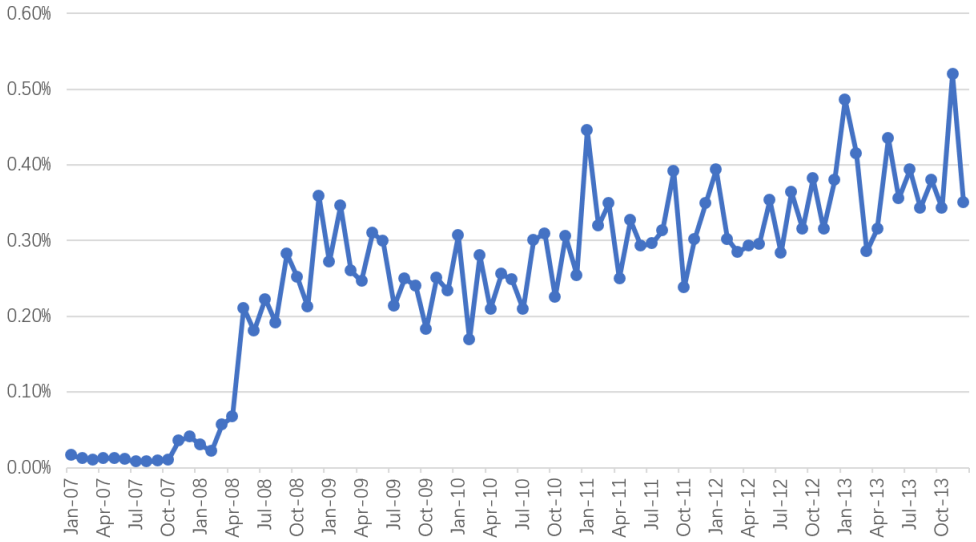


Figure 6: Share of Currency: Other Currencies

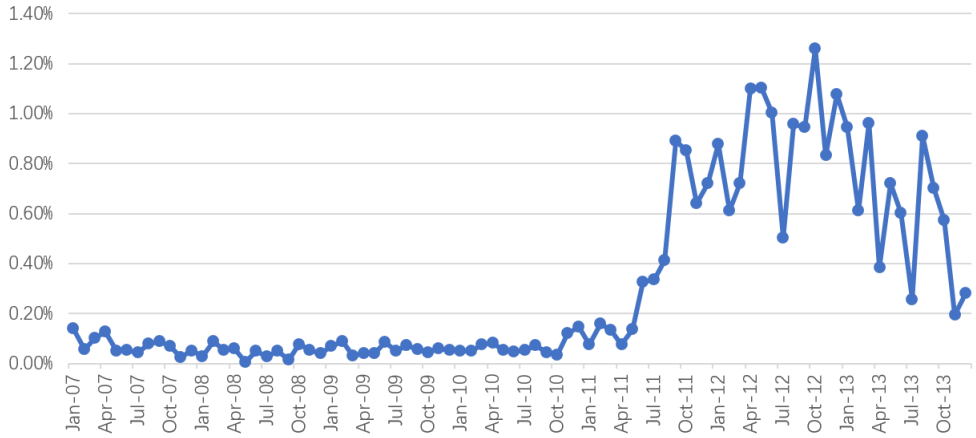


Figure 7: LCP and Financial Development

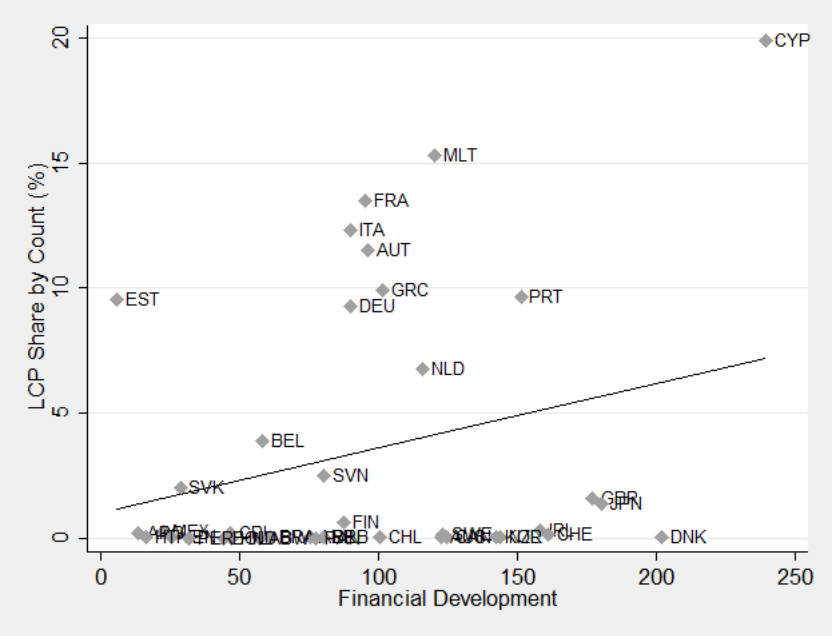


Figure 8: PCP and Financial Development

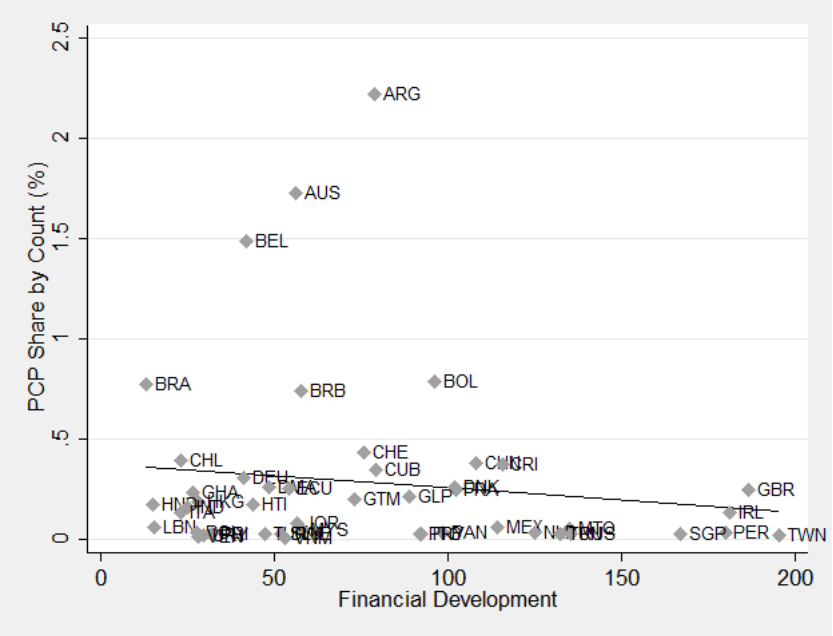


Figure 9: VCP and Financial Development

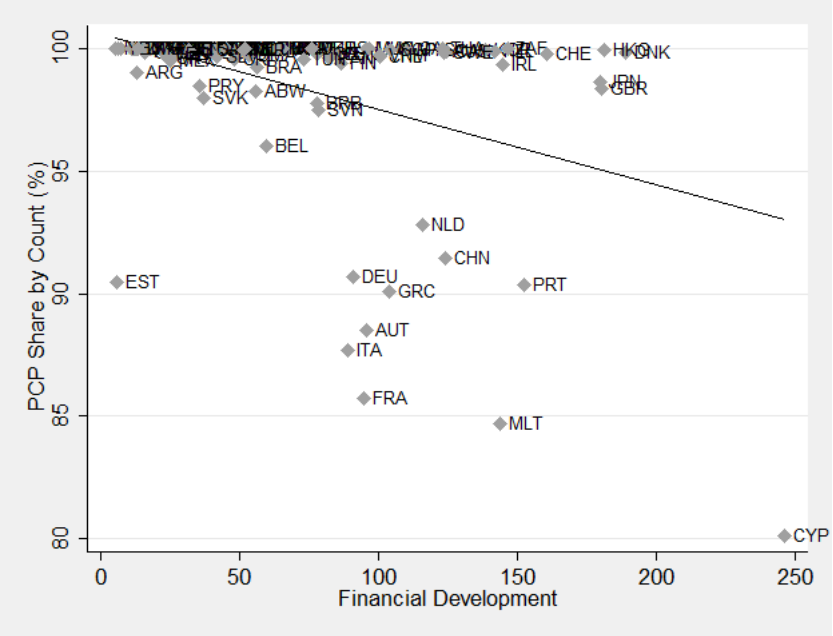


Figure 10: LCP and Inflation

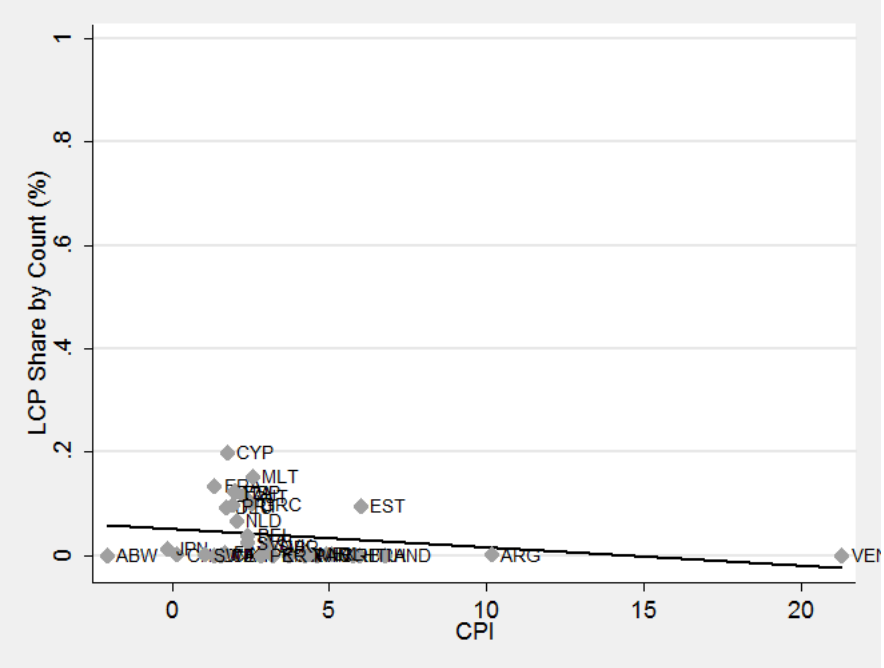


Figure 11: PCP and Inflation

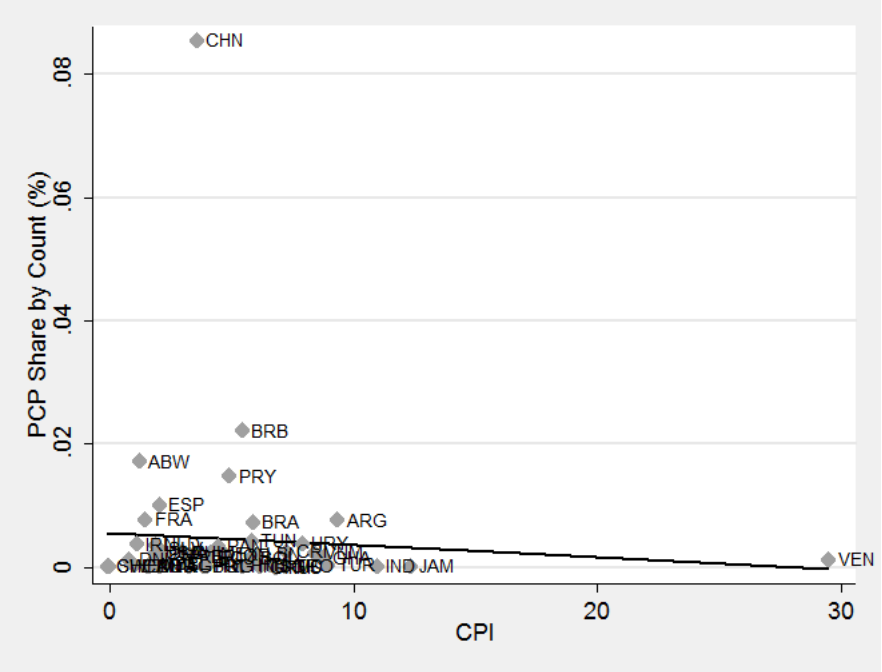


Figure 12: VCP and Inflation

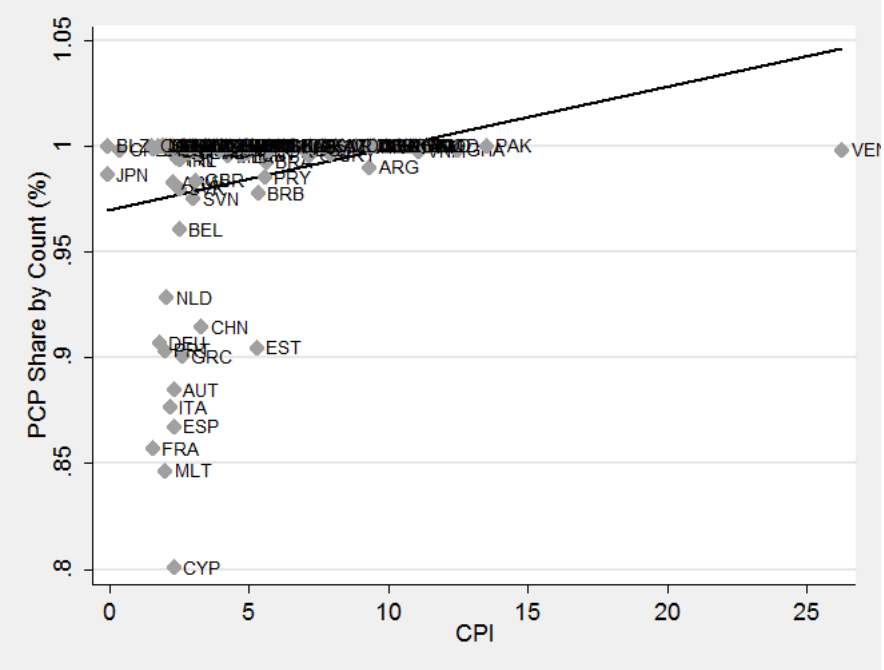


Figure 13: LCP and Exchange Rate Volatility

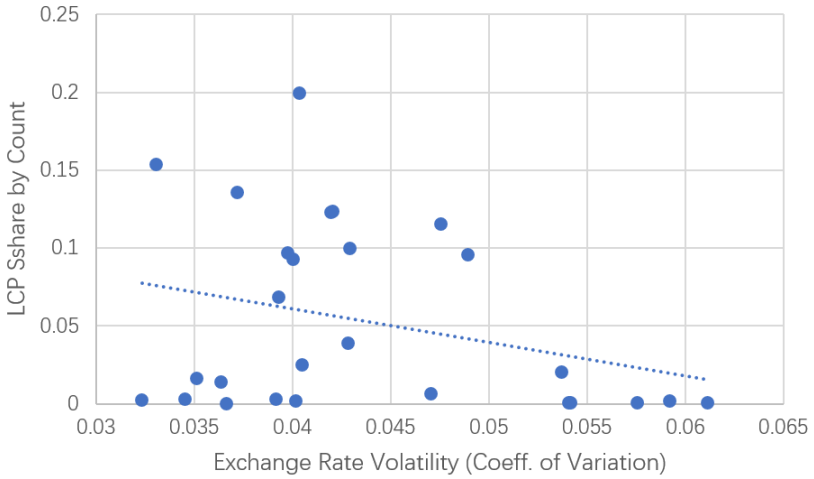


Figure 14: PCP and Exchange Rate Volatility

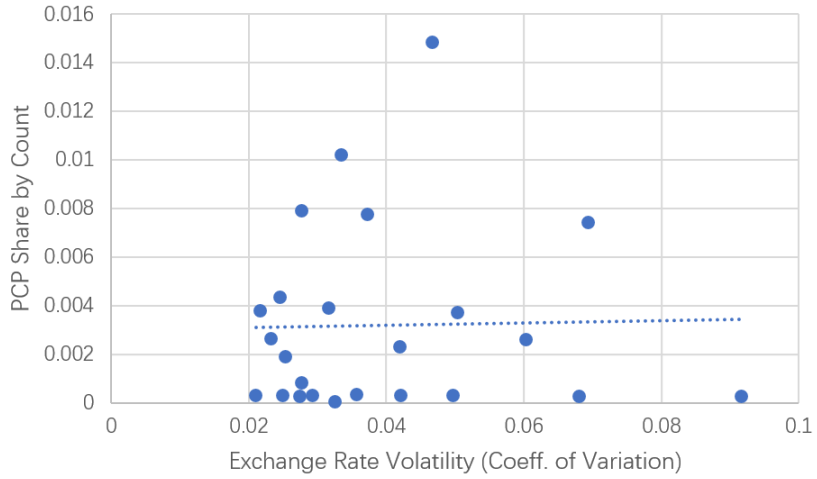
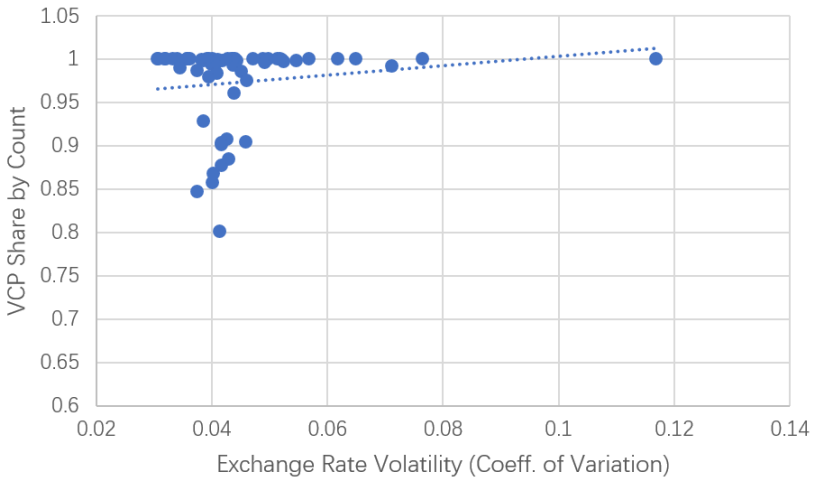


Figure 15: VCP and Exchange Rate Volatility



A Appendix

A.1 Monetary equilibrium of international trade

A.1.1 Two-country model

Given agent's optimal choice, money market should clear. Here we focus on monetary equilibrium allowing for international trade. $\forall i, j = \{1, 2\}, i \neq j$

$$\begin{cases} \sigma_i \phi_i m_i^i = \phi_i M_i & \text{if } \{s_i, s_j\} = \{0, 1\} \\ \sigma_i \phi_i m_i^i + (1 - 2\sigma_i)\phi_i z_{ij} + F_{ij} = \phi_i M_i & \text{if } \{s_i, s_j\} = \{0, 0\} \\ \sigma_j \phi_i m_i^j + (1 - 2\sigma_i)\phi_i z_{ii} + F_{ii} = \phi_i M_i & \text{if } \{s_i, s_j\} = \{1, 1\} \\ \sigma_i \phi_i m_i^i + \sigma_j \phi_i m_i^j + (1 - 2\sigma_i)\phi_i (z_{ii} + z_{ij}) + F_{ij} + F_{ii} = \phi_i M_i & \text{if } \{s_i, s_j\} = \{1, 0\} \end{cases} \tag{15}$$

With agent's optimal choice and money market clearing condition, now it's possible to define a stationary monetary equilibrium allowing the existence of international trade.

A stationary monetary equilibrium that allows for international trade is a list of time-invariant values including trade volume $\{q_j^i\}_{i,j=1}^2$*, banker's holding of real balance* $\{\phi_i z_i\}_{i=1}^2$*, and seller's currency choice* $\{s_i\}_{i=1}^2$ *such that, given other agent's behavior,*

1. *Seller's choice of* $\{s_i\}_{i=1}^2$ *solves 7 ;*

2. *Banker's choice of* $\{\phi_i z_i\}_{i=1}^2$ *solves 8;*

3. *Buyer's choice of* $\{q_j^i\}_{i,j=1}^2$ *solves 9 and 10 ;*

4. *Money market clears so that 15 holds.*

A.1.2 Three-country model

Since our main interest in three-country model is to explain the rise of IVC, here we consider a special case of hegemony in which all international trade is settled in country 1 currency. The following equilibrium condition is in order.

For seller

$$\pi_{ij}^1 = J_j^1 \phi_1 m_1^i - c(q_1^i) > 0, \quad \forall i, j \in \{1, 2, 3\}, i \neq j \tag{16}$$

Here $J_n^m \equiv (1 - \frac{F_{mn}}{(1-2\sigma_m)\phi_m z_{mn}})(1+R_m)^{-1}$ is the financial premium for country n seller to choose country m currency. The seller's equilibrium conditions state that international trade should be profitable for all exporters if they choose country 1 currency.

For banker

$$1 + R_1 = \frac{(n_{12}+n_{13})\phi_1 m_1^1 + (n_{21}+n_{23})\phi_1 m_1^2 + (n_{31}+n_{32})\phi_1 m_1^3}{(1-2\sigma_1)\phi_1 z_1} \tag{17}$$

Here $z_1 \equiv z_{11} + z_{12} + z_{13}$ is the total liquidity held by country 1 banker.

For buyer

$$\begin{cases} R_1 = (p_{11}+p_{12}+p_{13})L(q_1^1) = (p_{21}+p_{23})L(q_1^2) = (p_{31}+p_{32})L(q_1^3) \\ R_2 = p_{22}L(q_2^2) \\ R_3 = p_{33}L(q_3^3) \end{cases} \tag{18}$$

Money market

$$\begin{cases} \phi_1(\sigma_1 m_1^1 + \sigma_2 m_1^2 + \sigma_3 m_1^3) + (1-2\sigma_1)\phi_1 z_1 + F_{11} + F_{12} + F_{13} = \phi_1 M_1 \\ \sigma_2 \phi_2 m_2^2 = \phi_2 M_2 \\ \sigma_3 \phi_3 m_3^3 = \phi_3 M_3 \end{cases} \tag{19}$$

Similar to the two-country model above, the definition of monetary equilibrium condition is the following.

A stationary monetary equilibrium in three-country model with country 1 currency as the single IVC is a list of time-invariant values including trade volume $\{q_j^i\}_{i,j=1}^3$, *banker's holding of real balance* $\{\phi_i z_i\}_{i=1}^3$, *and all exporter's choosing country 1 currency such that, given other agent's behavior,*

1. *Seller's profit level satisfies 16*

2. *Banker's choice of* $\{\phi_i z_i\}_{i=1}^2$ *solves 17*

3. *Buyer's choice of* $\{q_j^i\}_{i,j=1}^2$ *solves 18*

4. *Money market clears so that 19 holds.*

The incumbency advantage applies here: as long as individual sellers enjoy positive profit from international trade, they have no incentive to deviate from the existing equilibrium of single international currency.

A.2 Proof of Proposition 2

A.2.1 Inflation and Currency Depreciation

Proposition 2.1 High inflation and currency depreciation would lower the international use of currency.

Notice that inflation level is tightly linked with nominal exchange rate in search model. If Law of One Price (LOP) holds for numéraire good, the determinant equation for exchange rate is

$$e_t = \phi_{j,t}/\phi_{i,t} = \frac{1+\mu_{i,t}}{1+\mu_{j,t}}$$

where e_t is the nominal exchange rate of currency i against currency j at time t, and the last equation holds if two countries had identical money growth rate in the last period. Obviously, a high level of inflation caused by rapid growth rate of money supply would also lead to currency depreciation.

From the FOC of buyer, high inflation and currency depreciation reduces his holding of real balance. Recall that, for country i buyer's holding of home currency, his FOC is the following.

$$R_i = (p_{ii} + (1-s_j)p_{ij})\frac{\theta(u'-c'/\beta)}{(1-\theta)u' + \theta c'/\beta}$$

Given that buyer's liquidity premium is decreasing in trade volume, an increase of nominal interest rate from high inflation would increase the marginal cost of using money, thus lowering buyer's holding of real balance.

On the part of bankers, if country i exporters choose home currency, the FOC for country i banker is the following.

$$1 + R_i = \frac{n_{ji}\phi_i m_i^j}{(1-2\sigma_i)\phi_i z_{ii}}$$

Higher level of nominal interest rate would therefore decrease the currency holding by both buyer and banker in this case.

On the part of sellers, the profit function for country i exporters to choose home currency is the following.

$$\pi_i = \left(1 - \frac{F_{ii}}{(1-2\sigma_i)\phi_i z_{ii}}\right)\left(\frac{1}{1+R_i}\right)\phi_i m_i^j - c(q_i^j)$$

High inflation would directly reduce exporter's profit through discount factor. It also has the indirect effect in lowering the currency holding by both buyer and banker, further decreasing exporter's incentive to choose this currency. In sum, high inflation and currency depreciation would lower the international use of currency.

A.2.2 Monetary Policy Volatility

Proposition 2.2 If the gross nominal interest rate follows a log-normal distribution, the increase of monetary policy uncertainty would lower the international use of currency.

Proof
We introduce the uncertainty of monetary policy by assuming the gross nominal interest rate follows a log-normal distribution, i.e., $\ln(1+R_{i,t}) \sim \mathcal{N}(x_i, \sigma_i^2)$, where $i \in \{1,2\}$ stands for the issuing country of currency and t indicates period. If we further assume the law of one price holds for numéraire good and monetary policy in two countries is identical in the last period, the nominal exchange rate would then follow a log-normal distribution.

$$e_t \equiv \frac{\phi_{2,t}}{\phi_{1,t}} = \frac{1+\mu_{1,t}}{1+\mu_{2,t}} = \frac{1+R_{1,t}}{1+R_{2,t}} \Rightarrow \ln e_t = \ln(1+R_{1,t}) - \ln(1+R_{2,t}) \Rightarrow$$

$$\ln e_t \sim \mathcal{N}(x_1 - x_2, \sigma_1^2 + \sigma_2^2)$$

The impact of uncertainty on buyer could be derived from his first order condition on currency holding. First consider country i buyer's optimal holding of home currency.

$$E(R_{i,t}) = (p_{ii} + (1-s_j)p_{ij})\frac{\theta(u' - c'/\beta)}{(1-\theta)u' + \theta c'/\beta}, \quad i,j \in \{1,2\}, \quad i \neq j$$

Given the log-normal distribution of gross nominal interest rate, buyer's expectation would be related with volatility, i.e., $\mathbb{E}(R_{i,t}) = \exp(x_i + \sigma_i^2/2) - 1$. Therefore, a rise of monetary policy volatility would also increase buyer's expectation of nominal interest rate, which is also his cost of holding money. After some transformation, we rewrite the FOC as

$$A\left[\exp(x_i + \sigma_i^2/2) - 1\right] = G(q) \equiv \frac{u' - c'/\beta}{(1-\theta)u' + \theta c'/\beta} \tag{20}$$

where $A \equiv [(p_{ii} + (1-s_j)p_{ij})\theta]^{-1}$. The volatility of monetary policy would decrease trade volume and buyer's currency holding as long as $G(q)$ is a decreasing function, i.e. $G'(q) < 0$. Given the assumption on function form such that $u' > 0, c' > 0, u'' < 0, c'' > 0$, it's easy to show that

$$G'(q) = \frac{1}{\beta}\left[(1-\theta)u' + \theta c'/\beta\right]^{-2}(u''c' - u'c'') < 0 \tag{21}$$

The procedure and result are similar for country i buyer's holding of foreign currency.

For bankers, his optimal currency holding is linked with buyer's decision through FOC. For example, in the case of PCP, banker's optimal choice is given by the following condition.

$$\mathbb{E}(1+R_{i,t}) = \frac{n_{ji}\phi_i m_i^j}{(1-2\sigma_i)\phi_i z_{ii}} \Rightarrow \exp(x_i+\sigma_i^2/2) = \frac{n_{ji}\phi_i m_i^j}{(1-2\sigma_i)\phi_i z_{ii}}$$

If both buyers and bankers perceived a higher level of monetary policy uncertainty, LHS of the above equation would increase. Given the results on buyer's optimal choice, his currency holding would decrease corresponding to the rising uncertainty. Consequently, banker's currency holding would decrease by a larger degree. Therefore, banker's response to volatility is in the same direction as buyer's.

Lastly, seller's profit from international trade is given by

$$\pi_i \equiv \underbrace{\left[1-\frac{F_{ii}}{(1-2\sigma_i)\phi_i z_{ii}}\right]}_{\text{financial development}} \underbrace{\left(\frac{1}{1+R_i}\right)}_{\text{discount}} \underbrace{\phi_i m_i^j - c(q_i^j)}_{\text{gain from trade}}$$

The drop of other agent's currency holding would lower exporter's profit ($\frac{\partial \pi_i}{\partial \phi_i z_{ii}} > 0$, $\frac{\partial \pi_i}{\partial \phi_i m_i^j} > 0$), thus reducing his incentive to use this currency. In sum, under general assumptions on function form, the increase of monetary policy uncertainty, such as inflation fluctuation and exchange rate volatility, would reduce the international use of a currency.

A.3 Proof of Proposition 3

Here we prove the relationship between exporter's bargaining power and his currency choice. As shown previously, exporter's profit function is the following if trade is settled by his home currency.

$$\pi = \left[1-\frac{F}{(1-2\sigma)\phi z}\right]\left(\frac{1}{1+R}\right)\phi m - c(q)$$

In contrast, if exporter settles international trade with foreign currency, he would suffer additional loss τ from cross-border transaction, which is assumed to be an increasing function of the real payment amount, i.e. $\tau = \tau(\phi m)$, $\frac{\partial \tau}{\partial(\phi m)} > 0$. His profit therefore becomes

$$\pi^* = \left(1-\tau(\phi^* m^*)\right)\left[1-\frac{F^*}{(1-2\sigma)\phi^* z^*}\right]\left(\frac{1}{1+R^*}\right)\phi^* m^* - c(q^*)$$

where superscript of asterisk denotes foreign variable. Here we focus on partial equilibrium analysis, so that production level q and variables in financial market such as

F, ϕz, and R are fixed from the perspective of exporter. This means exporter's bargaining power would affect real payment amount (ϕm) directly through bargaining and cross-border transaction cost ($\tau(\phi m)$) indirectly.

Proposition 3.1 *In partial equilibrium, exporters with higher bargaining power prefer to use home currency if transaction cost is elastic in real payment amount, i.e.* $\frac{\partial(1-\tau)}{\partial(\phi m)}\frac{\phi m}{1-\tau} < -1$.

Proof Recall the following equation from the proportional bargaining game between exporter and importer

$$\phi m - c(q)/\beta = (1-\theta)\big[u(q) - c(q)/\beta\big]$$

Keep q fixed and take differentiation with respect to exporter's bargaining power $(1-\theta)$.

$$\frac{\partial(\phi m)}{\partial(1-\theta)}\Big|_{q=\bar{q}} = u(q) - c(q)/\beta > 0 \tag{22}$$

This intuitive result means importer's real payment is increasing in exporter's bargaining power. Given that trade settled with home currency doesn't have transaction cost, so we have in a partial equilibrium

$$\frac{\partial \pi}{\partial(1-\theta)}\Big|_{q=\bar{q}} = \left[1 - \frac{F}{(1-2\sigma)\phi z}\right]\left(\frac{1}{1+R}\right)\frac{\partial(\phi m)}{\partial(1-\theta)} > 0 \tag{23}$$

with the obvious interpretation that exporters with high bargaining power would gain more profit if the trade is settled by home currency. For trade settled with foreign currency, however, transaction cost would make the analysis complicated. Again take differentiation of exporter's profit with respect to his bargaining power

$$\frac{\partial \pi^*}{\partial(1-\theta)}\Big|_{q=\bar{q}} = \Big(1-\tau\Big)\left[1-\frac{F^*}{(1-2\sigma)\phi^* z^*}\right]\left(\frac{1}{1+R^*}\right)\left[\frac{\partial(\phi^* m^*)}{\partial(1-\theta)}\right]\left[1+\frac{\partial(1-\tau)}{\partial(\phi^* m^*)}\frac{\phi^* m^*}{1-\tau}\right] \tag{24}$$

Given that $\frac{\partial(\phi^* m^*)}{\partial(1-\theta)} > 0$ in partial equilibrium, exporters with high bargaining power might experience profit decrease if transaction cost is elastic in real payment amount, i.e.

$$\left[1 + \frac{\partial(1-\tau)}{\partial(\phi^* m^*)}\frac{\phi^* m^*}{1-\tau}\right] < 0 \Rightarrow \frac{\partial(1-\tau)}{\partial(\phi^* m^*)}\frac{\phi^* m^*}{1-\tau} < -1 \Rightarrow \frac{\partial \pi^*}{\partial(1-\theta)}\Big|_{q=\bar{q}} < 0 \tag{25}$$

In summary, for exporters with high bargaining power, they always enjoy better profit if trade is settled by home currency, but they might experience profit loss if trade is

settled by foreign currency and transaction cost is elastic in real payment amount, and this would lead to exporters more likely to choose home currency.

A.4 Complementary material

Table 18 shows the time series of different currency choice. Before the financial crisis, 63.1 % of the transactions are invoiced in vehicle currency (mainly are US dollars). After the financial crisis, the share of VCP declined and then bump up after 2010. Although PCP is small in proportion, it is increasing in the sample years.

Table 19 reveal the currency denomination of exports for all industries. We also

Table 18: Currency of invoicing in Colombia exports (percent %)

	VCP	PCP	LCP
2007	63.127	0.008	36.865
2008	60.969	0.319	38.713
2009	58.803	0.309	40.888
2010	56.073	0.362	43.565
2011	60.491	0.449	39.060
2012	62.447	0.503	37.050
2013	67.128	0.610	32.262

observe a significant variation in invoicing currency across industries. The use of LCP is very low in Machinery industry and relatively hight in food industry.

Table 19: Currency of invoicing by industry (percent %)

SITC	VCP	PCP	LCP
0: Food and live animals	46.628	0.756	52.616
1: Beverages and tobacco	97.004	0.000	2.996
2: Crude materials	66.829	0.002	33.169
3: Mineral fuels	96.893	0.578	2.529
4: Animals and veg.oils	84.470	0.025	15.505
5: Chemicals	91.178	0.016	8.807
6: Manufactured goods	67.431	0.032	32.537
7: Machinery	100.000	0.000	0.000
8: Miscellaneous	80.845	0.107	19.048
9: Unclassified	90.917	0.097	8.986