Trade, Finance and International Currency*

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Abstract

Currency choices in international trade are related to the depth of financial market, especially in the provision of trade finance. This paper examines how this financial channel affects currency internationalization and its macroeconomic implications. First we use a novel dataset from SWIFT to document some empirical patterns of international currency, suggesting the importance of financial market development and identifying the distinct channel of trade finance. Then we build a two-country monetary search model featuring time-to-ship friction: goods are delivered one period after contract, and the lack of commitment between exporters and importers makes them rely on bank-intermediated trade finance. The currency choice is endogenized and related to the terms of trade, inflation level and financial efficiency. We further employ this model to discuss several related topics. The trade finance channel propagates and amplifies monetary policy effect and influences the status of international currency. It also shows that global imbalance is partially attributed to US dollar as the single dominant international currency. Numerical examples illustrate these results.

JEL Classification: E40, E50, F33, F41
Keywords: trade finance, financial development, monetary search, international currency.

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1 Introduction

Currency internationalization and its implications are one of the central issues in open-economy macroeconomics. Conventional wisdom holds that the emergence of international currency depends on the issuing country's economy size and openness, but historical experience shows the importance of financial factors. US surpassed UK in GDP around the 1870s and dominated international trade in the early 20th century, but the international role of US dollar (USD) was essentially zero, whereas British pound still invoiced over 60% of global trade until 1914 (Broz, 1997; Matsuyama et al., 1993). Eichengreen (2011) shows that the delayed internationalization of USD was largely due to its underdeveloped financial market. Another recent example is Chinese Yuan (CNY or RMB), which remains national largely because of its backward financial market, although China has already become the second largest economy and led in international trade. This again shows that financial factors are indispensable for currency internationalization.

In this paper we study trade finance as a distinct channel for financial factors to affect currency usage in international trade. According to Asmundson et al. (2011) and ICC Banking Commission (2016), more than 40% of global trade was directly supported by bank-intermediated trade finance, with much higher share for developing countries. Although the influence of trade finance on many dimensions of international trade has been well examined,[1] little is known so far on how it is related to the currency acceptance decision. What are the exact mechanisms allowing trade finance to influence one currency's international status? What is the role of financial factors in shaping the landscape of international monetary system? What are the positive and normative implications of international currency when we consider the interaction between trade and finance? Academic research on these questions provided many important insights,[2] but the formal analysis is yet illusive.[3] Our paper aims to bridge this gap by developing a general equilibrium framework to study the linkage among trade, finance and international currency.

To that end, we first employ a novel and comprehensive dataset from SWIFT (Society for Worldwide Interbank Financial Telecommunication) to document some empirical patterns of the currency choice in international trade. With private credit to GDP as a main measure of domestic financial market development, we find financial factors are statistically and economically significant in promoting the international use of a currency, especially when the degree of trade finance dependence is high. Moreover, the effect of financial factors on currency choices is on par with or greater than the impact of other well-known determinants such as inflation and exchange rate volatility. These empirical patterns suggest both the importance of financial market and the relevance of trade finance channel in determining the status of international currency.

[1] For example, Amiti and Weinstein (2011); Niepmann and Schmidt-Eisenlohr (2017).

[2] See McKinnon (1979), Krugman (1980), Rey (2001), Chinn and Ito (2006), Eichengreen (2011), Frankel (2012) and Gopinath (2015).

[3] 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."

Then we build a two-country model with endogenous currency choices, following the recent advance in monetary economics such as Matsuyama et al. (1993), Lagos and Wright (2005), Lester et al. (2012) and Zhang (2014). Our model features two key assumptions that could better capture the realities in international trade and finance: (i) International trade usually takes longer time than domestic trade (Ahn et al., 2011; Manova, 2012; Manova et al., 2015), so we assume goods are delivered one period after contract. The timing mismatch between payment and shipment, together with the lack of commitment among agents, calls for financial intermediary (banks) to help facilitate international trade. (ii) Operating with a certain currency requires a fixed total cost, reflecting the issuing country's financial development. This assumption is similar to the transaction cost in Rey (2001) and Devereux and Shi (2013). Exporters receive liquidity from banks at discount, so they choose currency to maximize their profit, which is related to the financial factor of a country's financial development, the macroeconomic factor of inflation level and the microeconomic factor of terms of trade. Consequently, a currency is never used in international trade if the issuing country does not have a liquid and efficient financial market.

Through the lens of search-theoretic framework, we revisit several classic topics in this field. First of all, we show that the effect of monetary policy on international trade is closely related with the specific currency regime. It is not always feasible to "beggar thy neighbor" and boost net export through nominal depreciation of home currency. Secondly, our model suggests the incumbency advantage of international currency is not as strong as once thought, which echoes the empirical findings in Eichengreen and Flandreau (2012). Conventional wisdom holds that once a currency becomes international, it shall keep the status for a long time. However, the trade finance channel propagates and amplifies monetary policy effect, so that an inflationary monetary policy hugely deteriorates the exporter's net profit and endangers the status of international currency, potentially leading to a rapid transformation of international monetary system.

Thirdly, the welfare analysis delivers an interesting result on size effect. Our model agrees with the previous literature that a large economy is in a better position to issue the international currency, but not due to a lower transaction cost. We find the relationship between the optimal inflation level and the issuing country's economy size is hump-shaped: for a relatively large or small economy, the seigniorage revenue is dwarfed by the gains from either domestic or international trade, so a lower level of inflation is a better choice. Therefore, a large economy has incentive to conduct a less inflationary monetary policy and improve the world welfare, making it an ideal issuer of international currency. This result extends the findings in Devereux and Shi (2013) where the optimal inflation level is monotone and increasing in the issuing country's economy size.

Lastly, the searching friction in our model provides an intuitive explanation for global imbalance characterized by the persistent current account deficit of US.[4] For a symmetric model in which country 1 issues the only international currency, country 1 residents would face less searching friction when holding country 1 currency, which is used for both domestic and international trade. So they tend to hold more home currency. By contrast, country 2

[4]See Bernanke (2005), Feldstein (2008) and Obstfeld and Rogoff (2009) for more discussion.

residents hold less of country 1 currency because it is accepted for only international trade, implying a higher level of searching friction. As a result, the over-consumption tendency of country 1 leads to its trade deficit. This model therefore implies that global imbalance is partially attributed to the status of USD as the single dominant international currency. This new perspective complements the discussion in Caballero et al. (2008) on US dollar's international role as a safety asset and they attribute the global imbalance to the ability of US to produce safe stores of value around the world.

We need to make two clarifications before proceeding to further discussion. First is the definition of *international currency*. A currency becomes international when used by foreigners in locations outside of the issuing country. As store of value, it could be central bank's international reserves or private agent's investment instrument. As medium of exchange, it could smooth government's foreign exchange (FX) intervention or settle international trade. As unit of account, it becomes the anchor of other currencies or denominates financial transaction. This paper will focus on the international currency used by private sector as the medium of exchange.[5] For the government usage of international currency, see Frankel (2012) and Zhang (2014). Another necessary clarification is the name for different currency usage patterns. Here we follow the convention in international macroeconomics with the terminology of Producer Currency Pricing (PCP), Local Currency Pricing (LCP), and Vehicle Currency Pricing (VCP, which is also called as International Vehicle Currency, IVC). If the international trade is settled by the home currency of exporters (importers), it's defined as PCP (LCP). Otherwise, if a third-country currency is used to settle international trade, it's defined as VCP.[6]

The rest of this paper is organized as follows. Section 2 reviews the related literature. Section 3 presents an empirical analysis of international currency with SWIFT dataset. Section 4 describes model environment and defines monetary equilibrium. Section 5 shows the essential role of financial intermediation. Monetary policy and its effects on currency choices are characterized in section 6. In section 7 we discuss the related topics such as incumbency advantage, size effect and global imbalance. Section 8 concludes.

2 Related literature

The rise and fall of international currencies are largely due to the decentralized decision by private agents, but most open-economy macroeconomic models, such as Obstfeld and Rogoff (1995), restrict this choice to PCP. Such assumption might be useful for many other

[5] In practice, there are subtle differences among pricing, invoicing, and settlement currency, although theoretical model usually takes them as equivalent. Pricing or invoicing currency might be considered as unit of account, while settlement currency is naturally classified as medium of exchange. Friberg and Wilander (2008) conducted a questionnaire study on the currency choice of Swedish exporter in 2006, and most firms reported to use the same currency in over 90% of their revenue. Of course, the discrepancy could be large, especially for developing countries. Reiss (2015) found that, for Brazil real, its use as invoicing currency is more than settlement currency, whereas Yu (2013) suggested that RMB was used more as settlement currency than invoicing currency.

[6] In this paper, we use settlement currency and pricing currency interchangeably.

issues, but is less than satisfactory for understanding the conditions under which one currency becomes more internationally accepted than another. Many theoretical frameworks with alternative assumption are therefore proposed, including trade models, sticky price models and search models.

Trade models try to explain the emergence of IVC with N-country model. Krugman (1980) studied the international currency in a partial equilibrium model mainly focusing on payment flows and currency market. Rey (2001) examined the trade and currency exchange in a general equilibrium model, and FX transaction is undertaken by financial intermediary with an increasing-return-to-scale technology. Under the assumption of cash in advance and PCP, agent's currency choice is exogenously given. The existence of a general equilibrium with IVC is crucially dependent on economic openness. Therefore, the currency issued by a large country intensively engaged in international trade would emerge as IVC. This thick market externality also makes the status of international currency a natural monopoly. More recently, Devereux and Shi (2013) provided a theory of IVC as well as an in-depth discussion on its welfare implication for both the central and peripheral countries. Unlike the literature above, our micro-founded model allows agents to make currency choices. Moreover, we are mainly interested in the domestic financial markets such as bond market rather than FX market.

Sticky price models endogenize currency choice by allowing exporters to set price one period before exchange rate shock is realized. For PCP, there's uncertainty in foreign demand and production cost, while LCP makes future price unpredictable. So exporters choose invoicing currency mainly to mitigate exchange rate risk. Bacchetta and Van Wincoop (2005) showed that exporter's currency choice is affected by competition in foreign markets: a higher level of exporter's market share and product differentiation tends to promote PCP. Goldberg and Tille (2008, 2013) continued this approach and incorporated vehicle currency. Their determinants of invoicing currency include exporter's motive to limit output volatility, hedge macroeconomic risk, and reduce transaction cost. For all their success, sticky price models are not explicit about the underlying process of currency circulation, and their nature of partial equilibrium also limits welfare analysis.

Search theory is interested in the rise of fiat money as medium of exchange. Earlier studies suffered from the indivisibility of output and money (Matsuyama et al., 1993) or inability to reach equilibrium (Trejos and Wright, 1996). With the breakthrough in Shi (1997) and Lagos and Wright (2005), search theory is now widely applied to topics in international macroeconomics such as currency area and monetary coorperation (Liu and Shi, 2010), home bias puzzle (Geromichalos and Simonovska, 2014), Uncovered Interest Parity (UIP) puzzle (Jung and Lee, 2015), over-the-counter FX market (Geromichalos and Jung, 2017) and international reserve (Jung and Pyun, 2016).[7] This paper mainly benefits from the historical experience of international currency in Eichengreen (2011) and incorporates

[7]This class of model has a large concern on asset, usually supplied in the manner of Lucas tree. The asset plays as both store of value in its claim to future output, and medium of exchange in acting as collateral to facilitate trade. Our model is focused on fiat money as medium of exchange so asset pricing only has minor effect on equilibrium condition. Moreover, buyer is assumed to get goods one period after contract, so he would never give asset to seller as payment without further guarantee.

trade finance into the two-country monetary search model recently developed by Lester et al. (2012) and Zhang (2014). Our contribution to this literature is threefold. (i) We focus on the financial factors that affect currency choices rather than the information cost in Lester et al. (2012) and Zhang (2014). (ii) We provide more systematic empirical evidence to support the importance of this financial channel. (iii) We draw rich implications from the model regarding incumbency advantage, size effect, global imbalance and other related topics.

3 Trade finance and empirical patterns

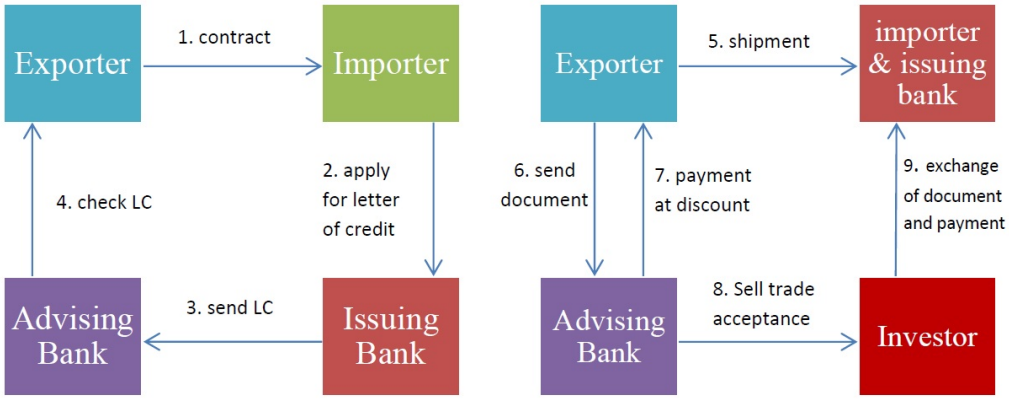
In this section, we briefly introduce the practice of trade finance, especially the letter of credit (LC), which is an important channel for financial factors to exert influence on international currency usage. Then we describe the novel dataset from SWIFT that could identify the bilateral countries' currency usage in international trade. Our paper is among the first few to discuss the currency choice with this comprehensive dataset. After presenting some summary statistics, we conduct a systematic evaluation on the bilateral countries' currency choices. The panel regression of bilateral currency usage for 105 countries from 2011 to 2013 shows the importance of financial factors in shaping the international currency usage. Our identification strategies show that financial factor plays an important role in currency choices among countries, especially for the trade more reliant on bank-intermediated trade finance. Finally, we show that the empirical pattern is quite robust in different specifications and subsamples.

3.1 International trade finance

The timing mismatch between payment and shipment is always a big issue for international trade. Without mutual trust or history records, the direct trade between exporters and importers is almost impossible: importers don't know whether they could get goods after payment, and exporters are not guaranteed payment after shipment. According to the order of timing, trade finance could be classified into *Cash-in-advance* (payment before shipment), *Open account* (payment after shipment), and *Bank-intermediated trade finance*. If importer and exporter trust each other, cash-in-advance or open account would be a better choice owing to their relatively lower transaction cost. If exporter doesn't trust importer but believes in the credit of importer's bank, bank-intermediated finance could help facilitate international trade. Auboin (2009) reports that up to 90% of world trade employ some form of trade finance.[8] The mainstream instrument covering half of trade finance is LC. Figure 1 illustrates its mechanism, and detailed procedures are relegated to appendix

[8] Committee on the Global Financial System (2014) estimated that bank credit directly supports about one third of global trade.

Figure 1: Mechanism of LC



Source: adapted from Niepmann and Schmidt-Eisenlohr (2014)

A.1.[9]

The timing mismatch between shipment and payment is easily solved by LC: the exporter gets timely funding once he shows shipment document and the importer is charged only after the delivery of goods. Holding LC is not attractive for banks given its average maturity of 2-3 months, but investors would be interested in this safe short-term asset, whose payment is guaranteed by bank credit. So banks would package LC as trade acceptance and sell it to investors. In the end, banks facilitate international trade by playing the role of intermediation among exporters, importers, and investors. The structure of trade finance will be useful in the theoretic framework we develop later.

Here we need to clarify the difference between trade finance used in this paper and trade credit in the broader literature. Although these two terms are sometimes used as equivalent, previous studies such as Amiti and Weinstein (2011) have pointed out their distinction. Trade credit is an accounting concept, referring to the account receivable generated from international or domestic orders of goods or services. On the other hand, trade finance is a finance concept, concerned with all methods to finance trade credit, such as working capital

[9]Recently there's a rising literature on trade finance theory, such as Ahn (2015) and Schmidt-Eisenlohr (2013). Their main concern is the contract choice on trade finance, i.e. the optimal choice among cash-in-advance, bank's trade finance, and open account. Firm's choice mostly depends on default probability and the difference in financing cost. Ahn (2015) pointed out that most of Colombia import is conducted in open account, but such observation is not in conflict with our paper: in bank's trade finance, exporter's profit depends on the financial development in trade acceptance market; in open account, exporters use account receivables as collateral to get loan from bank, so their profit also depends on the financial development of banking system, although an alternative measure should be considered, such as total factoring share.

loans and bank-intermediated finance.[10]

3.2 SWIFT Dataset and summary statistics

With improved data availability in recent years, the cross-country analysis of currency choice becomes feasible, and the relevant empirical research includes Kamps (2006), Goldberg and Tille (2008), Ito and Chinn (2013), Gopinath (2015) and He et al. (2016).[11] These works collect the data of trade invoicing currency mainly from the surveys by central banks, government agencies and statistical institutes. The importance of market share, product differentiation, and financial development is generally verified in the panel regression. For all its success, this dataset has several limitations. Firstly, there is measurement inconsistency across countries: central banks have different criteria for survey and data collection, leading to a potential estimation bias. Secondly, the sample size is quite small so far, covering only 35 countries and territories. Last but not the least, this dataset has only the aggregate currency choice of each country in international trade, where USD has an extremely large and persistent share of over 80%, difficult to be explained by standard macroeconomic variables.

To overcome these drawbacks, we use a novel and comprehensive dataset from SWIFT to provide an innovative insight on the determinants of currency choice. It involves over 200 countries and territories with detailed information on trade settlement currency.[12] The dataset comes at monthly frequency from October 2010 to August 2014, and each entry of information has country name, counterparty country name, message type, settlement currency, number and value for message sent and received. For confidentiality purpose, transaction value is recorded as 0 if the monthly bilateral transaction number is less than or equal to 4. Before the formal econometric analysis, we conduct the following data cleaning process.

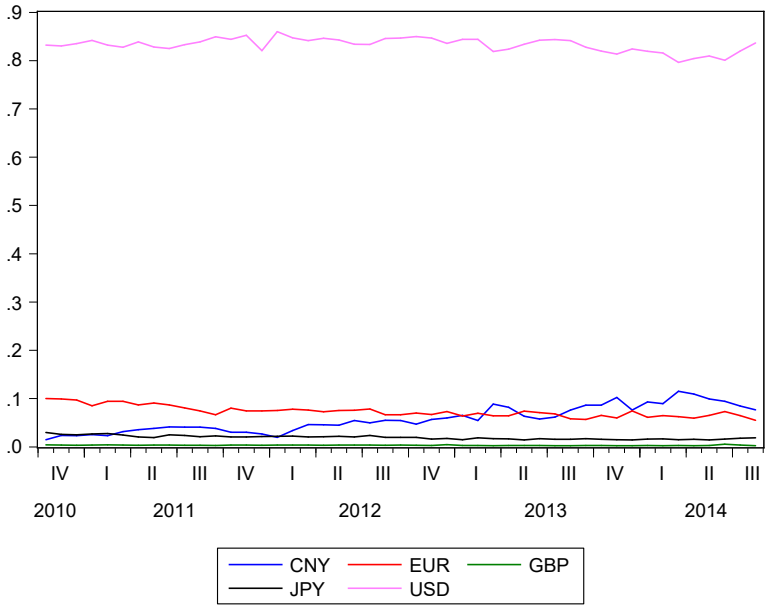
- Keep only the cross-border transaction, since we focus on international trade. Following the conventional practice, we treat the intra-Euro trade as domestic and the transaction among mainland China, Hong Kong, Macao, and Taiwan as cross-border.
- Keep the value of message sent and received to calculate the value share of each currency in bilateral trade. The number share is left for robustness test.

[10] To quote from Amiti and Weinstein (2011), "...Although trade credit and trade finance are sometimes used interchangeably, the terms can be confusing because trade credit has a clear definition in accounting and a looser one in finance. In particular, whenever a firm receives an order for goods or services that will be paid later, it records a trade credit on the accounts receivable section of its balance sheet. This is true regardless of whether the purchaser is foreign or domestic, so firms with a lot of trade credit on their books may not do any international trade. In finance, trade credit is also sometimes used to refer to working-capital loans used to finance international trade credits on the balance sheets of exporters. To avoid confusing these two senses of trade credit, we always refer to trade credit in the accounting sense and refer to export working-capital loans and other means of financing these trade credits as trade finance."

[11] Another new trend of empirical work on currency choices use the firm-level or transaction-level data, such as Chung (2016) and Goldberg and Tille (2016).

[12] As discussed above, empirical literature such as Friberg and Wilander (2008) shows that trade invoicing currency is the same as settlement currency most of the time, so our result is comparable to the previous studies.

Figure 2: Currency use in trade finance, value share



- Keep the message type related with trade finance, including MT 400 (*Advice of Payment*) and MT 700 (*Issue of a Documentary Credit*).

Next we report some summary statistics. Figure 2 shows the value share of several international currencies in trade finance. The dominant position of USD is obvious and persistent, making up over 80% of total currency use throughout sample period. In contrast, the share of EUR is at a much smaller level of less than 10%, although it's also quite stable over time. Perhaps the most notable feature in figure 2 is the rise of China, with CNY increasing from almost zero to around 10% in 2014.[13] The other international currencies such as JPY and GBP play a minor role in international trade.

In table 1, we further the currency choice by major countries and regions. For United States, it is able to use home currency in over 98% of its export and import. With the exception of Germany, most countries rely on USD as vehicle currency to settle their international trade. The case of China is quite special. It relies on USD as VCP to a large degree, but makes some progress in RMB internationalization, with 23.22% of Chinese import settled

[13]Interpreting the rapid increase of CNY in trade finance requires some caution. For one thing, part of this might result from the drastic nominal appreciation of CNY during sample period, keeping in mind that we plot value share in figure. In addition, it's also possible that the arbitrage between onshore and offshore RMB market leads to the wide use of CNY.

Table 1: Currency use in trade finance, country and region

	Export			Import		
	PCP	LCP	VCP	PCP	LCP	VCP
US	**98.89%**	2.64%	0.37%	1.49%	**98.43%**	0.08%
UK	2.59%	5.21%	92.20%	7.61%	7.41%	84.98%
Germany	**47.51%**	5.26%	47.23%	2.74%	**25.18%**	72.08%
France	32.34%	2.09%	65.57%	3.91%	8.10%	88.00%
Japan	33.71%	6.43%	59.87%	9.70%	8.93%	81.37%
Canada	4.25%	8.95%	86.79%	16.19%	20.05%	63.76%
Australia	1.14%	9.35%	89.51%	8.12%	12.91%	78.97%
China	0.69%	7.10%	92.22%	10.81%	**23.22%**	65.97%
OPEC	6.35%	9.43%	84.23%	25.27%	0.67%	74.06%
OECD without US	17.67%	7.26%	75.07%	10.20%	6.20%	83.60%
Eurozone	37.90%	4.03%	58.07%	3.91%	14.37%	81.71%
World	11.98%	13.37%	74.65%	13.37%	11.98%	74.65%

Notes: Statistics calculated from sample average between 2010 October and 2014 August, using MT 400 and MT 700 message type in SWIFT dataset. PCP for producer currency pricing; LCP for local currency pricing; VCP for vehicle currency pricing, mainly USD in this dataset. Intra Euro-zone trade excluded. Transaction among mainland China, Hong Kong, Macao, and Taiwan regarded as cross-border.

in CNY, but not so much for export, where only 0.69% is done in CNY.[14]

3.3 Baseline Empirical Results

Now we employ SWIFT dataset to conduct econometric analysis and investigate the determinants of currency choice in international trade. Our empirical specification is the following.

$$s_{ijk}^t = \beta_1 X_{ij}^t + \beta_2 \text{FD}_{ij}^t + \epsilon_{ij}^t$$

where subscript i stands for export country, j for import country, k for settlement currency, and superscript t for period. The dependent variable s_{ijk}^t is the share of international trade between country i and j settled in currency k. If k happens to be the home currency of country i (j), the dependent variable then becomes the value share of PCP (LCP). The independent variable X_{ij}^t includes several conventional determinants of currency choice such as market share, inflation, exchange rate, distance, product differentiation and real GDP.

[14]There should be some caution with the interpretation of table 1. Although letter of credit is estimated to directly support one sixth of total merchandise trade, its coverage is unbalanced across regions. Less than 10% of US export is linked with bank trade finance, whereas Asian countries heavily relies on it. This is also true for mainland China: around 30% of its import is financed by letter of credit, but that share is less than 10% for export. For comparison, data from PBOC and China's custom showed that 20.94% of China's merchandise trade was settled by RMB in November 2015. One possible interpretation of RMB's progress in import is the stable trend of appreciation for RMB during this period: foreign exporters are willing to accept RMB if it's almost certain to appreciate over 3% each year.

Most of these determinants are calculated as the level difference between the exporter and the importer country. For the detailed information about these measures, see table 7 in appendix. Most importantly, we capture the exporting and the importing country's difference in financial development with $FD_{ij}^t \equiv FD_i^t - FD_j^t$, proxied by private credit over GDP and Chinn-Ito index. Private credit over GDP is a standard measure of financial development, calculated as the financial resource channeled to private sector by financial intermediary, scaled by GDP. Chinn-Ito index is a de jure measure of capital account openness. A large value of either variable indicates a well-developed financial market, which is expected to increase the use of that country's currency. ϵ_{ij}^t is the error term.

In terms of estimation method, we choose panel Tobit regression since our dataset is truncated. As mentioned earlier, the transaction value in SWIFT dataset is recorded as 0 if the bilateral transaction number is less than or equal to 4. Many countries, especially developing countries, were unable to use their home currency in international trade, and these observations of zero make the panel Tobit regression fitting and proper. As for sampling frequency, we aggregate the monthly observation into annual level from 2011 to 2013, in order to match the frequency of other macroeconomic variables.

Table 2 is the result of our benchmark regression. To ensure the robustness of our empirical finding, we take PCP share in the first three columns and LCP share in the rest as our dependent variable. Because industrial countries are generally in a better position to use their home currency in trade, we also check the subsample of OECD exporters (column 2 and 5) as well as Non-OECD exporters (column 3 and 6).

The positive and significant coefficient of private credit to GDP and Chinn-Ito index in the first three columns imply that, when the exporter country has better financial development, more of its export would be settled in home currency, improving the share of PCP and decreasing the share of LCP.[15] The regression outcome for financial development proves quite consistent with our expectation. In general, private credit over GDP and Chinn-Ito index are statistically significant with the expected sign: positive in the first three columns, and negative in the rest.

The performance of other determinants is not always satisfactory. Exporter's market share works well in the PCP regression with positive and significant coefficient estimation, but it becomes insignificant in the LCP regression. Inflation level and volatility were rarely significant. The exchange rate level has good performance: an appreciating currency is preferred. The geographic distance plays an interesting role in the regression: the shares of PCP and LCP are both decreasing in distance. One possible explanation is that the increased distance elevates information asymmetry, so that both countries use VCP to reduce this friction. The degree of product differentiation, calculated according to Rauch (1999), also works as expected. Commodities such as oil and copper have standard exchange and pricing system where USD as a vehicle currency has a dominant presence. Therefore, trading more differentiated goods leads to the deviation from VCP. The real GDP difference

[15] It must be cautioned here that regression significance implies correlation rather than causality. So it's safer to conclude that financial market development is a necessary but not sufficient condition for currency internationalization.

Table 2: Determinants of currency use in trade, 2011-2013

	PCP share			LCP share		
	Total	OECD	Non-OECD	Total	OECD	Non-OECD
Private credit over GDP	**0.10*** **	**0.07*** **	**0.14*** **	**-0.13*** **	**-0.31*** **	**-0.09*** **
	(0.02)	(0.03)	(0.03)	(0.02)	(0.04)	(0.03)
Chinn-Ito index	**0.20*** **	**0.12*** **	0.01	**-0.17*** **	**-0.21*** **	**-0.24*** **
	(0.02)	(0.03)	(0.02)	(0.02)	(0.04)	(0.03)
Market share	0.57*	2.12***	1.17***	0.50	0.87	0.77*
	(0.29)	(0.54)	(0.22)	(0.36)	(0.74)	(0.44)
Inflation	-0.00	-0.00	-0.00	-0.00*	0.01	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.01	-0.02*	-0.01	0.00	-0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Exchange rate	-0.08***	-0.09***	-0.01*	0.07***	0.09***	0.06***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	0.01	-0.01	-0.01	-0.01	-0.02	-0.03**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Distance	-0.19***	-0.14***	-0.10***	-0.26***	-0.16***	-0.25***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.03)
Product differentiation	0.61***	0.30***	0.41***	0.30***	0.38***	0.19***
	(0.07)	(0.10)	(0.08)	(0.06)	(0.13)	(0.07)
GDP	0.04***	-0.01	-0.03***	-0.06***	-0.06***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
N	8,373	3,355	5,018	8,319	3,429	4,890
N (uncensored)	1584	1282	302	1158	409	749

Notes: Sample covers only cross-border trade. Constant omitted. US not included. The trade within Euro zone not included. The trade among mainland China, Hong Kong, and Taiwan treated as cross-border. Data frequency is annual. For dependent variable, it's the value share of PCP in column (1)-(3), and the value share of LCP in column (4)-(6). Econometric method is random-effect panel Tobit. Column (1) and (4) present regression outcome for whole sample, column (2) and (5) for OECD exporter, and column (3) and (6) for non-OECD exporter. Standard error in parenthesis. *, **, *** for 10%, 5% and 1 % significance level.

works well in LCP regression but not in PCP regression.

To further identify the channel of trade finance, we add the interaction term of financial development and trade finance dependence (TFD_{ij}^t) to the benchmark regression, which now becomes

$$s_{ijk}^t = \beta_1 X_{ij}^t + \beta_2 \text{FD}_{ij}^t + \beta_3 \text{FD}_{ji}^t \times \text{TFD}_{ij}^t + \epsilon_{ij}^t$$

While the access to bank-intermediated trade finance is important in international trade, countries differ in the degree of reliance. The bilateral countries' trade finance dependence (TFD_{ij}^t) is proxied by the following measures. (i) The continental dummy, equal to 1 if the exporter and the importer countries are on different continents. Ahn et al. (2011) show that international trade transported by sea is more sensitive to financial shocks. Since there's no transportation mode data at country level, we employ this continental dummy, assuming countries in different continents rely more on sea transportation. (ii) The share of bank-intermediated trade finance in the total of merchandise trade, collected from Committee on the Global Financial System (2014). Although this data covers only 12 countries in the year

Table 3: Determinants of currency use, with interaction term

	PCP share			LCP share		
	(1)	(2)	(3)	(4)	(5)	(6)
FD*Continent	**0.13*** **			**-0.17*** **		
	(0.04)			(0.04)		
FD*TF_share		**0.39*** **			**-0.56*** **	
		(0.14)			(0.15)	
FD*Partner			**0.24*** **			**-0.16*** **
			(0.03)			(0.04)
Market share	0.66**	-0.84**	0.87***	0.37	-0.00	0.32
	(0.29)	(0.42)	(0.29)	(0.35)	(0.33)	(0.35)
Inflation	-0.00	-0.00	-0.00	-0.00*	-0.00	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.01	0.10***	-0.01	0.00	-0.00	0.00
	(0.01)	(0.04)	(0.01)	(0.01)	(0.03)	(0.01)
Exchange rate	-0.07***	-0.09***	-0.07***	0.07***	0.05***	0.07***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	0.01	0.11***	0.00	-0.01	-0.03*	-0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Private credit over GDP	-0.00	-0.17***	-0.02	0.01	-0.01	-0.05*
	(0.04)	(0.06)	(0.02)	(0.04)	(0.05)	(0.02)
Chinn-Ito index	0.20***	0.21***	0.17***	-0.16***	-0.04*	-0.14***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.02)	(0.02)
Product differentiation	0.60***	1.16***	0.59***	0.31***	0.13	0.31***
	(0.07)	(0.19)	(0.07)	(0.06)	(0.10)	(0.06)
GDP	0.04***	-0.03**	0.03***	-0.05***	-0.04***	-0.05***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Distance	-0.19***	-0.34***	-0.18***	-0.27***	-0.08***	-0.26***
	(0.02)	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)
N	8,373	782	8,373	8,319	798	8,319
N (uncensored)	1584	275	1584	1158	143	1158

Notes: the dependent variable is PCP share for the first three columns and LCP share for the rest. For independent variables, FD is the same as private credit over GDP; Continent is a dummy equal to 1 if the export and import countries are not on the same continent; TF_share is the share of bank-intermediated finance in the total merchandise trade in 2011, collected from table 2 in Committee on the Global Financial System (2014); Partner is a dummy equal to 1 if the exporter is OECD country and the importer is Non-OECD countries.

of 2011, it provides a more accurate description of the reliance on trade finance. We apply this measure for the export of these countries. (iii) Trade partner dummy, equal to 1 for the international trade between OECD and non-OECD countries. Niepmann and Schmidt-Eisenlohr (2017) show that letter of credit is used more often for riskier destination and countries with intermediate contract enforcement, so the trade between OECD and non-OECD countries should resort to trade finance more often.

The variables above are positively correlated with the reliance on external finance, therefore we expect their interaction term with financial development to significantly affect the currency choice. Since our focus is on domestic financial market development, here we only show the result for the interaction term with private credit over GDP.[16] Table 3 confirms

[16]The regression outcome for the interaction term of Chinn-Ito index is in table 9. The power of financial factor remains robust.

our expectation. All three interaction terms are positive and significant in the first three columns of PCP regression, which means the exporter's home currency is more likely to be chosen if it has a better developed financial market, especially for the international trade more reliant on bank-intermediated trade finance. Similarly, the negative and significant estimation result in the LCP regression indicates, for countries with less developed financial market, their currencies are less preferred for the trade more supported by trade finance.

3.4 Economic Significance and Robustness Check

First, we calculate the economic significance when there is one standard deviation increase in the independent variables. The influence of financial factors is ranked generally above macroeconomic variables such as exchange rate and economic size, but a little bit below market share and product differentiation. In other words, the large effect of financial factor is on par with or greater than the impact of other well-known determinants. Interested reader could refer to table 8 in appendix for more details.

Secondly, we conduct a rich set of robustness check. After controlling for message types, valuation effect, year/region fixed effect, additional control variables, trade partners and alternative estimations method, the importance of financial development remains robust. All related tables are moved to appendix. Supported by these solid empirical findings, we build a two-country monetary search model in the following section.

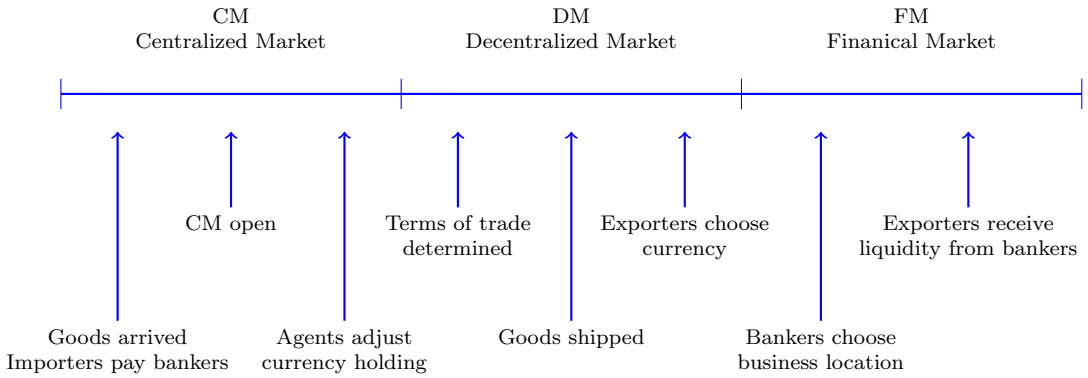
4 The Model

4.1 Physical Environment

Time is discrete and infinite. There are two countries in the world, 1 and 2, each resided with buyers and sellers, whose respective population is σ and $(1-\sigma)$. There is also a unit measure of bankers who could freely move across border. Agents have a fixed identity over time and their common discount factor is $\beta \in (0,1)$. Each period is divided into three rounds of centralized market (CM), decentralized market (DM), and financial market (FM). The CM is an internationally integrated Walrasian market whereas the DM features searching friction and geographical separation. Sellers always stay at home but buyers could go abroad with a certain probability. If the buyer and the seller are from different countries, we call them importer and exporter. The FM is a perfect competitive market of banking sector. There is divisible and storable fiat money circulating in each country, and the money 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 the current period, and variables with a hat denote the next period's level. The growth rate of money supply μ_i is controlled by each country's central bank.

We start with a brief introduction and more detailed formulation would follow. In the DM, sellers are specialized in producing perishable and differentiated goods q but unable

Figure 3: Model timing

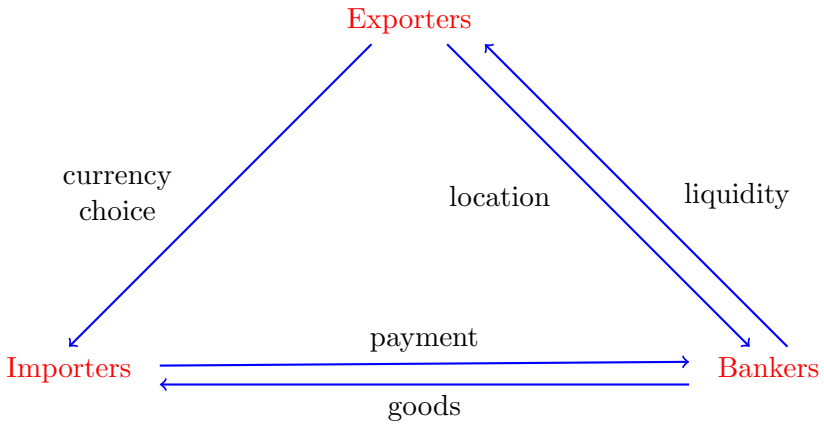


to consume, while buyers are able to consume but couldn't produce.[17] Buyers and sellers therefore search for each other and bargain over the quantity of production and payment in a successful meeting. For domestic trade, q is delivered instantly and agents use home currency as medium of exchange. The adoption of home currency could be attributed to the legal restriction of local government or a lower level of transaction cost. By contrast, international trade takes time and q is delivered at the beginning of next period. In this case, agents do not trust each other and the perceived default probability is prohibitively high, necessitating financial intermediation from bankers. Specifically, there is a perfect competitive banking sector in the FM, where bankers could invest in a record-keeping technology to track each agent's transaction history in international trade. This record is the banker's private information so that exporters and importers remain anonymous to each other, eliminating the possibility to arrange any trade credit among themselves. To reflect the banking sector's economy of scale, we assume a fixed total cost (F_i) for the bankers to operate with country i currency. Guaranteed by this trade finance arrangement, exporters send goods to importers and get shipment proof at the end of the DM.

Crucially, we assume exporters bear all the cost associated with trade finance and allow them to choose a single settlement currency to maximize their profit from the DM trade. This choice is public information observable to everyone. Bankers will establish business in the corresponding country, identify both parties in international trade and pay exporters with the chosen currency upon the presentation of shipment proof. Goods arrive at the beginning of next period and importers pay bankers with the same currency to get q. All agents produce a perishable numéraire good X and adjust their holdings of fiat money in the subsequent CM. Figure 3 depicts the model timing.

[17] To match the timing of this model, here we assume numéraire good is perished at the end of CM while differentiated goods perished at the beginning of each period.

Figure 4: Strategic complementarity



4.2 Discussion

Some features of our model deserve detailed discussion since they are sometimes non-standard in search-theoretic framework. We make strong assumptions on the currency choice to keep our model tractable while maintaining the importance of relevant factors. Exporters are allowed to choose currency although there is strategic complementarity, in the sense that the decision by one type of agents would affect other agents' optimal choice. For example, the exporter's currency choice depends on whether bankers could provide liquidity and whether importers agree to make payment in this currency. Similarly, the banker's business location and the importer's holding of fiat money are both tightly linked to the exporter's currency choice. This strategic complementarity is summarized in figure 4. However, we believe it is without loss of generality to let exporters choose currency because: (i) empirical evidence shows that exporters have more bargaining power over the currency choice, reflected in the fact that the share of PCP in a country's export is generally higher than the share of LCP in its import (Grassman, 1973; Goldberg and Tille, 2008; Ito and Chinn, 2013) and (ii) our theoretical results, as will become clear later, remain robust if we allow importers to bear the financial cost and make currency choice.

Another important assumption is that exporters choose a single currency to settle international trade. A discrete choice might be less than ideal in terms of theoretical modelling, but the trade finance business in reality normally has L/C denominated in one currency only. In addition, our focus is to explore the determinants of international currency and emphasize the role of financial development, so this simplifying assumption makes our model illustrative and straightforward.

Several assumptions on the banking sector and trade finance arrangement also require explanation. First of all, our definition of banking business is quite different from the existent literature where banks absorb deposit, make loans and provide risk insurance (Dia-

mond and Dybvig, 1983; Berentsen et al., 2007; Williamson, 2012). Instead, bankers in our model are actually middlemen providing financial intermediation to solve the commitment problem. Bankers exist because the time-to-ship friction makes the direct trade between exporters and importers less attractive due to a high level of default probability. Therefore, bankers improve welfare by increasing the gain from international trade, and we will show this effect in section 5

Secondly, our model features the coexistence of money and credit. In previous literature, there must be an absence of record-keeping for money to be essential, but credit requires transaction history in case of default. Berentsen et al. (2007) solved this issue with a costless record-keeping technology for financial transaction but not for goods transaction. Our model takes an alternative approach by allowing bankers to invest in a costly record-keeping technology and get each agent's identity as private information. If such information becomes public, exporters and importers would then arrange trade credit among themselves, eliminating fiat money as medium of exchange. By keeping this information private to bankers, we maintain the coexistence of money and credit since exporters still get paid by fiat money and importers rely on the loan from bankers to finish international trade. To be more explicit, we assume fiat money is the only acceptable instrument to settle debt, so money and credit are complements rather than substitutes in our model.

Finally, exporters are assumed to receive payment from bankers at the end of FM rather than wait until the beginning of next period. This might seem strange because exporters have nowhere to spend money until CM opens, so they should be indifferent between receiving payment today and tomorrow. There are at least two reasons to justify this assumption. In terms of model environment, exporters possess no record-keeping technology and could not identify bankers in the next period, so they would like to get payment immediately after shipment. In terms of trade finance practice, exporters are usually in urgent need of liquidity since international trade involves huge amount of pre-sale investment in equipment and labor. Rather than wait for the maturity of L/C and receive slightly more payment later, exporters prefer to get reimbursed even at a discount.

4.3 Value Functions and Optimal Decision

Now we are ready to formalize the setup of physical environment. Assume the instantaneous utility functions for buyer, seller, and banker are

$$U^B = u(q) + U(X) - H$$

$$U^S = -c(q) + U(X) - H$$

$$U^M = U(X) - H$$

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 at the cost of $c(q)$. The optimal

consumption in CM is X^* such that $U'(X^*) = 1$. The conventional assumption on function form also holds, so that $u(0) = c(0) = 0, u'(0) = +\infty, c'(0) = 0, u' > 0, u'' < 0, c' > 0, c'' > 0$. 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.

4.3.1 CM Value function

CM value function differs according to agent types. Buyers would like to hold money at the end of CM to enjoy differentiated good in the next period. The CM maximization problem for buyer in country i is therefore

$$\begin{aligned} W_i^B(m_i^i, m_j^i) = &\max_{\hat{m}_i^i, \hat{m}_j^i, H, X} U(X) - H + V_i^B(\hat{m}_i^i, \hat{m}_j^i) \\ &\text{s.t. } \phi_i \hat{m}_i^i + \phi_j \hat{m}_j^i + X \leq H + \phi_i m_i^i + \phi_j m_j^i + T_i \end{aligned}$$

where m_j^i is country i buyer's holding of country j currency; V_i^B is country i buyer's value function in DM; T_i is the lump-sum transfer from country i central bank. Simplify this CM value function into the following.

$$W_i^B(m_i^i, m_j^i) = U(X^*) - X^* + \phi_i m_i^i + \phi_j m_j^i + T_i + \max_{\hat{m}_i^i, \hat{m}_j^i} \left\{ V_i^B(\hat{m}_i^i, \hat{m}_j^i) - \phi_i \hat{m}_i^i - \phi_j \hat{m}_j^i \right\} \quad (1)$$

Since buyer's value function is linear in his holding of money, we further simplify it.

$$W_i^B(m_i^i, m_j^i) = W_i^B(0, 0) + \phi_i m_i^i + \phi_j m_j^i \quad (2)$$

For sellers, they don't have any incentive to hold money in CM since that is irrelevant with their gain from DM trade. Seller's CM value function therefore becomes

$$W_i^S(m_i^i, m_j^i) = W_i^S(0, 0) + \phi_i m_i^i + \phi_j m_j^i \quad (3)$$

where $W_i^S(0, 0)$ is constant with respect to seller's currency holding in the next period. For bankers, their CM maximization problem is

$$\begin{aligned} W^M(z_i, z_j) = &\max_{\hat{z}_i, \hat{z}_j, H, X} U(X) - H + V^M(\hat{z}_i, \hat{z}_j) \\ &\text{s.t. } \phi_i \hat{z}_i + \phi_j \hat{z}_j + X \leq H + \phi_i z_i + \phi_j z_j + T_i \end{aligned} \quad (4)$$

where z_i is banker's holding of country i currency and $V^M(\hat{z}_i, \hat{z}_j)$ is banker's value function in FM. This value function is also linear in the banker's currency holding.

$$W^M(z_i, z_j) = W^M(0, 0) + \phi_i z_i + \phi_j z_j \quad (5)$$

4.3.2 Terms of trade in DM

DM is open to buyers and sellers, but geographically separated across country. Buyers could go abroad with a probability of $(1-\alpha)$ while sellers always stay at home. Agents meet pairwise and at random, with a matching function of $N_i = \frac{B_i S_i}{B_i + S_i}$, where N_i is the number of successful matching in country i, and B_i and S_i denote the number of buyer and seller in the DM of country i. Accordingly, 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}) could be determined. In a successful meeting, buyer and seller make a proportional bargaining (Kalai, 1977) to determine the quantity of production and payment.

For international trade, country i importer's maximization problem is

$$\max_{q_{ij}, d_{ij}} \{u(q_{ij}) - d_{ij}\}$$

$$\text{s.t.} \quad \frac{u(q_{ij}) - d_{ij}}{d_{ij} - c(q_{ij})/\beta} = \frac{\theta}{1-\theta}$$

$$d_{ij} \leq s_j \phi_j m_j^i + (1 - s_j)\phi_i m_i^i$$

where q_{ij} is the DM trade volume between country i importer and country j exporter; d_{ij} is the real value of the corresponding payment; $\theta \in (0, 1)$ is buyer's bargaining power; s_j is country j exporter's currency choice, equal to 1 if the exporter's home currency is chosen. The solution is

$$d_{ij} = \begin{cases} (1 - s_j)\phi_i m_i^* + s_j \phi_j m_j^* & \text{if } (1 - s_j)\phi_i m_i^i + s_j \phi_j m_j^i \geq (1 - \theta)u(q_{ij}^*) + \theta c(q_{ij}^*)/\beta \\ (1 - s_j)\phi_i m_i^i + s_j \phi_j m_j^i & \text{if otherwise} \end{cases} \tag{6}$$

where q_{ij}^* is the production level maximizing total surplus such that $u'(q_{ij}^*) = c'(q_{ij}^*)/\beta$, and $\phi_i m_i^* = \phi_j m_j^* \equiv (1 - \theta)u(q_{ij}^*) + \theta c(q_{ij}^*)/\beta$ corresponds to the real value of payment when social surplus is maximized. The case for domestic transaction is similar, except that q is delivered instantly and sellers accept only home currency. The bargaining solution for country i's domestic trade therefore becomes

$$d_{ii} = \begin{cases} \phi_i m_i^{**} & \text{if } \phi_i m_i^i \geq (1 - \theta)u(q_{ii}^{**}) + \theta c(q_{ii}^{**}) \\ \phi_i m_i^i & \text{if otherwise} \end{cases} \tag{7}$$

where q_{ii}^{**} maximizes the total surplus of domestic trade such that $u'(q_{ii}^{**}) = c'(q_{ii}^{**})$, and $\phi_i m_i^* \equiv (1 - \theta)u(q_{ii}^{**}) + \theta c(q_{ii}^{**})$ is the real value of corresponding payment.

It will become clear in equilibrium that buyer's holding of fiat money would never exceed the optimal level maximizing total surplus, because excessive money doesn't increase his gains from trade, but would incur a loss from inflation. Accordingly, the real value of country i buyer's payment is $(1 - s_j)\phi_i m_i^i + s_j \phi_j m_j^i$ for international trade and $\phi_i m_i^i$ for domestic trade.

4.3.3 Buyer's optimal choice in CM

For country i buyer, his DM value function is

$$V_i^B(m_i^i, m_j^i) = p_{ii}(u(q_{ii}) - d_{ii}) + \beta p_{ij}(u(q_{ij}) - d_{ij}) + \beta \hat{W}_i^B(m_i^i, m_j^i) \tag{8}$$

where the first item captures his gain from meeting domestic sellers, and the second item measures his surplus from international trade. Substitute this into the expression in equation 1 and the buyer's maximization problem becomes

$$\max_{m_i^i, m_j^i} \left\{ (\beta\hat{\phi}_i - \phi_i)m_i^i + (\beta\hat{\phi}_j - \phi_j)m_j^i + p_{ii}\Big(u(q_{ii}) - d_{ii}(m_i^i)\Big) + \beta p_{ij}\Big(u(q_{ij}) - d_{ij}(m_i^i, m_j^i)\Big) \right\}$$

Several conventional observation in monetary search model would also apply here. For example, the solution for maximization problem requires $\beta\hat{\phi}_i - \phi_i < 0$. In addition, the exporter's currency choice also affects the buyer's optimal holding of fiat money. If country j exporters choose their home currency for international trade ($s_j = 1$), we then have the following solution for buyer's maximization problem

$$s_j = 1 \Rightarrow \begin{cases} R_i = p_{ii}L_D(q_{ii}) \quad , \quad R_j = p_{ij}L_I(q_{ij}) \\ \phi_i m_i^i = \frac{1}{\beta}\Big[(1-\theta)u(q_{ii}) + \theta c(q_{ii})\Big] \\ \phi_j m_j^i = (1-\theta)u(q_{ij}) + \theta c(q_{ij})/\beta \end{cases} \tag{9}$$

Here $R \equiv (1+\mu)/\beta$ denotes the nominal interest rate calculated according to Fisher equation, since β^{-1} is the real interest rate. $L_D(q) \equiv \frac{\theta(u'(q)-c'(q))}{(1-\theta)u'(q)+\theta c'(q)}$ and $L_I(q) \equiv \frac{\theta(u'(q)-c'(q)/\beta)}{(1-\theta)u'(q)+\theta c'(q)/\beta}$ capture the marginal utility of currency in domestic and international trade. The first line of equations are from the first order condition of m_i^i and m_j^i, and they have the standard interpretation of marginal cost of holding money is equal to its expected marginal utility. If country j exporter choose foreign currency to settle international trade ($s_j = 0$), country i buyer's optimal decision satisfies the following conditions.

$$s_j = 0 \Rightarrow \begin{cases} R_i = p_{ii}L_D(q_{ii}) + p_{ij}L_I(q_{ij}) \\ \phi_i m_i^i = \frac{1}{\beta}\Big[(1-\theta)u(q_{ii}) + \theta c(q_{ii})\Big] = (1-\theta)u(q_{ij}) + \theta c(q_{ij})/\beta \\ m_j^i = 0 \end{cases} \tag{10}$$

In this case, country i buyer would hold only home currency to settle both domestic and international trade.

4.3.4 Financial market and banker's optimal decision

Bankers in our model pay exporters in the current period and receive repayment in the next period, This process of trade finance is equivalent to banker's extending loans to importers. Recall that the fixed total cost for bankers to operate with country i currency is F_i. Such investment is used for a record-keeping technology to identify both parties in international trade and conduct financial business.

$$V^M(z_i, z_j) = \max_{L_i, L_j} \Big\{ \beta \hat{W}^M(z_i + \max\{s_i, 1-s_j\} r_i L_i + \max\{s_j, 1-s_i\} r_j L_j) \\ - \max\{s_i, 1-s_j\} f_i - \max\{s_j, 1-s_i\} f_j \Big\} \\ \text{s.t.} \quad 0 \le L_i \le z_i, \quad 0 \le L_j \le z_j \tag{11}$$

where L_i denotes the loan amount in country i currency, and r_i represents the loan's nominal interest rate for country i currency. Bankers take r_i as given and choose the optimal loan amount. The existence of financial business depends on the exporter's currency choice, so the loans in country i currency is possible only when country i currency is chosen, i.e., $\max\{s_i, 1-s_j\} = 1$. Due to the fixed total cost for record-keeping technology, each banker incurs an individual cost f_i. Given the linearity of CM value function, we can rewrite the banker's maximization problem.

$$\max_{z_i, z_j, L_i, L_j} \Big\{ (\beta \hat{\phi}_i - \phi_i) z_i + \max\{s_i, 1-s_j\} \Big(\beta \hat{\phi}_i r_i L_i - f_i \Big) \\ + (\beta \hat{\phi}_j - \phi_j) z_j + \max\{s_j, 1-s_i\} \Big(\beta \hat{\phi}_j r_j L_j - f_j \Big) \Big\} \\ \text{s.t.} \quad 0 \le L_i \le z_i, \quad 0 \le L_j \le z_j \tag{12}$$

If none of the exporters choose country i currency ($s_i = 1 - s_j = 0$), bankers would never hold currency in CM since monetary equilibrium requires $\beta \hat{\phi}_i \le \phi_i$. On the other hand, if country i currency is chosen and the loan's interest rate is positive, country i bankers would keep home currency ($z_i > 0$) in CM and invest all of it in trade finance business ($z_i = L_i$). Because banking sector is perfect competitive with free entry, there would be no utility gain for bankers at equilibrium. Aggregating over all bankers leads to our zero-profit condition in banking industry.

$$\max\{s_i, 1-s_j\} = 1 \Rightarrow \left[\frac{\beta \hat{\phi}_i (1 + r_i)}{\phi_i} - 1 \right] \phi_i z_i = F_i \tag{13}$$

$$\max\{s_j, 1-s_i\} = 1 \Rightarrow \left[\frac{\beta \hat{\phi}_j (1 + r_j)}{\phi_j} - 1 \right] \phi_j z_j = F_j \tag{14}$$

This condition means the banking sector's gain from trade finance business should be equal to the fixed total cost. We can further derive the relationship between loan rate and nominal interest rate, given that $\phi_i/(\beta\hat{\phi}_i) = (1+R_i)$.

$$\max\{s_i, 1-s_j\} = 1 \Rightarrow \quad 1+r_i = \left(1+\frac{F_i}{\phi_i z_i}\right)(1+R_i) \tag{15}$$

$$\max\{s_j, 1-s_i\} = 1 \Rightarrow \quad 1+r_j = \left(1+\frac{F_j}{\phi_j z_j}\right)(1+R_j) \tag{16}$$

Intuitively, the interest rate spread is positive in the fixed total cost F_{ii} and negative in the financial market liquidity $\phi_i z_i$. In addition, the banking sector's liquidity is also related with the importer's payment amount in the next period.

$$(1+r_i)\phi_i z_i = s_i n_{ji}\phi_i m_i^j + (1-s_j)n_{ij}\phi_i m_i^i \tag{17}$$

$$(1+r_j)\phi_j z_j = s_j n_{ij}\phi_j m_j^i + (1-s_i)n_{ji}\phi_j m_j^j \tag{18}$$

4.3.5 Exporter's choice and currency regime

To simplify our analysis below, we assume exporters always prefer the financial intermediation by bankers so that we could focus on their currency choice. Such restriction on the pattern of trade finance would be relaxed later. If an exporter in country j choose to rely on the financial intermediation by bankers to settle international trade with country i currency, the exporter's ultimate gain is

$$\pi_j^i = \frac{1}{1+r_i}\phi_i m_i^i - \frac{c(q_{ij})}{\beta} = \underbrace{\left[\frac{\phi_i z_i}{\phi_i z_i + F_i}\right]}_{\text{financial factor}} \underbrace{\left(\frac{1}{1+R_i}\right)}_{\text{discount}} \underbrace{\phi_i m_i^i - \frac{c(q_{ij})}{\beta}}_{\text{Terms of trade}} \tag{19}$$

It is from this profit function that we propose three determinants of international currency usage. First and foremost, financial factors matter. A currency with less cost in banking sector ($F_i \downarrow$) and better liquidity condition ($\phi_i z_i \uparrow$) should be preferred, which is consistent with our empirical finding with SWIFT dataset. Notice that the fixed cost F_i is assumed to be exogenous whereas the banking sector's liquidity is endogenously derived from the banker's optimal choice of currency holding.

Secondly, a sound monetary policy helps promote currency internationalization at the macro level. Country i central bank controls the growth rate of its home currency supply μ_i, directly influencing the discount factor through Fisher equation $1+R_i \equiv \frac{1+\mu_i}{\beta}$. Moreover, the exchange rate in our model is also determined by the central bank's monetary policy. The CM actually functions as a frictionless foreign exchange market, so that Law of One Price (LOP) holds for the numéraire good and the nominal exchange rate of country i currency per country j currency is $e_{i/j} = \phi_i/\phi_j$. Given that $\phi_i = (1+\mu_i)\hat{\phi}_i$ in a stationary monetary equilibrium, the exchange rate movement could be expressed as $\hat{e}_{i/j}/e_{i/j} = (1+\mu_j)/(1+\mu_i)$.

Consequently, an inflationary monetary policy ($\mu_i \uparrow$) leading to a high discount rate ($R_i \uparrow$) and currency depreciation $e_{ij} \uparrow$ would make the corresponding currency less attractive for exporters to settle international trade.

Finally, the terms of trade from the DM bargaining solution also has influence at the micro level. Exporters with a high level of bargaining power tend to gain more from international trade. Although our model does not assume heterogeneous bargaining power, the empirical evidence in previous literature (e.g. Goldberg and Tille, 2008) finds that exporters producing differentiated goods with a large market share prefer home currency.

With a similar procedure, the profit function for country j currency is

$$\pi_j^j = \left[\frac{\phi_j z_j}{\phi_j z_j + F_j}\right]\left(\frac{1}{1+R_j}\right)\phi_j m_j^i - \frac{c(q_{ij})}{\beta} \tag{20}$$

Based on the respective profit level, exporters make their currency choice.

$$s_j = \begin{cases} 1 & \text{if } \pi_j^j > \pi_j^i \geq 0 \\ 0 & \text{if } \pi_j^i > \pi_j^j \geq 0 \end{cases} \tag{21}$$

The currency regime in our two-country model is therefore determined. To be consistent with the previous literature, we define the system as *Producer Currency Pricing (PCP)* when exporters choose their home currency to settle international trade and *Local Currency Pricing (LCP)* when importer's home currency is chosen. For the asymmetric case when only one currency becomes international, we call it *Single Currency Pricing (SCP)*. More specifically,

$$\text{Currency Regime} \Rightarrow \begin{cases} \text{Producer Currency Pricing, PCP} & \text{if } \{s_i, s_j\} = \{1,1\} \\ \text{Local Currency Pricing, LCP} & \text{if } \{s_i, s_j\} = \{0,0\} \\ \text{Single Currency Pricing, SCP} & \text{if } \{s_i, s_j\} = \{0,1\} \text{ or } \{1,0\} \end{cases}$$

4.4 Monetary equilibrium of international trade

Before defining the equilibrium, we show the market clearing condition for money market, which depends on the type of currency regime.

$$\begin{cases} \sigma\phi_i m_i^i = \phi_i M_i & \text{if } \{s_i, s_j\} = \{0,1\} \\ \sigma\phi_i m_i^i + \phi_i z_i + F_i = \phi_i M_i & \text{if } \{s_i, s_j\} = \{0,0\} \\ \sigma\phi_i m_i^i + \sigma\phi_i m_i^j + \phi_i z_i + F_i = \phi_i M_i & \text{if } \{s_i, s_j\} = \{1,0\} \text{ or } \{1,1\} \end{cases} \tag{22}$$

For the first case, country i currency remains national, so its demand comes from only domestic buyer. For the second case, the demand comes from the buyers and bankers in home country. In the last case, home bankers and all buyers would have demand for country i currency.

With every agent's optimal choice available, we can now define a stationary monetary equilibrium. We focus on the monetary equilibrium in which international trade is settled through banker's financial intermediation.

Proposition 1 *Suppose the default probability is prohibitively high so that agents rely on banker's intermediation to settle international trade. There is a unique and stationary equilibrium with a list of time-invariant variables including trade volume* $\{q_{ij}\}_{i,j=1}^{2}$*, banker's holding of real balance* $\{\phi_i z_i\}_{i=1}^{2}$*, and exporter's choice of settlement currency* $\{s_i\}_{i=1}^{2}$ *such that, given other agent's decision,*

1. *Buyer's choice of* $\{q_{ij}\}_{i,j=1}^{2}$ *solves equation (9) and (10);*

2. *Banker's choice of* $\{\phi_i z_i\}_{i=1}^{2}$ *solves equation (15)(16)(17)(18);*

3. *Exporter's choice of* $\{s_i\}_{i=1}^{2}$ *solves equation (21);*

4. *Money market clears so that equation (22) holds.*

The proof is in the appendix.

5 The role of financial intermediation

In this section we relax the previous restriction and allow exporters to choose among different patterns of trade finance, including bank-intermediated trade finance, open account and cash in advance. The method of *open account* or *cash-in-advance* provides a cheaper way to settle international trade, but brings with them the non-payment or non-delivery risk. On the other hand, if the exporter relies on bank-intermediated trade finance and gets insulated from the default risk, he would bear the cost associated with trade finance business. Exporters therefore make decision based on the expected profit in different patterns of trade finance. Assume the default probability is τ_I for importers and τ_E for exporters. We have the following proposition regarding the optimal pattern of trade finance.

Proposition 2 *If the perceived default probability is sufficiently higher than the loan's interest rate, such that* $\min\{\tau_E, \tau_I\} > \min\{\frac{r_1}{1+r_1}, \frac{r_2}{1+r_2}\}$*, exporters prefer bank-intermediated trade finance to settle international trade.*

Proof: for simplicity, we focus on the partial equilibrium where the trade volume is fixed, i.e., $q = \bar{q}$. If both parties agree on the use of *open account*, the importer's expected surplus is still $u(\bar{q}) - d$ while the exporter's expected profit becomes $(1 - \tau_I) - c(q)/\beta$. Notice that here we assume that nobody would actually default and τ_I is just the importer's default probability perceived by the exporter. From the bargaining solution we get the exporter's

gain from trade.

$$\pi^{\mathrm{OA}} = \frac{1-\theta}{(1-\theta)+\theta(1-\tau_I)}\Big[(1-\tau_I)u(\bar{q}) - c(\bar{q})/\beta\Big] \tag{23}$$

Similarly, the profit function under *cash in advance* is

$$\pi^{\mathrm{CIA}} = (1-\theta)\Big[(1-\tau_E)u(\bar{q}) - c(\bar{q})/\beta\Big] \tag{24}$$

Apply the same procedure to the bargaining game with bank-intermediated trade finance and get the corresponding profit function for exporters

$$\begin{cases} \pi_{ji}^{\mathrm{LC}} = \frac{1-\theta}{1-\theta+\theta(1+r_i)^{-1}}\Big[(1+r_i)^{-1}u(\bar{q}) - c(\bar{q})\Big] \\ \\ \pi_{jj}^{\mathrm{LC}} = \frac{1-\theta}{1-\theta+\theta(1+r_j)^{-1}}\Big[(1+r_j)^{-1}u(\bar{q}) - c(\bar{q})/\beta\Big] \end{cases} \tag{25}$$

where π_{ji}^{LC} denotes the country j exporter's profit settled with country i currency and financial intermediation.

Given the profit functions above, exporters choose trade finance pattern. The comparison between open account and cash in advance is straightforward: with the same perceived default probability $\tau_I = \tau_E$, open account is always preferred because $1-\theta+\theta(1-\tau) < 1$. This is also consistent with the empirical finding in Ahn (2015) that open account is the dominant method in Colombia's international trade. The function form is similar between open account and bank-intermediated trade finance, so we define

$$\pi(\tau) \equiv \frac{1-\theta}{(1-\theta)+\theta(1-\tau)}\Big[(1-\tau)u(\bar{q}) - c(\bar{q})/\beta\Big]$$

It is easy to verify that $\pi(\tau_I) = \pi^{\mathrm{OA}}$ and $\pi(\frac{r_i}{1+r_i}) = \pi_{ji}^{\mathrm{LC}}$. Because the profit function is decreasing in the perceived default probability $(\partial\pi/\partial)$, the banker's financial intermediation is preferred over open account if and only if $\tau_I > \min\{\frac{r_1}{1+r_1}, \frac{r_2}{1+r_2}\}$. With the same mechanism, the sufficient condition for bank-intermediated trade finance to be preferred over cash in advance is $\tau_I > \min\{\frac{r_1}{1+r_1}, \frac{r_2}{1+r_2}\}$. Proposition 1 is herein proved.

Intuitively, exporters resort to financial intermediation when the default probability is prohibitively high, although that would introduce a financial cost. This mechanism is similar to the optimal contract choice in Schmidt-Eisenlohr (2013). It is also this mechanism that makes banking business increase agent's gain from international trade and improve the social welfare. With the banker's provision of financial intermediation, exporters could hope to gain more than π^{CIA} and π^{OA} if the loan's interest rate is not too high. This welfare-enhancing effect also explains the essential role of banking section in facilitating international trade.

6 Monetary policy and international trade

Given the existence and uniqueness of a monetary equilibrium, we conduct comparative statics analysis now. It is straightforward to show that, under very general conditions on function form, a central bank's monetary policy has uniform effect on welfare: higher inflation level hurts everyone. The effect on a country's net export, however, differs according to the specific currency regime, as displayed in proposition 4.

Proposition 3 *Under some general assumptions, higher inflation level of international currency would hurt whoever used it for trade settlement. Consider the case when home currency becomes international.*

(i) For SCP, the inflation of home currency would hurt the importers and the exporters from both countries, i.e., $\frac{\partial q_{12}}{\partial R_1} < 0, \frac{\partial q_{21}}{\partial R_1} < 0, \frac{\partial \pi_1^1}{\partial R_1} < 0, \frac{\partial \pi_2^1}{\partial R_1} < 0$. The effect on net export is ambiguous.

(ii) For PCP, the inflation of home currency would hurt only home exporters and foreign importers, i.e., $\frac{\partial \pi_1^1}{\partial R_1} < 0, \frac{\partial q_{21}}{\partial R_1} < 0, \frac{\partial \pi_2^2}{\partial R_1} = \frac{\partial q_{12}}{\partial R_1} = 0$. Home currency depreciation would decrease home net export.

(iii) For LCP, the inflation of home currency would hurt only home importers and foreign exporters, i.e., $\frac{\partial q_{12}}{\partial R_1} < 0, \frac{\partial \pi_2^1}{\partial R_1} < 0, \frac{\partial q_{21}}{\partial R_1} = \frac{\partial \pi_1^2}{\partial R_1} = 0$. Home currency depreciation would boost home net export.

Proof in appendix

One interesting observation from proposition 2 is the relationship between nominal exchange rate and net export. In particular, whether it is possible to "beggar thy neighbor" and boost net export through nominal depreciation depends on the specific currency regime. As discussed previously, LOP ensures a tight link between the growth rate of monetary supply and exchange rate movement, so that an inflationary monetary policy naturally leads to currency depreciation [18]. Here we the discuss the effect of home country inflation and currency depreciation, and the result is summarized in table 4

For SCP with home currency as the only international currency, the result is unclear and contingent on parameter value and function form, because home country's export and import are both decreased after home currency depreciation. For PCP, nominal depreciation

[18]The discussion of exchange rate in search model could be traced back to Trejos and Wright (1996), who highlighted the dominance of USD as a big reason for the out-lier performance of USD exchange rate. In appendix A.4, we revisited this topic by applying LOP to differentiated goods. The conclusion remains similar under general assumptions: as long as wholesale price is lower than retail price, the international currency would enjoy appreciation relative to national currency. Of course, the validity of LOP is always a big controversy, and it remains unclear whether LOP could be readily applied to market with searching friction.

Table 4: International currency and international trade

	SCP	PCP	LCP
Home importer	$\frac{\partial q_{12}}{\partial R_1} < 0$	$\frac{\partial q_{12}}{\partial R_1} = 0$	$\frac{\partial q_{12}}{\partial R_1} < 0$
Home exporter	$\frac{\partial \pi_1^1}{\partial R_1} < 0$	$\frac{\partial \pi_1^1}{\partial R_1} < 0$	$\frac{\partial \pi_1^2}{\partial R_1} = 0$
Foreign importer	$\frac{\partial q_{21}}{\partial R_1} < 0$	$\frac{\partial q_{21}}{\partial R_1} < 0$	$\frac{\partial q_{21}}{\partial R_1} = 0$
Foreign exporter	$\frac{\partial \pi_2^1}{\partial R_1} < 0$	$\frac{\partial \pi_2^2}{\partial R_1} = 0$	$\frac{\partial \pi_2^1}{\partial R_1} < 0$
home net export	?	$\frac{\partial \mathrm{NX}_1}{\partial R_1} < 0$	$\frac{\partial \mathrm{NX}_1}{\partial R_1} > 0$
foreign net export	?	$\frac{\partial \mathrm{NX}_2}{\partial R_1} > 0$	$\frac{\partial \mathrm{NX}_2}{\partial R_1} < 0$

Notes: Country 1 is regarded as home country. In the first column, country 1 currency emerged as the single international currency. For the second column, international trade is settled by the exporter's home currency. For the last column, international trade is settled by the importer's home currency.

of home currency would hurt home exporter but leave home importer intact, thus lowering home export and net export. Similarly for LCP, home currency depreciation discourages home importer but home export remains the same as before, therefore decreasing the net export of home country. In sum, our model suggests that "beggar thy neighbor" through nominal depreciation is possible in LCP, impossible in PCP and uncertain in SCP.

7 Related topics

7.1 Hegemony and incumbency advantage

Conventional wisdom holds that once a currency becomes international, it shall enjoy the exorbitant privilege for a long time and does not easily get dethroned. While admitting the existence of incumbency advantage, Eichengreen (2011) questions whether it is so strong and persistent. In this section we discuss this issue with our search-theoretical framework.

Now consider the case of SCP when country 1 currency becomes international and country 2 currency remains national ($s_1 = 1, s_2 = 0$). Intuitively, country 1 buyers would hold only home currency, which is universally acknowledged and appreciated for transaction. By contrast, country 2 buyers hold home currency for domestic trade and foreign currency for international trade. Moreover, this system of single international currency makes financial market active only in country 1, entailing incumbency advantage for its currency. Due to the economy of scale in banking sector, country 2 currency could hardly become international

without collective action, government promotion or an external shock disrupting financial market liquidity. This observation is summarized in proposition 4.

Proposition 4 *In a monetary equilibrium with international trade settled by banker's financial intermediation, if country 1 issues the only international currency, an individual exporter has no incentive to choose country 2 currency.*

Proof In this case, if some country 1 exporters decide to accept country 2 currency, their profit function has an upper limit.

$$\pi_{12}^{M} \leq N \underbrace{(1-\theta)\left[u(q_2^1) - c(q_2^1)/\beta\right]}_{\text{DM surplus for seller}} - F_2,$$

where N is the number of exporters trying to accept country 2 currency. If N is not sufficiently large relative to F_2, the exporter's profit would be negative due to banker's fixed cost of operating with country 2 currency. Notice the difference between this incumbency advantage and the size effect emphasized in previous literature, which argued that the huge trade volume of a large economy would help lower the transaction cost in FX market, therefore justifying its status of international currency. But proposition 4 shows that economy size alone is not enough. Financial development proves indispensable.

This situation of hysteresis leaves room for policy intervention if a country wants to make its currency international. To reduce market friction and information asymmetry, a central bank could decrease F by financial reform and liberalization, or increase N by becoming market maker and providing liquidity. Eichengreen (2011) convincingly showed that FED took advantage of both options to foster the rise of USD. On one hand, the Federal Reserve Act in 1913 authorized U.S. banks to deal with trade finance business and extend foreign branch networks. On the other hand, regional federal reserve banks purchased trade acceptance and temporally became the market maker to stabilize and reduce discount rate. Such favorable policies, in coincidence with World War I and the subsequent shrinkage of trade credit in Euro, are believed to accelerate the internationalization of USD. Therefore, central banks trying to internationalize their home currencies should take initiative when necessary rather than wait for the invisible hand of market power.

For the issuing country of international currency, its central bank should also be aware of the monetary policy effect on currency regime, which is crucially dependent on the exporter's gain from international trade. From agents' optimal decision, the channel of trade finance turns out to amplify the effect of an inflationary monetary policy both directly and indirectly. A higher level of inflation ($\mu \uparrow$) directly raises the discount rate and cuts the exporter's net profit. Indirectly, an inflationary monetary policy reduces the currency holding of both importers and bankers by increasing their marginal cost of holding fiat money. Such change would shrink not only the payment for international trade ($\phi_i m_i^j \downarrow$) but also the liquidity in banking sector ($\phi_i z_i \downarrow$), further deteriorating the exporter's profit and potentially jeopardizing the status of international currency. This amplification effect is summarized in table 5. Given this mechanism of trade finance, central banks issuing

Table 5: Amplification of monetary policy effect

$$R_i \uparrow \Rightarrow \begin{cases} \frac{1}{1+R_i} \downarrow & \text{(discount factor)} \\ \phi_i m_i^j \downarrow & \text{(foreign buyer)} \\ \phi_i z_i \downarrow & \text{(home investor)} \end{cases} \Rightarrow \pi_i \downarrow\downarrow\downarrow$$

international currency should think carefully about the consequence of their monetary policy on both international trade and financial market.

In sum, out theoretical discussion confirms the existence of incumbency advantage for international currency, but also shows it is not as strong as previously thought. Countries trying to internationalize their home currencies should foster an efficient and liquid financial market with proactive measures. The issuing country of international currency should be aware of the amplification effect of trade finance channel and carefully conduct its monetary policy.

7.2 Size effect revisited

What is the optimal arrangement for international monetary system? Should we let the largest economy to provide the single international currency? Previous literature agreed because big size and huge trade volume help reduce transaction cost and improve social welfare. In this part we re-evaluate this size effect with welfare analysis in monetary search model. As discussed in the last section, agent's gain from DM trade is uniformly decreasing in the nominal interest rate. Therefore, we investigate the relationship between the economy size and the central bank's optimal monetary policy. Specifically, our task is to find out whether the central bank of a large economy has the incentive to conduct anti-inflationary monetary policy and converge to Friedman rule of zero nominal interest rate.

Central banks in our model control the growth rate of money supply and set nominal interest rate to maximize the social welfare of their own countries. So it is necessary to first analyze the component of social welfare function. The general equilibrium nature of our model helps us derive the social welfare function of country 1 when it issues the only international currency.

$$\begin{aligned} W_1 = & \underbrace{\mu_1 \sigma \phi_1 m_1^2}_{\text{Seigniorage revenue}} + \underbrace{n_{11}\big[u(q_{11}) - c(q_{11})\big]}_{\text{domestic trade surplus}} + \underbrace{n_{12}\theta\big[u(q_{12}) - c(q_{12}/\beta)\big]}_{\text{importer surplus}} \\ & + \underbrace{n_{21}\left\{\frac{\phi_1 z_1}{\phi_1 z_1 + F_1}\left(\frac{1}{1+R_1}\right)\phi_1 m_1^2 - c(q_{21})/\beta\right\}}_{\text{exporter surplus}} - F_1 \end{aligned} \tag{26}$$

This function is divided into three parts: (i) the seigniorage revenue from foreign demand of home currency (ii) the gains from DM trade including both domestic and international

trade (iii) the fixed total cost of banking industry. As intensively discussed in Zhang (2014), Friedman rule is not necessarily optimal for the issuing country of international currency. Central banks in this case face the trade-off between seigniorage revenue and gains from trade: a lower level of inflation stimulates international trade and improve agent's gain from that, but it also reduces the amount of seigniorage revenue. Similarly, the social welfare function for country 2 is as follows.

$$\begin{aligned} W_2 = &- \mu_1 \sigma \phi_1 m_1^2 + n_{22}\big[u(q_{22}) - c(q_{22})\big] + n_{21}\theta\big[u(q_{21}) - c(q_{21})/\beta\big] \\ &+ n_{12}\left\{\left[\frac{\phi_1 z_1}{\phi_1 z_1 + F_1}\right]\left(\frac{1}{1+R_1}\right)\phi_1 m_1^1 - c(q_{12})/\beta\right\} \end{aligned} \tag{27}$$

Obviously, for a social planner trying to maximize the world's welfare level, Friedman rule of zero nominal interest rate is optimal because seigniorage revenue would cancel out in the summation of welfare function.

Now we are ready to talk about the size effect for international currency. Economy size in our model is approximated by national population, i.e., the total number of buyer and seller in a country. A change in population would, according to the matching function, directly influence the number and probability of the meeting between buyer and seller from different countries, thus affecting equilibrium outcome. Now consider the optimal policy for country 1 issuing the only international currency. Figure 5 shows the relationship between the center country's population and its optimal nominal interest rate that would maximize the welfare level in country 1. For the purpose of illustration, the function form is borrowed from Lagos and Wright (2005) with $u(q) = ln(q+b) - ln(q)$, $c(q) = q$, $b = 0.0001$. Additionally, $\alpha = 0.5$, $\beta = 0.966$, $\sigma = 0.3$, $\theta = 0.5$, $F_1 = 0.01$. Country 1 population varies from 0.1 to 10, while the country 2 population stays at 1. A hump-shape is surprising at first sight, but the decomposition of country 1 welfare level in figure 6 clarifies everything. In essence, size effect alters the degree of trade-off between seigniorage revenue and gains from trade. For a large economy, gains from domestic trade consist the dominant part of its total welfare, so higher inflation is not a good choice. With a similar token, gains from international trade makes up the lion's share of social welfare for a small open economy, reducing the attractiveness of reaping seigniorage revenue through inflation.

Economy size is crucial here not because of its absolute value, but due to its impact on the relative importance of seigniorage revenue: if gains from trade strongly dominate seigniorage revenue, convergence to Friedman rule becomes a better choice. It is the share of gains from trade in total welfare that determines whether a country is qualified as a legitimate provider of international currency. This result also means hegemony is reasonable for a unipolar world dominated by an economic superpower, whereas multiple international currencies make sense in a multipolar world with competing economies of similar sizes.

7.3 Global imbalance

The 2008 financial crisis brought into attention the huge trade deficit of United States, known as global imbalance now. Many studies regard it as a transitory phenomenon due

Figure 5: Size effect

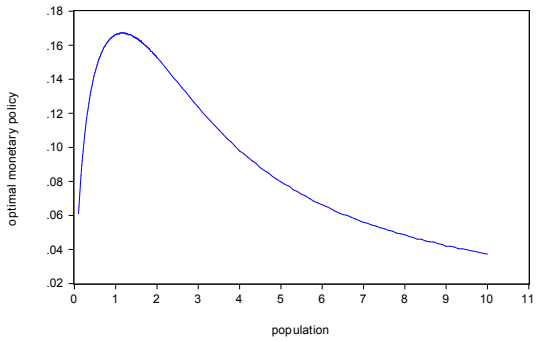
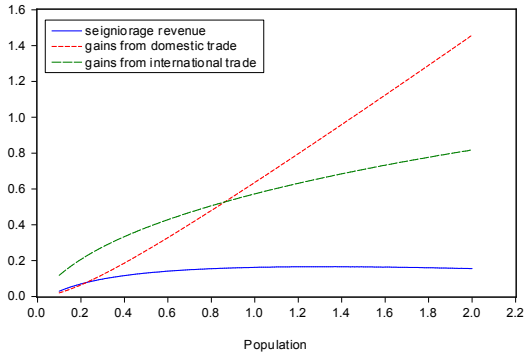


Figure 6: Welfare decomposition



to the saving glut of Asian countries (Bernanke, 2005) or the monetary policies of United states and exchange rate policy of emerging market countries (Obstfeld and Rogoff, 2009). Our model of international currency, as we will show latter, implies that global imbalance is a sustainable and structural symptom arising from the arrangement of international monetary system. If there's only one single international currency, the center country tends to experience trade deficit whereas a system of multiple international currencies would help reduce this global imbalance.

Now consider a perfect symmetric two country model, in which both countries are identical in size, openness, and monetary policy, so that $n_{12} = n_{21}$, $p_{12} = p_{21}$, $p_{11} = p_{22}$, $R_1 = R_2 > 0$. If country 1 issues the only international currency, the buyer's first order conditions indicate

$$R_1 = p_{11}L_D(q_{11}) + p_{12}L_I(q_{12}) = p_{21}L_I(q_{21}) \tag{28}$$

Due to the symmetry setup in model, we can have

$$p_{11}L_D(q_{11}) = p_{21}\Big(L_I(q_{21}) - L_I(q_{12})\Big) > 0 \tag{29}$$

As proved previously, the liquidity premium is decreasing in trade volume $L_I^{'}(q) < 0$, which leads to $q_{21} < q_{12}$. All these help determine country 1's trade balance as follows.

$$\mathrm{TB}_1 = \mathrm{EX}_1 - \mathrm{IM}_1 = n_{21}q_{21} - n_{12}q_{12} = n_{21}(q_{21} - q_{12}) < 0 \tag{30}$$

Why would country 1 experience trade deficit? This is related with the peculiar mechanism of monetary search model. Buyers hold currency because it is accepted for DM transaction in a successful matching. The currency holding therefore increases if the matching probability is higher. For country 1 buyers, they enjoy a good chance to get matched when holding country 1 currency, which is appreciated for both domestic and international trade. By

contrast, the matching probability for country 2 buyers is relatively lower when they hold country 1 currency, since it is accepted in only international trade. In this way, a better chance to get matched leads to the over-consumption tendency of country 1 buyers as well as the persistent global imbalance, which doesn't hold for other currency regimes. In PCP,

$$\begin{cases} R_1 = p_{11} L_D(q_{11}) = p_{21} L_I(21) \\ R_2 = p_{22} L_D(q_{22}) = p_{12} L_I(12) \\ R_1 = R_2 \end{cases} \tag{31}$$

With $q_{12} = q_{21}$, the trade balance of is zero. Similarly for LCP

$$\begin{cases} R_1 = p_{11} L_D(q_{11}) + p_{12} L_I(q_{12}) \\ R_2 = p_{22} L_D(q_{22}) + p_{21} L_I(q_{21}) \\ R_1 = R_2 \end{cases} \tag{32}$$

If we take the approximation that $L_I(q) \approx L_D(q)$, it must hold that $q_{12} = q_{21}$ and international trade is still balanced. This finding echoes Liu and Zhou (2015), who built a general equilibrium model to show the sustainability of US current account deficit resulting from the status of dollar as an international currency.[19] It should be cautioned here our model doesn't provide any normative analysis on global imbalance, since agents would always benefit from international trade, irrelevant with current account surplus or deficit. So this application only states that a system of multiple international currencies is desirable if global imbalance proves problematic and unsustainable.

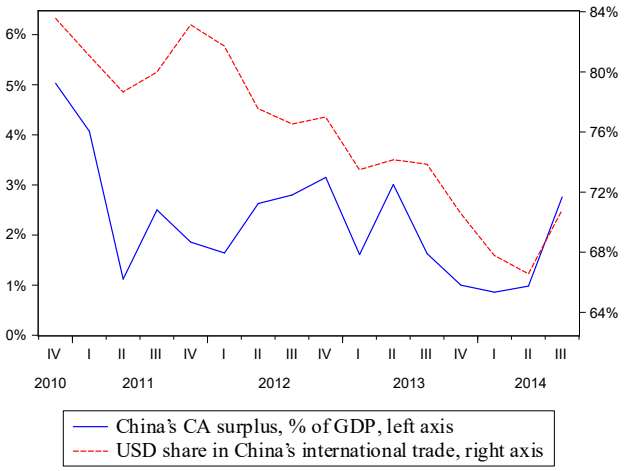
To further check the relationship between global imbalance and international currency, figure 7 shows the case for China during 2010Q4 and 2014Q3. We plot both its current account surplus and the share of USD in its international trade. The data on China's current account is from OECD dataset and the USD share is calculated from SWIFT dataset with the message type of MT 400 and MT 700. The result proves consistent with our theoretical expectation: the USD share is positively related with China's current account surplus. This also means RMB internationalization has the hope to alleviate both China's dependence on greenback and its excessive surplus in current account.

7.4 International vehicle currency

Our theoretical framework can be extended into N-country model to account for the emergence of IVC. Model details and equilibrium conditions are derived in appendix. Here we show one of its main finding: exporters in different countries tend to choose the same

[19] The mechanism of their model is quite different from ours. Like most invoicing currency model, they presumed CIA to introduce fiat money. USD is also exogenously assumed to be the only international currency. US trade deficit is determined by foreign demand of dollar. With positive long-run growth of global economy, there would be a structural global imbalance, whose magnitude is affected by the degree of openness, substitution elasticity between home and foreign goods, and the relative size of US economy to the rest of world.

Figure 7: Global imbalance and international currency



currency for their export to a certain country, as long as they are identical in bargaining power and cost function. In other words, exporters display herding behavior in their currency choice.

We still focus on the monetary equilibrium of international trade settled with financial intermediation. Consider country j exporter's gain from international trade with country i importer, settled in country k currency, and its expression follows.

$$\pi_{jik} = \left(\frac{\phi_k z_k}{\phi_k z_k + F_k}\right)\left(\frac{1}{1+R_k}\right)\phi_k m_k^i - \frac{c_j(q_{ij})}{\beta}$$

Notice that the heterogeneity of exporters would influence only the terms of trade. If exporters are identical in this aspect, their profit function would be identical for the export to a certain country, which leads to the rise of a common IVC to reduce financial friction. Therefore, exporters of commodity or homogeneous good tend to choose the same currency for settlement, which is consistent with the previous empirical literature. Goldberg and Tille (2008) showed that USD is the dominant invoicing currency for the international trade of commodity and homogeneous goods[20].

8 Conclusion

This paper examines the interaction among trade, finance and international currency both empirically and theoretically. Motived by the historical examples in Eichengreen

[20]Their explanation for this phenomenon is different. They argued that commodity price shows excessive volatility, and IVC is used to reduce exchange rate risk.

(2011) and the research initiative in Gopinath (2015), we argue for the importance of financial factors in determining the status of international currency. Empirically, we are the first to verify the financial channel in currency choices using a novel and comprehensive dataset from SWIFT. Theoretically, we provide a search-based model with financial intermediary to discuss the determinants of international currency, with particular emphasis on financial factors. The novelty of our model is that we not only allow the private agent to make currency choice, but also incorporate the financial intermediary as a middleman to facilitate international trade. The financial channel is important for the transmission and amplification of monetary policy effect, enabling us to explain the currency hegemony and incumbency advantage from a new perspective. The theoretic model also emphasizes government's role in taking initiative to foster domestic financial market and explores the conduct of monetary policy in different currency regimes, which has not been discussed in the previous literature. Last but not least, we argue that the global imbalance is partially attributed to USD as the single dominant international currency. The quantitative analysis shows the hump-shaped relationship between optimal inflation rate and international currency issuing country's economy size.

The findings in our paper have important policy implications for countries seeking to internationalize their home currencies. People's Bank of China (PBOC) has been trying to internationalize RMB in the past decade. Several measures are taken to accelerate this process, including currency swap agreement, offshore market development, cross-border trade settlement, and capital account liberalization. Our study highlights the importance of a deep and liquid domestic financial market, which should be among the new initiatives by PBOC to further promote RMB internationalization.

Our model makes the agent's currency choice as an equilibrium outcome where we explicitly formalized the essential role of money. However, the financial intermediary is simplified as a middleman to provide liquidity with fixed cost. Although this assumption makes the model tractable, it would be interesting to endogenize the rise of financial intermediary. Also, we've considered the international currency only as a medium of exchange, but its feature of safe asset in financial transaction might be more important, especially in times of crisis. Combining the dual roles of international currencies, as both medium of exchange and store of value, would be promising and rewarding, and we leave that to future research.

References

Ahn, J. (2015). Understanding trade finance: Theory and evidence from transaction-level data. *Working paper*.

Ahn, J., Amiti, M., and Weinstein, D. E. (2011). Trade finance and the great trade collapse. *The American Economic Review*, 101(3):298–302.

Amiti, M. and Weinstein, D. E. (2011). Exports and financial shocks. *The Quarterly Journal of Economics*, 126(4):1841–1877.

Asmundson, I., Dorsey, T., Khachatryan, A., Niculcea, I., and Saito, M. (2011). Trade and trade finance in the 2008-09 financial crisis. *International Monetary Fund*.

Auboin, M. (2009). Boosting the availability of trade finance in the current crisis: Background analysis for a substantial g20 package. *CEPR Policy Insight*, 35.

Bacchetta, P. and Van Wincoop, E. (2005). A theory of the currency denomination of international trade. *Journal of International Economics*, 67(2):295–319.

Berentsen, A., Camera, G., and Waller, C. (2007). Money, credit and banking. *Journal of Economic Theory*, 135(1):171–195.

Bernanke, B. S. (2005). The global saving glut and the us current account deficit.

Broz, J. L. (1997). *The international origins of the Federal Reserve System*. Cornell University Press.

Caballero, R. J., Farhi, E., and Gourinchas, P.-O. (2008). An equilibrium model of" global imbalances" and low interest rates. *The American Economic Review*, 98(1):358.

Chinn, M. D. and Ito, H. (2006). What matters for financial development? capital controls, institutions, and interactions. *Journal of development economics*, 81(1):163–192.

Chung, W. (2016). Imported inputs and invoicing currency choice: Theory and evidence from uk transaction data. *Journal of International Economics*, 99:237–250.

Cohen, B. J. (1971). *Future of sterling as an international currency*. St. Martin's Press.

Committee on the Global Financial System (2014). *Trade finance: developments and issues*. Bank for International Settlements.

Devereux, M. B. and Shi, S. (2013). Vehilcle currency. *International Economic Review*, 54(1):97–133.

Diamond, D. W. and Dybvig, P. H. (1983). Bank runs, deposit insurance, and liquidity. *The journal of political economy*, pages 401–419.

Eichengreen, B. (2011). *Exorbitant Privilege: The rise and fall of the Dollar and the Future of the International Monetary System*. Oxford University Press.

Eichengreen, B. and Flandreau, M. (2012). The federal reserve, the bank of england, and the rise of the dollar as an international currency, 1914–1939. *Open Economies Review*, 23(1):57–87.

Feldstein, M. (2008). Resolving the global imbalance: The dollar and the us saving rate. *The Journal of Economic Perspectives*, 22(3):113–125.

Frankel, J. (2012). Internationalization of the rmb and historical precedents. *Journal of Economic Integration*, 27(3):329–365.

Friberg, R. and Wilander, F. (2008). The currency denomination of exportsa questionnaire study. *Journal of International Economics*, 75(1):54–69.

Geromichalos, A. and Jung, K. M. (2017). An over-the-counter approach to the forex market. *International Economic Review, forthcoming*.

Geromichalos, A. and Simonovska, I. (2014). Asset liquidity and international portfolio choice. *Journal of Economic Theory*, 151:342–380.

Goldberg, L. S. and Tille, C. (2008). Vehicle currency use in international trade. *Journal of International Economics*, 76(2):177–192.

Goldberg, L. S. and Tille, C. (2013). A bargaining theory of trade invoicing and pricing. *NBER working paper*.

Goldberg, L. S. and Tille, C. (2016). Micro, macro, and strategic forces in international trade invoicing: Synthesis and novel patterns. *Journal of International Economics*.

Gopinath, G. (2015). The international price system. *NBER working paper*.

Grassman, S. (1973). A fundamental symmetry in international payment patterns. *Journal of International Economics*, 3(2):105–116.

He, Q., Korhonen, I., Guo, J., and Liu, F. (2016). The geographic distribution of international currencies and rmb internationalization. *International Review of Economics & Finance*, 42:442–458.

ICC Banking Commission (2016). Rethinking Trade and Finance 2016: An ICC Private Sector Development Perspective.

Ito, H. and Chinn, M. (2013). The rise of the 'redback' and china's capital account liberalization: an empirical analysis on the determinants of invoicing currencies. *Working Paper*.

Jung, K. M. and Lee, S. (2015). A liquidity-based resolution of the uncovered interest parity puzzle. *Working Paper*.

Jung, K. M. and Pyun, J. H. (2016). International reserves for emerging economies: A liquidity approach. *Journal of International Money and Finance*, 68:230–257.

Kalai, E. (1977). Proportional solutions to bargaining situations: interpersonal utility comparisons. *Econometrica: Journal of the Econometric Society*, pages 1623–1630.

Kamps, A. (2006). The euro as invoicing currency in international trade. *ECB working paper*.

Krugman, P. (1980). Vehicle currencies and the structure of international exchange. *Journal of Money, Credit and Banking*, 12(3):513–26.

Lagos, R. and Wright, R. (2005). A unified framework for monetary theory and policy analysis. *Journal of Political Economy*, 113(3).

Lester, B., Postlewaite, A., and Wright, R. (2012). Information, liquidity, asset prices, and monetary policy. *The Review of Economic Studies*, 79(3):1209–1238.

Liu, K. and Zhou, X. (2015). The US dollar and global imbalance. *MPRA working paper*.

Liu, Q. and Shi, S. (2010). Currency areas and monetary coordination. *International Economic Review*, 51(3):813–836.

Manova, K. (2012). Credit constraints, heterogeneous firms, and international trade. *Review of Economic Studies*, 80(2):711–744.

Manova, K., Wei, S.-J., and Zhang, Z. (2015). Firm exports and multinational activity under credit constraints. *Review of Economics and Statistics*, 97(3):574–588.

Matsuyama, K., Kiyotaki, N., and Matsui, A. (1993). Toward a theory of international currency. *The Review of Economic Studies*, 60(2):283–307.

McKinnon, R. I. (1979). *Money in international exchange: the convertible currency system*. Oxford University Press.

Niepmann, F. and Schmidt-Eisenlohr, T. (2014). International trade, risk and the role of banks. *CESifo Working Paper Series*.

Niepmann, F. and Schmidt-Eisenlohr, T. (2017). International trade, risk and the role of banks. *Journal of International Economics*, 107:111 – 126.

Obstfeld, M. and Rogoff, K. (1995). Exchange rate dynamics redux. *The Journal of Political Economy*, 103(3):624–660.

Obstfeld, M. and Rogoff, K. (2009). Global imbalances and the financial crisis: products of common causes. *CEPR Discussion Paper No. DP7606*.

Rauch, J. E. (1999). Networks versus markets in international trade. *Journal of international Economics*, 48(1):7–35.

Reiss, D. G. (2015). Invoice currency: Puzzling evidence and new questions from brazil. *EconomiA*, 16(2):206–225.

Rey, H. (2001). International trade and currency exchange. *The Review of Economic Studies*, 68(2):443–464.

Schmidt-Eisenlohr, T. (2013). Towards a theory of trade finance. *Journal of International Economics*, 91(1):96–112.

Shi, S. (1997). A divisible search model of fiat money. *Econometrica: Journal of the Econometric Society*, pages 75–102.

Trejos, A. and Wright, R. (1996). Searchtheoretic models of international currency. *Federal Reserve Bank of St. Louis Review*, 78(May/June 1996).

Williamson, S. D. (2012). Liquidity, monetary policy, and the financial crisis: A new monetarist approach. *American Economic Review*, 102(6):2570–2605.

Yu, Y. (2013). How Far Internationalization of the RMB Can Go. *Mimeo. Chinese Academy of Social Sciences (CASS)*.

Zhang, C. (2014). An information-based theory of international currency. *Journal of International Economics*, 93(2):286–301.

A Appendix

A.1 Letter of credit step by step

Figure 1 shows the working mechanism of LC. The following step of LC is in order.

Step 1 Exporter and importer determine terms of trade and sign business contract.

Step 2 Importer would go to issuing bank, show the contract, and apply for LC. The issuing bank usually asks for a certain amount of collateral from importer before LC is issued.

Letter of credit is "a commitment by a bank on behalf of the buyer that payment would be made to the beneficiary provided that the terms and conditions stated in LC has been met, consisting of the presentation of specified documents" (US department of commerce). The issuing bank would make payment only a certain days after shipment, and that's the maturity of LC, usually around 3 months.

Step 3 The issuing bank would send LC to advising bank for scrutiny.

Step 4 After checking details, advising bank would notify exporter so that he could prepare shipment.

Step 5 Exporter makes shipment and gets the required document, especially bill of lading (B/L).

Bill of lading is a document issued by carrier which details a shipment of merchandise and gives title of that shipment to a specified party, usually its holder.

Step 6 Exporter sends required document to advising bank for payment.

Step 7 After checking the required document, advising bank would notify the issuing bank. In principle, exporter needs to wait until maturity of LC, but he is usually in urgent need of liquidity, so advising bank would make payment to exporter at discount.

Step 8 The principle of "borrow short and lend long" makes advising bank unwilling to hold LC, given its short maturity. Advising bank would sell combine LC and other required documents as trade acceptance and sell it to any interested parties.

The set of documents including LC and B/L is referred to as trade acceptance or banker's acceptance, whose payment is guaranteed by both issuing bank and advising bank, making it attractive for short-term investment.

Step 9 Upon maturity, anyone holding trade acceptance could go to issuing bank for payment. After checking the required document, issuing bank would notify importer. The importer then makes payment and gets shipment.

A.2 Proof of Proposition 1

To prove that there is a unique and stationary equilibrium, we need to start from buyer's maximization problem

$$\max_{m_i^i, m_j^i} \left\{ (\beta\hat{\phi}_i - \phi_i)m_i^i + (\beta\hat{\phi}_j - \phi_j)m_j^i + p_{ii}\Big(u(q_{ii}) - d_{ii}(m_i^i)\Big) + \beta p_{ij}\Big(u(q_{ij}) - d_{ij}(m_i^i, m_j^i)\Big) \right\}$$

To prove the uniqueness and existence of this maximization problem's solution, define the following function of buyer's currency holding. To simplify our analysis below, we only show the case for LCP regime. The situations in other regimes are similar.

$$F(m_i^i, m_j^i) = (\beta\hat{\phi}_i - \phi_i)m_i^i + (\beta\hat{\phi}_j - \phi_j)m_j^i + p_{ii}\Big(u(q_{ii}) - d_{ii}(m_i^i)\Big) + \beta p_{ij}\Big(u(q_{ij}) - d_{ij}(m_i^i, m_j^i)\Big)$$

We would like to show this function is monotonically increasing and concave. With respect to country i buyer's holding of home currency, the first and second-order derivatives follow.

$$\frac{\partial F}{\partial m_i^i} = \beta\hat{\phi}_i - \phi_i + \beta\hat{\phi}_i p_{ii}\frac{\theta(u'(q) - c'(q))}{(1-\theta)u'(q) + \theta c'(q)}$$

$$\frac{\partial F}{\partial m_j^i} = \beta\hat{\phi}_j - \phi_j + \beta\hat{\phi}_j p_{ij}\frac{\theta(u'(q) - c'(q/\beta))}{(1-\theta)u'(q) + \theta c'(q)/\beta}$$

$$\frac{\partial^2(F)}{\partial(m_i^i)^2} = \beta\hat{\phi}_i p_{ii}\frac{\theta(c'u'' - u'c'')}{[(1-\theta)u' + \theta c']^2}$$

$$\frac{\partial^2(F)}{\partial(m_j^i)^2} = \beta\hat{\phi}_j p_{ij}\frac{\theta(c'u'' - u'c'')/\beta}{[(1-\theta)u' + \theta c'/\beta]^2}$$

Recall our assumption function form such as $c' > 0,\ c'' > 0,\ u' > 0,\ u'' < 0,\ u'(0) = \infty,\ c'(0) = 0$. If the nominal interest rate is not very high, we can have $\frac{\partial F}{\partial m_i^i} > 0,\ \frac{\partial F}{\partial m_j^i} > 0$. Our assumption on function form also ensures that $\frac{\partial^2(F)}{\partial(m_i^i)^2} < 0,\ \frac{\partial^2(F)}{\partial(m_i^i)^2} < 0$. The solution for buyer's maximization problem therefore exists and is unique. Other variables in our equilibrium, such as banker's holding of fiat money and exporter's currency choice, are determined with linear function due to the linearity of CM value function, so they are the unique solution for maximization problem. Our equilibrium is therefore unique and stationary. Proposition 2 is herein proved.

A.3 Proof of proposition 2

For simplicity, we focus on the equilibrium of PCP, and the proof in other currency regime is similar.

the first order condition for country 1 buyer is now

$$R_2 = p_{12}\left[\frac{\theta(u'(q_{12}) - c'(q_{12})/\beta)}{(1-\theta)u'(q_{12}) + \theta c'(q_{12})/\beta}\right]$$

Recall the definition of liquidity premium.

$$L_I(q) \equiv \frac{\theta(u'(q) - \frac{c'(q)}{\beta})}{(1-\theta)u'(q) + \theta\frac{c'(q)}{\beta}}$$

Take differentiation with respect to q, we could get the following result.

$$L_I'(q) = \frac{\theta}{\beta}\left[(1-\theta)u'(q) + \frac{\theta}{\beta}c'(q)\right]^{-2}(u''c' - u'c'')$$

With previous assumption on function form, $u' > 0, c' > 0, u'' < 0, c'' > 0$, it's obvious that $L'(q) < 0$, so buyer's liquidity premium is decreasing in his trade volume.

With these results, return to the first order condition of country 1 buyer, and take differentiation with respect to R_2 on both sides, we get

$$1 = p_{12}L_I'(q_{12})\frac{\partial q_{12}}{\partial R_2}$$

Obviously, $L'(q_{12}) < 0$ leads to $\frac{\partial q_{12}}{\partial R_2} < 0$. Therefore, a higher inflation level would decrease trade volume ($q_{12} \downarrow$) as well as buyer's currency holding ($m_2^1 \downarrow$).

Now consider banker's holding of country 2 currency

$$\phi_2 z_2 + F_2 = \frac{n_{12}\phi_2 m_2^1}{1+R_2}$$

Obviously banker's currency holding also goes down given that $R_2 \downarrow$ and $\phi_2 m_{12} \downarrow$. Then we are ready to move to the final stage of proof, summarized in lemma 1.

Lemma 1 *If exporter's financial loss is more sensitive than DM cost function in response to interest rate shock, i.e.,* $(\epsilon_f + \epsilon_c) > 0$ *, exporter's gain from international trade is decreasing in nominal interest rate, i.e.,* $\frac{\partial \pi}{\partial R} < 0$.

Proof Let $\beta^E \equiv (\frac{\phi z}{\phi z + F})(1+R)^{-1}$ denote the effective discount factor for exporter. Without loss of generality, assume $\beta^E < \beta$ so that financial friction would reduce exporter's gain from trade. Therefore, $(\beta - \beta^E) > 0$ is a measure of seller's financial loss. Combine the expression of buyer's payment in DM and seller's profit in section (3.2.4), we get

$$\pi = \beta^E(1-\theta)\left[u(q) - \frac{c(q)}{\beta}\right] - \frac{1}{\beta}(\beta - \beta^E)c(q).$$

Given that $\frac{\partial \phi z}{\partial R} < 0$, it's easy to find that $\frac{\partial \beta^E}{\partial R} < 0$. With the previous condition in proportional bargaining, $q < q^*,\ u'(q*) = \frac{c'(q^*)}{\beta},\ u' < 0,\ c' > 0$, the first item is decreased in R. For the second item, differentiate with respect to R, we get $\frac{cf}{\beta R}(\epsilon_f + \epsilon_c)$, where $f \equiv (\beta - \beta_E)$ captures the degree of seller's financial loss, $\epsilon_f \equiv \frac{\partial f}{\partial R}\frac{R}{f}$ is the elasticity of financial loss on nominal interest rate. Similarly, ϵ_c is the elasticity of seller's DM cost in response to interest rate shock. Obviously, $\epsilon_f > 0, \epsilon_c < 0$. A sufficient condition for $\frac{\partial \pi}{\partial R} < 0$ is $\epsilon_f + \epsilon_c > 0$. Therefore, as long as financial loss is more sensitive to the change of nominal interest rate, higher inflation level would decrease exporter's gain from international trade.

A.3.1 Welfare level

For PCP, the welfare level is the following.

$$\begin{aligned} W_1 =& \underbrace{\mu_1\sigma\phi_1 m_1^2 - \mu_2\sigma\phi_2 m_2^1}_{\text{Seigniorage revenue}} + \underbrace{n_{11}\big[\beta u(q_1^1) - c(q_1^1)\big]}_{\text{domestic trade surplus}} + \underbrace{n_{12}\theta\big[\beta u(q_2^1) - c(q_2^1)\big]}_{\text{importer surplus}} \\ &+ \underbrace{n_{21}\left\{\big[1 - \frac{F_1}{(1-2\sigma)\phi_1 z_1}\big]\big(\frac{1}{1+R_1}\big)\phi_1 m_1^2 - c(q_1^2)\right\}}_{\text{exporter surplus}} - F_1 \end{aligned}$$

$$\begin{aligned} W_2 =& \mu_2\sigma\phi_2 m_2^1 - \mu_1\sigma\phi_1 m_1^2 + n_{22}\big[\beta u(q_2^2) - c(q_2^2)\big] + n_{21}\theta\big[\beta u(q_1^2) - c(q_1^2)\big] \\ &+ n_{12}\left\{\big[1 - \frac{F_2}{(1-2\sigma)\phi_2 z_2}\big]\big(\frac{1}{1+R_2}\big)\phi_2 m_2^1 - c(q_2^1)\right\} - F_2 \end{aligned}$$

For LCP, welfare level is the following.

$$\begin{aligned} W_1 =& \underbrace{n_{11}\big[\beta u(q_1^1) - c(q_1^1)\big]}_{\text{domestic trade surplus}} + \underbrace{n_{12}\theta\big[\beta u(q_1^1) - c(q_1^1)\big]}_{\text{importer surplus}} \\ &+ \underbrace{n_{21}\left\{\big[1 - \frac{F_2}{(1-2\sigma)\phi_2 z_2}\big]\big(\frac{1}{1+R_2}\big)\phi_2 m_2^2 - c(q_2^2)\right\}}_{\text{exporter surplus}} - F_1 \end{aligned}$$

$$\begin{aligned} W_2 =& n_{22}\big[\beta u(q_2^2) - c(q_2^2)\big] + n_{21}\theta\big[\beta u(q_2^2) - c(q_2^2)\big] \\ &+ n_{12}\left\{\big[1 - \frac{F_1}{(1-2\sigma)\phi_1 z_1}\big]\big(\frac{1}{1+R_1}\big)\phi_2 m_1^1 - c(q_1^1)\right\} - F_2 \end{aligned}$$

A.4 Determinants of exchange rate in search model

In search model, the determinants of nominal exchange rate depends on the law of one price. In previous study, the law of one price is assumed to hold only for numéraire good, so that its price denominated in different currencies should be the same. This implies

$$\frac{1}{\phi_i} = \frac{1}{\phi_j} e_{i/j} \quad \forall i, j \in \{1, 2\},\ i \neq j$$

where $e_{i/j}$ is the nominal exchange rate of country i currency against country j currency, with its increase indicating a relative appreciation of country j currency and depreciation of country i currency. The assumption of law of one price for numéraire good is reasonable, since it's traded in CM, which is a Walrasian market allowing for arbitrage and equalized price. The determinants of exchange rate ($e_{i/j} = \phi_j/\phi_i$) are totally based on currency value, under the control of central banks: a higher level of inflation leads to value decrease and currency depreciation. This fundamental-based determinant, however, couldn't explain exchange rate dynamics to a satisfactory degree. The well-known exchange rate disconnection puzzle revealed the poor performance of such models in forecasting and prediction. In this part, we would revisit the determinants of exchange rate in search model, by applying the law of one price to differentiated good.

Search theory has a long history of discussing international currency and exchange rate. Previous studies used second-generation search model to show that the status of international currency gives USD more purchasing power, which could explain why the exchange rate of USD is an out-lier according standard theory. Here we would continue this discussion with our two-country third-generation search model. Since DM in our model is segmented by border, the law of one price would only be applied to the differentiated good originating from the same country. For all the discussion below, $\forall i, j \in \{1, 2\},\ i \neq j$.

A.4.1 Producer Currency Pricing, PCP

In a world of PCP where the international trade is settled by exporter's home currency, the law of one price for differentiated good couldn't be applied. For the differentiated good in country i, if country i seller meets country i buyer, the domestic trade is settled by country i currency at the price level of m_i^i/q_i^i; if country i seller meets country j buyer, the export is still denominate by country i currency, only at a different price level of m_i^j/q_i^j. So here's one good with two prices, but denominated in the same currency. So it's proper to interpret this as price discrimination due to searching friction.

A.4.2 Local Currency Pricing, LCP

In a world of LCP where the international trade is settled by importer's home currency, the law of one price could be applied. For the differentiated good in country i, if country i seller meets country i buyer, the domestic trade is settled by country i currency, at the price level of m_i^i/q_i^i; if country i seller meets country j buyer, the country would be settled

by country j currency at the price level of m_j^j/q_j^j. Here's one good denominated in different currencies at different price levels. If the law of one price holds, the determinant equation for exchange rate is

$$\frac{1}{\phi_i}\frac{\phi_i m_i^i}{q_i^i} = \frac{1}{\phi_j}\frac{\phi_j m_j^j}{q_j^j} e_{i/j} \Rightarrow e_{i/j} = \left(\frac{\phi_j}{\phi_i}\right)\left(\frac{\phi_i m_i^i/q_i^i}{\phi_j m_j^j/q_j^j}\right) \Rightarrow e_{i/j} = \left(\frac{\phi_j}{\phi_i}\right)\left\{\frac{[(1-\theta)u(q_i^i)+\theta c(q_i^i)/\beta]/q_i^i}{[(1-\theta)u(q_j^j)+\theta c(q_j^j)/\beta]/q_j^j}\right\}$$

The last step of derivation used the DM bargaining solution for buyer's payment. In contrast to the fundamental-based determinants of exchange rate, the equation above also incorporates the relative searching friction.

$$e_{i/j} = \underbrace{\left(\frac{\phi_j}{\phi_i}\right)}_{\text{monetary policy}} \underbrace{\left\{\frac{[(1-\theta)u(q_i^i)+\theta c(q_i^i)/\beta]/q_i^i}{[(1-\theta)u(q_j^j)+\theta c(q_j^j)/\beta]/q_j^j}\right\}}_{\text{Relative searching friction}}$$

To further discuss the impact of searching friction on exchange rate, it's necessary to make reasonable assumption on the function form of utility and cost.

Assumption 1 *The average price of differentiated good is decreasing in trade volume, i.e.* $\partial(\phi m/q)/\partial q < 0$. *Given the DM bargaining solution for buyer's the payment, this is equivalent to* $(1-\theta)u'(q) + \theta c'(q)/\beta < 1$.

This assumption is also consistent with the daily experience that wholesale price is normally lower than retail price. Now it's possible to discuss the impact of searching friction on exchange rate.

Proposition 5 *All else equal, the currency with a lower level of searching friction would experience nominal appreciation.*

Proof Consider the first order condition for country i buyer's optimal currency holding

$$R_i = (p_{ii} + p_{ij})L(q_i^i)$$

In this case, lower searching friction means a higher level of matching probability. Therefore, the following result could be derived at a given nominal interest rate.

$$(p_{ii}+p_{jj}) \uparrow \Rightarrow L(q_i^i) \downarrow \Rightarrow q_i^i \uparrow \Rightarrow (\phi_i m_i^i/q_i^i) \downarrow \Rightarrow \left(\frac{\phi_j}{\phi_i}\right)\left(\frac{\phi_i m_i^i/q_i^i}{\phi_j m_j^j/q_j^j}\right) \downarrow \Rightarrow e_{i/j} \downarrow$$

Along this line of derivation, the second step utilized the property of liquidity premium, and the fourth step is from assumption 1. Intuitively, less searching friction leads to better matching probability, and increased trade volume improves the purchasing power of currency, with nominal appreciation as a result.

A.4.3 Single international currency in symmetric case

If country i currency becomes the single international currency to settle trade, it's PCP for country i and LCP for country j. Given our discussion above, the law of one price could be applied to only country j differentiated good.

$$\frac{1}{\phi_i}\frac{\phi_i m_i^i}{q_i^i} = \frac{1}{\phi_j}\frac{\phi_j m_j^j}{q_j^j} e_{i/j} \Rightarrow e_{i/j} = \left(\frac{\phi_j}{\phi_i}\right)\left(\frac{\phi_i m_i^i / q_i^i}{\phi_j m_j^j / q_j^j}\right)$$

Assume a symmetric case in which two countries are identical in every aspect other than that country i issues the only international currency. In this situation, similar to the discussion on global imbalance, country i residents have better chance to get matched so they hold more currency and consume more. According to proposition 5, international currency normally enjoys appreciation, i.e.,

$$q_i^i > q_j^j \Rightarrow e_{i/j} < 1$$

A.5 Three-country model

The potential payment system in three-country model is quite numerous, and this part is concerned about the rise of international vehicle currency (IVC), which is used to settle trade between non-issuing countries. The assumption in two-country model could be easily applied here, requiring only minor change of notation. $\forall i, j, k \in 1, 2, 3$, p_{ij} is the probability of successful matching between country i buyer and country j seller; n_{ij} is the corresponding number of meeting; q_j^i is country i buyer's holding of country j currency; π_{ij}^k is country j seller's profit from his trade with country i buyer, settled in country k currency. Most importantly, here we assume sellers in different countries are identical in bargaining power and cost function, so that the consistency from proposition 2 would hold. For simplicity, the following discussion covers only the case of single and double international currency.

A.5.1 Single dominance

Now consider a case of hegemony in three-country model, assuming country 1 issues the only international currency. Figure 8 shows the payment system in this case, where all the international trade is settled in country 1 currency. The following equilibrium condition is in order.

For buyer

$$\begin{cases} R_1 = (p_{11} + p_{12} + p_{13})L(q_1^1) = (p_{21} + p_{23})L(q_1^2) = (p_{31} + p_{32})L(q_1^3) & (3.1.1) \\ R_2 = p_{22}L(q_2^2) & (3.1.2) \\ R_3 = p_{33}L(q_3^3) & (3.1.3) \end{cases}$$

For seller

$$\begin{cases} \pi_{21}^1 = \pi_{23}^1 = J_1\phi_1 m_1^2 - c(q_1^2) > 0 & (3.1.4) \\ \pi_{31}^1 = \pi_{32}^1 = J_1\phi_1 m_1^3 - c(q_1^3) > 0 & (3.1.5) \end{cases}$$

For investor

$$\big[(1-2\sigma)\phi_1 z_1\big](1+R_1) = (n_{12}+n_{13})\phi_1 m_1^1 + (n_{21}+n_{23})\phi_1 m_1^2 + (n_{31}+n_{32})\phi_1 m_1^3 \quad (3.1.6)$$

Money market

$$\begin{cases} \sigma(\phi_1 m_1^1 + \phi_1 m_1^2 + \phi_1 m_1^3) + (1-\sigma)\phi_1 z_1 + F_1 = \phi_1 M_1 & (3.1.7) \\ \sigma\phi_2 m_2^2 = \phi_2 M_2 & (3.1.8) \\ \sigma\phi_3 m_3^3 = \phi_3 M_3 & (3.1.9) \end{cases}$$

The incumbency advantage from proposition 4 still applies here: as long as individual sellers enjoy positive profit from international trade, they have no incentive to deviate from the existing equilibrium.

A.5.2 Dual dominance: PCP

Now consider the case of double international currencies where the international trade between country 1 and 2 is settled through PCP, while country 3 relies on other country's currency for settlement. To achieve consistency of decision, country 3 sellers choose country 1 currency to settle trade with country 2, which is the same as country 1 seller's choice. Apply a similar procedure to other seller's choice, and the payment pattern is shown in figure 9, with the following equilibrium condition. *For buyer*

$$\begin{cases} R_1 = p_{11}L(q_1^1) = (p_{21}+p_{23})L(q_1^2) = (p_{31}+p_{32})L(q_1^3) & (3.2.1) \\ R_2 = p_{22}L(q_2^2) = (p_{13}+p_{12})L(q_2^1) & (3.2.2) \\ R_3 = p_{33}L(q_3^3) & (3.2.3) \end{cases}$$

For seller

$$\begin{cases} \pi_{12}^2 = \pi_{13}^2 = J_2\phi_2 m_2^1 - c(q_2^1) > 0 & (3.2.4) \\ \pi_{21}^1 = \pi_{23}^1 = J_1\phi_1 m_1^2 - c(q_1^2) > 0 & (3.2.5) \\ \pi_{31}^1 = \pi_{32}^1 = J_1\phi_1 m_1^3 - c(q_1^3) > 0 & (3.2.6) \\ \pi_{21}^1 > \pi_{21}^2 \Rightarrow J_1\phi_2 m_2^1 - c(q_2^1) > J_2\phi_2 m_2^2 - c(q_2^2) & (3.2.7) \\ \pi_{12}^2 > \pi_{12}^1 \Rightarrow J_2\phi_2 m_2^1 - c(q_2^1) > J_1\phi_1 m_1^1 - c(q_1^1) & (3.2.8) \end{cases}$$

For investor

$$\begin{cases} \big[(1-2\sigma)\phi_1 z_1\big](1+R_1) = (n_{21}+n_{23})\phi_1 m_1^2 + (n_{31}+n_{32})\phi_1 m_1^3 & (3.2.9) \\ \big[(1-2\sigma)\phi_2 z_2\big](1+R_2) = (n_{12}+n_{13})\phi_2 m_2^1 & (3.2.10) \end{cases}$$

Money market

$$\begin{cases} \sigma(\phi_1 m_1^1 + \phi_1 m_1^2 + \phi_1 m_1^3) + (1-2\sigma)\phi_1 z_1 + F_1 = \phi_1 M_1 & (3.2.11) \\ \sigma(\phi_2 m_2^2 + \phi_2 m_2^1) + (1-2\sigma)\phi_2 z_2 + F_2 = \phi_2 M_2 & (3.2.12) \\ \sigma\phi_3 m_3^3 = \phi_3 M_3 & (3.2.13) \end{cases}$$

With double international currencies, the incumbency advantage in proposition 4 is no longer present. The existence of such equilibrium requires not only positive profit for sellers, but also the incentive-compatible condition in (3.2.7) and (3.2.8), otherwise deviation is justified.

A.5.3 Dual dominance: LCP

For another possibility of double international currency, assume the trade between country 1 and 2 to be settled through LCP. Figure 10 shows the payment system, and several equilibrium conditions follow. *For buyer*

$$\begin{cases} R_1 = (p_{11} + p_{12} + p_{13})L(q_1^1) = (p_{31} + p_{32})L(q_1^3) & (3.3.1) \\ R_2 = (p_{22} + p_{21} + p_{23})L(q_2^2) & (3.3.2) \\ R_3 = p_{33}L(q_3^3) & (3.3.3) \end{cases}$$

For seller

$$\begin{cases} \pi_{12}^1 = \pi_{13}^1 = J_1\phi_1 m_1^1 - c(q_1^1) > 0 & (3.3.4) \\ \pi_{21}^2 = \pi_{23}^2 = J_2\phi_2 m_2^2 - c(q_2^2) > 0 & (3.3.5) \\ \pi_{31}^1 = \pi_{32}^1 = J_1\phi_1 m_1^3 - c(q_1^3) > 0 & (3.3.6) \end{cases}$$

For investor

$$\begin{cases} \big[(1-2\sigma)\phi_1 z_1\big](1+R_1) = (n_{12}+n_{13})\phi_1 m_1^2 + (n_{31}+n_{32})\phi_1 m_1^3 & (3.3.7) \\ \big[(1-2\sigma)\phi_2 z_2\big](1+R_2) = (n_{21}+n_{23})\phi_2 m_2^2 & (3.3.8) \end{cases}$$

Money market

$$\begin{cases} \sigma(\phi_1 m_1^1 + \phi_1 m_1^3) + (1-2\sigma)\phi_1 z_1 + F_1 = \phi_1 M_1 & (3.3.9) \\ \sigma\phi_2 m_2^2 + (1-2\sigma)\phi_2 z_2 + F_2 = \phi_2 M_2 & (3.3.10) \\ \sigma\phi_3 m_3^3 = \phi_3 M_3 & (3.3.13) \end{cases}$$

One interesting feature in this system is the pattern of IVC. For PCP in figure 9, the trade between country 2 and 3 is completely settled by country 1 currency, while for LCP in figure 10, there's no such dominant IVC.

A.6 Data source and description

Table 6: Country list in panel regression

Country name	ISO 3-letter code	Sample period
Albania	ALB	2011, 2012, 2013
Algeria	DZA	2011, 2012, 2013
Argentina	ARG	2011

continued on next page

Country name	ISO 3-letter code	Sample period
Armenia	ARM	2011, 2012, 2013
Austria	AUT	2011, 2012, 2013
Azerbaijan	AZE	2011, 2012, 2013
Bangladesh	BGD	2011
Belarus	BLR	2011, 2012, 2013
Belgium	BEL	2011, 2012, 2013
Benin	BEN	2011, 2012, 2013
Bolivia	BOL	2011
Brazil	BRA	2011, 2012, 2013
Bulgaria	BGR	2011, 2012, 2013
Burkina Faso	BFA	2011, 2013
Cabo Verde	CPV	2011, 2012, 2013
Cambodia	KHM	2011, 2012, 2013
Cameroon	CMR	2011, 2012
Chile	CHL	2011, 2012, 2013
China, Hong Kong	HKG	2011, 2012, 2013
China, Macao	MAC	2011, 2012
China, mainland	CHN	2011, 2012, 2013
Colombia	COL	2011, 2012, 2013
Republic of Congo	COG	2012, 2013
Costa Rica	CRI	2011, 2012, 2013
Croatia	HRV	2011, 2012, 2013
Cyprus	CYP	2011, 2012
Czech Republic	CZE	2011, 2012, 2013
Denmark	DNK	2011, 2012, 2013
Dominican Republic	DOM	2011, 2012, 2013
Egypt	EGY	2011, 2012, 2013
Estonia	EST	2011, 2012, 2013
Fiji	FJI	2011, 2012, 2013
Finland	FIN	2011, 2012, 2013
France	FRA	2011, 2012, 2013
Gambia	GMB	2011, 2012, 2013
Georgia	GEO	2011
Germany	DEU	2011, 2012, 2013
Ghana	GHA	2011
Greece	GRC	2011, 2012
Guatemala	GTM	2011, 2012, 2013
Guyana	GUY	2011, 2012, 2013
Honduras	HND	2011, 2012
Hungary	HUN	2011, 2012, 2013
Iceland	ISL	2011, 2012, 2013
India	IND	2011, 2012, 2013
Indonesia	IDN	2011, 2012, 2013
Iran	IRN	2011
Ireland	IRL	2011, 2012, 2013
Israel	ISR	2011

continued on next page

Country name	ISO 3-letter code	Sample period
Italy	ITA	2011, 2012, 2013
Japan	JPN	2013
Kazakhstan	KAZ	2011, 2012, 2013
Kenya	KEN	2013
Republic of Korea	KOR	2011, 2012, 2013
Latvia	LVA	2011, 2012
Lithuania	LTU	2011, 2012, 2013
Macedonia	MKD	2011, 2012, 2013
Madagascar	MDG	2011, 2012, 2013
Malawi	MWI	2013
Malaysia	MYS	2011, 2012, 2013
Maldives	MDV	2011, 2012, 2013
Mali	MLI	2011, 2012
Malta	MLT	2011, 2012, 2013
Mauritania	MRT	2011, 2012
Mauritius	MUS	2011, 2012, 2013
Mexico	MEX	2011, 2012, 2013
Moldova	MDA	2011, 2013
Mongolia	MNG	2013
Morocco	MAR	2011, 2012, 2013
Mozambique	MOZ	2011, 2012, 2013
Nepal	NPL	2011, 2012, 2013
Netherlands	NLD	2011, 2012, 2013
Nicaragua	NIC	2011, 2012, 2013
Niger	NER	2011, 2012, 2013
Nigeria	NGA	2011, 2012, 2013
Pakistan	PAK	2011, 2012, 2013
Paraguay	PRY	2011, 2012, 2013
Peru	PER	2011, 2012, 2013
Philippines	PHL	2011, 2012, 2013
Poland	POL	2011, 2012, 2013
Portugal	PRT	2011, 2012, 2013
Romania	ROU	2011, 2012, 2013
Russia	RUS	2011, 2012, 2013
Sao Tome and Principe	STP	2011, 2012
Senegal	SEN	2011, 2012, 2013
Singapore	SGP	2011, 2012, 2013
Slovenia	SVN	2011, 2012, 2013
Solomon Islands	SLB	2011, 2012, 2013
South Africa	ZAF	2011, 2012, 2013
Spain	ESP	2011, 2012, 2013
Sri Lanka	LKA	2011, 2012, 2013
Sudan	SDN	2011
Sweden	SWE	2011, 2012
Switzerland	CHE	2011
Tanzania	TZA	2011, 2012, 2013

continued on next page

Country name	ISO 3-letter code	Sample period
Thailand	THA	2011, 2012, 2013
Togo	TGO	2011, 2012, 2013
Tunisia	TUN	2011, 2012, 2013
Turkey	TUR	2011, 2012, 2013
Uganda	UGA	2011, 2012, 2013
United Kingdom	GBR	2011, 2012, 2013
Uruguay	URY	2011, 2012, 2013
Vietnam	VNM	2011, 2013
Yemen	YEM	2012
Zambia	ZMB	2011, 2012, 2013

Data source: SWIFT dataset.

Figure 8: Three-country model: single international currency

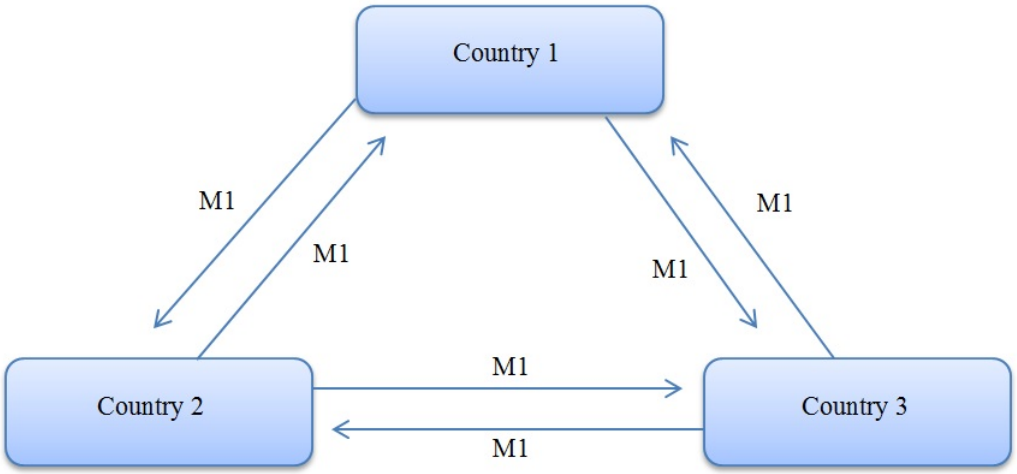


Figure 9: Three-country model: dual international currency, PCP

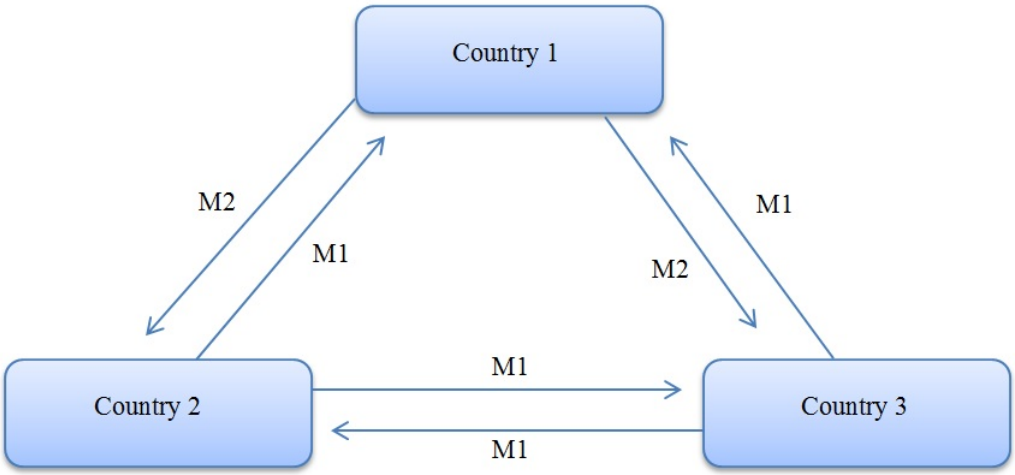


Figure 10: Three-country model: dual international currency, LCP

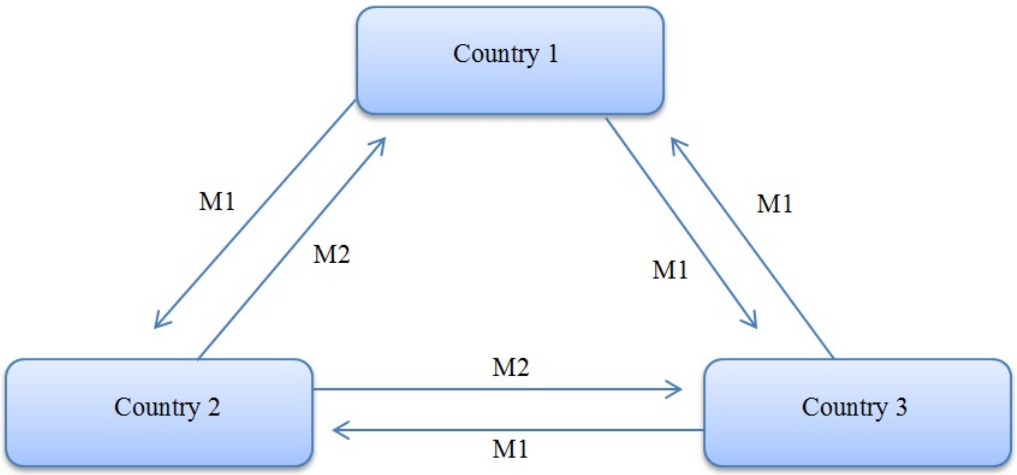


Table 7: Independent variables in panel regression

Name	Description	Source
Market share	the share of country i's export in country j's total import	UN Comtrade database
Inflation differential	inflation difference between exporter and importer country Inflation measured by YoY change of CPI	IMF
Inflation volatility	coefficient of variation for monthly inflation, difference between exporter and importer	IMF
Exchange rate	average log change of bilateral nominal exchange rate within a year Nominal exchange rate is exporter currency per importer currency	IMF
Exchange rate volatility	coefficient of variation for monthly exchange rate within a year	IMF
Private credit / GDP	financial resources channeled to private sector by financial intermediary, scaled by GDP log difference between exporter and importer	World Bank
Chinn-Ito index	Chinn-Ito index, de jure measure of capital account openness log difference between exporter and importer	Chinn and Ito (2006)
Distance	the great circle distance between capital cities, in kilometers, in log	Kristian Skrede Gleditsch Google map
Product differentiation	the share of differentiated goods in trade flow, in log	UN Comtrade Database Rauch (1999)
GDP	log difference of real GDP between exporter and importer country	World Bank
GDP per capita	log difference of real GDP per capita between exporter and importer country	World Bank
Border	equal to 1 if exporter and importer share border	Andrew Rose dataset
Former colonial relationship	equal to 1 if exporter and importer has former colonial relationship	Andrew Rose dataset
Common language	equal to 1 if exporter and importer share language	Andrew Rose dataset
Peg to USD	equal to 1 if country's home currency is pegged to USD	IMF

Notes: Bilateral nominal exchange rate calculated from each currency's nominal exchange rate against USD. For product differentiation, the goods with standard exchange or reference price is regarded as homogeneous, and the conservative category is adopted. The Chinn-Ito index is normalized between 0 and 1.

A.7 Economic Significance

In this part, we rank the regressors by their marginal effect on currency share. As explained previously, SWIFT dataset is truncated, so our observation in the dataset is

$$s = \begin{cases} s^* & \text{if } \ 0 < s^* < 1 \\ 0 \ \text{ or } \ 1 & \text{otherwise} \end{cases}$$

where s^* is latent variable of unobserved currency trade, and s is the currency share we could observe and calculate in SWIFT dataset. For simplicity, we only consider the marginal effect on s, which is simply

$$\frac{\partial E(s^*|x)}{\partial x_k} = \beta_k$$

where x_k is the independent variable and β_k is the coefficient estimation. Of course, estimating the marginal effect on s would generate a quantitatively different outcome, which is given by

$$\frac{\partial E(s|x)}{\partial x_k} = \beta_k \underbrace{\left[\Phi\left(\frac{x\beta}{\sigma}\right) - \Phi\left(\frac{x\beta - 1}{\sigma}\right)\right]}_{Pr(0<s<1)}$$

where $\Phi(.)$ is the normal distribution. This result doesn't invalidate our ranking of regressors, because it's just an increasing and monotone transformation of β_k. To make our outcome comparable across independent variables, we consider the marginal effect of one-standard-deviation on currency share, i.e.,

$$\text{Marginal effect of } x_k = \beta_k \sigma_{x_k}$$

where σ_{x_k} is the standard deviation of x_k. We find that financial factors have a relatively strong effect than exchange rate.

Table 8: Marginal effect in benchmark regression

	PCP			LCP		
	Total	OECD	Non-OECD	Total	OECD	Non-OECD
	(i)	(ii)	(iii)	(iv)	(v)	(vi)
Market share	0.1688	1.1448	0.2533	0.1788	0.6398	0.3422
Inflation	0.0000	0.0000	0.0000	0.0000	0.0001	0.0000
Inflation volatility	0.0000	-0.0001	-0.0001	0.0000	-0.0002	0.0002
Exchange rate	-0.0004	-0.0006	0.0000	0.0005	0.0010	0.0005
Exchange rate volatility	0.0000	-0.0001	-0.0001	-0.0001	-0.0004	-0.0004
Private credit over GDP	0.0020	0.0021	0.0036	-0.0029	-0.0134	-0.0024
Capital account liberalization	0.0035	0.0033	0.0002	-0.0038	-0.0094	-0.0066
Geographical distance	-0.0038	-0.0039	-0.0021	-0.0062	-0.0050	-0.0076
Product differentiation	0.0417	0.0305	0.0323	0.0184	0.0472	0.0137
Real GDP	0.0003	0.0000	-0.0003	-0.0005	-0.0010	-0.0010

Notes: This table report the marginal effect measured by $\beta_k \sigma_{x_k}$. The dependent variable is the share of PCP in the first three columns and the share of LCP in the last three columns. Column (ii) and (v) for the subsample of OECD exporters. Column (iii) and (vi) for the subsample of Non-OECD exporters.

A.8 Robustness test of panel regression

To test the robustness of empirical finding in table 2, we did the following to verify the importance of financial development.

- Interaction of Chinn-Ito index with trade finance dependence (table 9)
- Sub-sample test for different message types in SWIFT dataset (table 10 and 11)
- Determinants of VCP (table 12)
- Panel Heckit estimation (table 13, 14, 15)
- Use count share to get rid of valuation effect (table 16)
- Add fixed effect for year and destination region (table 17)
- Additional control variable (table 18)
- Different trade partners (table 19)

In sum, financial development is mostly significant with the expected sign.

Table 9: Determinants of currency use, interaction with KAOPEN

	PCP share			LCP share		
	(1)	(2)	(3)	(4)	(5)	(6)
KAOPEN*Continent	**0.12*** **			**-0.14*** **		
	(0.04)			(0.05)		
KAOPEN*TF_share		**0.70*** **			-0.00	
		(0.16)			(0.16)	
KAOPEN*Partner			**0.13*** **			**-0.11*** **
			(0.03)			(0.04)
Market share	0.58**	-0.62	0.60**	0.53	-0.14	0.48
	(0.29)	(0.42)	(0.29)	(0.35)	(0.33)	(0.35)
Inflation	-0.00	-0.00	-0.00	-0.00*	0.01	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.01	0.10***	-0.01	0.00	0.00	0.00
	(0.01)	(0.04)	(0.01)	(0.01)	(0.03)	(0.01)
Exchange rate	-0.07***	-0.09***	-0.07***	0.07***	0.04***	0.07***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	0.01	0.10***	0.01	-0.01	-0.03	-0.01
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Private credit over GDP	0.10***	-0.04	0.10***	-0.12***	-0.17***	-0.12***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.02)
Chinn-Ito Index	0.10***	-0.06	0.12***	-0.05	-0.05	-0.10***
	(0.04)	(0.07)	(0.03)	(0.04)	(0.07)	(0.03)
Product differentiation	0.62***	1.06***	0.61***	0.30***	0.19*	0.30***
	(0.07)	(0.19)	(0.07)	(0.06)	(0.10)	(0.06)
GDP	0.04***	-0.03**	0.04***	-0.05***	-0.04***	-0.05***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.01)	(0.01)
Distance	-0.19***	-0.31***	-0.19***	-0.26***	-0.10***	-0.26***
	(0.02)	(0.04)	(0.02)	(0.02)	(0.03)	(0.02)
N	8,373	782	8,373	8,319	798	8,319
N (uncensored)	1,584	275	1,584	1,158	143	1,158

Notes: the dependent variable is PCP share for the first three columns and LCP share for the rest. For independent variables, KAOPEN is the same as Chinn-Ito Index; Continent is a dummy equal to 1 if the export and import countries are not on the same continent; TF_share is the share of bank-intermediated finance in the total merchandise trade in 2011, collected from table 2 in Committee on the Global Financial System (2014); Partner is a dummy equal to 1 if the exporter is OECD country and the importer is Non-OECD countries.

Table 10: Determinants of currency use in trade, MT 700

	PCP			LCP		
	Total	OECD	Non-OECD	Total	OECD	Non-OECD
Market share	0.60*	1.97***	1.35***	-0.06	-1.64	0.36
	(0.33)	(0.59)	(0.24)	(0.35)	(1.55)	(0.37)
Inflation	-0.00	0.00	-0.00	-0.00**	0.04**	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.02)	(0.00)
Inflation volatility	-0.00	-0.00	-0.02	0.00	0.03	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
Exchange rate	-0.09***	-0.10***	-0.03***	0.07***	0.15***	0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
Exchange rate volatility	0.01	-0.02	-0.01	-0.01	0.00	-0.02*
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
Private credit over GDP	0.09***	0.09***	0.10***	-0.11***	-0.42***	-0.06**
	(0.02)	(0.03)	(0.03)	(0.02)	(0.11)	(0.03)
Chinn-Ito index	0.24***	0.12***	0.02	-0.13***	-0.22**	-0.14***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.09)	(0.02)
Distance	-0.17***	-0.10***	-0.09***	-0.24***	-0.31***	-0.17***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.07)	(0.03)
Product differentiation	0.59***	0.27**	0.38***	0.47***	0.47**	0.38***
	(0.07)	(0.11)	(0.09)	(0.07)	(0.23)	(0.08)
GDP	0.06***	0.01	-0.03***	-0.03***	-0.03	-0.04***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)	(0.01)
N	7,523	3,046	4,477	7,377	3,071	4,306
N (uncensored)	1375	1152	223	674	211	463

Note: Dependent variable is the value share of PCP in column (1)-(3), and the share of LCP in column (4)-(6), calculated from MT 700 message in SWIFT dataset. Sample covers only cross-border trade. US not included. The trade within Euro zone not included. The trade among mainland China, Hong Kong, and Taiwan treated as cross-border. Data frequency is annual from 2011 to 2013. Econometric method is random-effect panel Tobit, since SWIFT dataset is restricted for confidentiality purpose: if the monthly transaction number for a country pair is less than or equal to 4, it's recorded as 0. Column (2) and (5) covers the subsample when exporter is OECD country, whereas column (3) and (6) for non-OECD exporter.

Table 11: Determinants of currency use in trade, MT 400

	PCP			LCP		
	Total	OECD	Non-OECD	Total	OECD	Non-OECD
Market share	0.87**	4.25***	0.82***	0.75*	0.82	1.25**
	(0.43)	(0.78)	(0.26)	(0.41)	(0.80)	(0.58)
Inflation	-0.00	0.01	-0.00	0.00	0.01	0.01*
	(0.00)	(0.01)	(0.00)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.00	-0.00	0.00	0.01	0.00	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Exchange rate	-0.06***	-0.07***	0.01	0.09***	0.11***	0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	0.01	-0.01	-0.01	-0.01	0.00	-0.04***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
Private credit over GDP	0.08***	0.02	0.14***	-0.13***	-0.28***	-0.10***
	(0.03)	(0.04)	(0.03)	(0.02)	(0.05)	(0.03)
Chinn-Ito index	0.21***	0.17***	0.01	-0.17***	-0.31***	-0.24***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.05)	(0.03)
Distance	-0.25***	-0.21***	-0.11***	-0.30***	-0.22***	-0.29***
	(0.03)	(0.04)	(0.02)	(0.03)	(0.04)	(0.04)
Product differentiation	0.66***	0.18	0.39***	0.34***	0.45***	0.22**
	(0.11)	(0.15)	(0.10)	(0.07)	(0.13)	(0.09)
GDP	0.07***	0.05***	-0.02**	-0.07***	-0.08***	-0.10***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.02)	(0.01)
N	5,532	2,396	3,136	5,615	2,518	3,097
N (uncensored)	856	698	158	988	353	635

Note: Dependent variable is the value share of PCP in column (1)-(3), and the share of LCP in column (4)-(6), calculated from MT 400 message in SWIFT dataset. Sample covers only cross-border trade. US not included. The trade within Euro zone not included. The trade among mainland China, Hong Kong, and Taiwan treated as cross-border. Data frequency is annual from 2011 to 2013. Econometric method is random-effect panel Tobit, since SWIFT dataset is restricted for confidentiality purpose: if the monthly transaction number for a country pair is less than or equal to 4, it's recorded as 0. Column (2) and (5) covers the subsample when exporter is OECD country, whereas column (3) and (6) for non-OECD exporter.

Table 12: Determinants of vehicle currency use in trade, 2011-2013

	Total	OECD	Non-OECD
Market share	0.88**	0.37	-1.46**
	(0.43)	(0.57)	(0.65)
Inflation	-0.00	-0.00	-0.00
	(0.00)	(0.00)	(0.00)
Inflation volatility	-0.03***	-0.01	-0.05***
	(0.01)	(0.01)	(0.02)
Exchange rate	0.04***	0.06***	-0.01
	(0.01)	(0.01)	(0.01)
Exchange rate volatility	0.01	0.02	0.04**
	(0.01)	(0.01)	(0.02)
Private credit over GDP	0.14***	0.02	0.24***
	(0.03)	(0.03)	(0.04)
Chinn-Ito index	-0.01	0.08***	0.14***
	(0.02)	(0.03)	(0.03)
Distance	0.30***	0.19***	0.39***
	(0.03)	(0.03)	(0.05)
Product differentiation	-0.14**	-0.28***	0.04
	(0.07)	(0.10)	(0.11)
GDP	0.09***	0.01	0.26***
	(0.01)	(0.01)	(0.02)
N	8,484	3,449	5,035
N (uncensored)	2671	1567	1104

Note: US not included in sample. Data frequency is annual. Dependent variable is the share of VCP. Econometric method is panel Tobit, since SWIFT dataset is restricted for confidentiality purpose: if the monthly transaction number for a country pair is less than or equal to 4, it's recorded as 0. Column (2) covers subsample when exporter is OECD country, and column (3) for non-OECD exporter.

Table 13: Determinants of PCP, panel Heckit

	Total		OECD		Non-OECD	
	Selection	Intensity	Selection	Intensity	Selection	Intensity
Market share	15.16***	-0.46***	51.01***	0.02	11.75***	0.49
	(3.28)	(0.17)	(6.53)	(0.27)	(1.65)	(0.31)
Inflation	-0.00	-0.00	0.01	0.00	-0.00	-0.01***
	(0.02)	(0.00)	(0.02)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.09	-0.00	-0.15*	-0.00	-0.02	-0.02*
	(0.07)	(0.00)	(0.08)	(0.01)	(0.09)	(0.01)
Exchange rate	-0.65***	-0.03***	-0.60***	-0.03***	-0.10**	0.00
	(0.06)	(0.01)	(0.05)	(0.01)	(0.04)	(0.01)
Exchange rate volatility	0.09	-0.01	0.05	-0.02***	-0.20***	0.00
	(0.07)	(0.01)	(0.10)	(0.01)	(0.07)	(0.01)
Private credit over GDP	0.75***	0.00	0.37**	0.01	0.79***	0.11***
	(0.18)	(0.02)	(0.19)	(0.02)	(0.17)	(0.04)
Chinn-Ito index	2.30***	0.07***	1.60***	0.02	-0.09	0.06***
	(0.18)	(0.02)	(0.19)	(0.02)	(0.12)	(0.02)
Distance	-1.44***	-0.10***	-0.24	-0.09***	-0.60***	-0.08**
	(0.22)	(0.02)	(0.18)	(0.02)	(0.15)	(0.03)
Product differentiation	5.72***	0.19***	1.89***	0.22***	3.35***	0.13
	(0.60)	(0.07)	(0.72)	(0.07)	(0.75)	(0.12)
GDP	0.31***	0.03***	-0.30***	0.01*	-0.22***	-0.01
	(0.08)	(0.01)	(0.08)	(0.01)	(0.06)	(0.01)
Inverse Mills ratio		0.02*		0.03		0.07**
		(0.01)		(0.02)		(0.04)
Observations	8,373	1,985	3,355	1,696	5,018	326

Note: The first part model is panel Probit with random effect, while the second part is panel random-effect regression, adding inverse Mills ratio as correction. The dependent variable in first part is a dummy variable for producer currency settlement: equal to 1 when exporter's home currency is used, otherwise equal to zero. The second part is panel random-effect regression for the subsample when exporter's home currency is used. The dependent variable is the value share of producer currency settlement.

Table 14: Determinants of LCP, panel Heckit

	Total		OECD		Non-OECD	
	Selection	Intensity	Selection	Intensity	Selection	Intensity
Market share	4.99**	-0.62**	17.07***	-1.71***	4.55***	0.82
	(2.37)	(0.31)	(4.37)	(0.62)	(1.68)	(0.75)
Inflation	-0.02*	0.00	0.16**	0.01	-0.02	-0.00
	(0.01)	(0.00)	(0.07)	(0.01)	(0.01)	(0.00)
Inflation volatility	-0.04	0.01	-0.01	-0.01	-0.01	0.01*
	(0.06)	(0.01)	(0.15)	(0.01)	(0.07)	(0.01)
Exchange rate	0.41***	0.02	0.87***	0.05***	0.26***	0.08*
	(0.04)	(0.02)	(0.07)	(0.01)	(0.04)	(0.04)
Exchange rate volatility	-0.13**	0.01	-0.34**	-0.00	-0.20***	-0.04
	(0.06)	(0.01)	(0.16)	(0.01)	(0.06)	(0.03)
Private credit over GDP	-0.57***	-0.05*	-2.27***	-0.15***	-0.29***	-0.10**
	(0.14)	(0.03)	(0.32)	(0.04)	(0.11)	(0.05)
Chinn-Ito index	-1.22***	-0.03	-2.15***	-0.09	-1.26***	-0.36*
	(0.14)	(0.05)	(0.30)	(0.05)	(0.14)	(0.20)
Distance	-1.22***	-0.18***	-1.06***	-0.15***	-0.70***	-0.37***
	(0.15)	(0.05)	(0.22)	(0.03)	(0.12)	(0.11)
Product differentiation	2.63***	-0.09	3.33***	0.12	1.42***	0.18
	(0.42)	(0.11)	(0.95)	(0.10)	(0.32)	(0.22)
GDP	-0.31***	-0.03*	-0.70***	-0.01	-0.32***	-0.12**
	(0.06)	(0.01)	(0.12)	(0.01)	(0.05)	(0.05)
Inverse Mills ratio		0.01		0.02		0.28*
		(0.05)		(0.02)		(0.17)
Observations	8,319	1,506	3,429	493	4,890	998

Note: The first part model is panel Probit with random effect, while the second part is panel random-effect regression, adding inverse Mills ratio as correction. The dependent variable in first part is a dummy variable for local currency settlement: equal to 1 when importer's home currency is used, otherwise equal to zero. The second part is panel random-effect regression for the subsample when importer's home currency is used. The dependent variable is the value share of local currency settlement.

Table 15: Determinants of VCP, panel Heckit

	Total		OECD		Non-OECD	
	Selection	Intensity	Selection	Intensity	Selection	Intensity
Market share	8.36***	-0.20**	11.46***	-1.38***	0.71	-0.17***
	(1.84)	(0.08)	(2.93)	(0.21)	(2.87)	(0.06)
Inflation	-0.01	0.00	-0.00	0.00	-0.03	0.00*
	(0.01)	(0.00)	(0.01)	(0.00)	(0.02)	(0.00)
Inflation volatility	-0.07	-0.00	0.03	0.00	-0.13	-0.00*
	(0.05)	(0.00)	(0.07)	(0.00)	(0.12)	(0.00)
Exchange rate	0.05**	0.00***	0.22***	0.01***	-0.30***	-0.00***
	(0.02)	(0.00)	(0.04)	(0.00)	(0.08)	(0.00)
Exchange rate volatility	0.10**	-0.00	0.17**	0.01**	0.26**	-0.00
	(0.05)	(0.00)	(0.09)	(0.00)	(0.11)	(0.00)
Private credit over GDP	0.22***	0.01***	-0.01	0.02*	0.93***	0.01*
	(0.08)	(0.01)	(0.14)	(0.01)	(0.25)	(0.00)
Chinn-Ito index	0.17**	-0.02***	0.45***	-0.00	1.32***	0.01***
	(0.07)	(0.00)	(0.14)	(0.01)	(0.29)	(0.00)
Distance	1.41***	0.05***	1.44***	0.04***	3.40***	0.02***
	(0.09)	(0.01)	(0.13)	(0.01)	(0.33)	(0.00)
Product differentiation	0.18	-0.09***	0.08	-0.12***	0.69	-0.04***
	(0.26)	(0.01)	(0.61)	(0.03)	(0.64)	(0.01)
GDP	0.06*	0.00*	-0.23***	0.02***	1.10***	0.01***
	(0.03)	(0.00)	(0.06)	(0.00)	(0.12)	(0.00)
Inverse Mills ratio		0.22***		0.72***		-0.03***
		(0.08)		(0.21)		(0.01)
Observations	7,242	5,926	3,213	2,516	4,029	3,410

Note: The first part model is panel Probit with random effect, while the second part is panel random-effect regression, adding inverse Mills ratio as correction. The dependent variable in first part is a dummy variable for vehicle currency settlement: equal to 1 when vehicle currency is used, otherwise equal to zero. The second part is panel random-effect regression for the subsample when vehicle currency is used. The dependent variable is the value share of vehicle currency settlement.

Table 16: Determinants of currency use in trade, count share

	PCP			LCP		
	Total	OECD	Non-OECD	Total	OECD	Non-OECD
Market share	0.37*	1.64***	1.29***	0.46*	0.98*	0.60*
	(0.22)	(0.49)	(0.20)	(0.25)	(0.54)	(0.36)
Inflation	-0.00	-0.00	-0.00	-0.00	0.01*	-0.00
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.01	-0.01**	-0.00	0.01*	-0.01	0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate	-0.07***	-0.09***	-0.02***	0.07***	0.09***	0.06***
	(0.00)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	0.00	-0.01	-0.01	-0.01	-0.01	-0.02**
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Private credit over GDP	0.10***	0.07***	0.13***	-0.11***	-0.30***	-0.07***
	(0.01)	(0.02)	(0.02)	(0.02)	(0.03)	(0.02)
Chinn-Ito index	0.16***	0.09***	0.01	-0.15***	-0.20***	-0.22***
	(0.01)	(0.02)	(0.01)	(0.01)	(0.03)	(0.02)
Distance	-0.19***	-0.17***	-0.08***	-0.25***	-0.16***	-0.24***
	(0.01)	(0.03)	(0.02)	(0.02)	(0.02)	(0.03)
Product differentiation	0.39***	0.11	0.28***	0.17***	0.33***	0.09*
	(0.05)	(0.08)	(0.06)	(0.04)	(0.09)	(0.05)
GDP	0.04***	0.00	-0.04***	-0.05***	-0.06***	-0.08***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
N	8,412	3,384	5,028	8,373	3,440	4,933
N (uncensored)	1735	1389	346	1392	465	927

Note: Dependent variable is the count share of PCP in column (1)-(3), and the share of LCP in column (4)-(6), calculated SWIFT dataset. Sample covers only cross-border trade. US not included. The trade within Euro zone not included. The trade among mainland China, Hong Kong, and Taiwan treated as cross-border. Data frequency is annual from 2011 to 2013. Econometric method is random-effect panel Tobit, since SWIFT dataset is restricted for confidentiality purpose: if the monthly transaction number for a country pair is less than or equal to 4, it's recorded as 0. Column (2) and (5) covers the subsample when exporter is OECD country, whereas column (3) and (6) for non-OECD exporter.

Table 17: Determinants of currency use in trade, adding fixed effect

	PCP			LCP		
	Total	OECD	Non-OECD	Total	OECD	Non-OECD
Market share	0.93***	2.29***	1.31***	0.46	0.79	0.69
	(0.29)	(0.53)	(0.22)	(0.32)	(0.80)	(0.47)
Inflation	-0.00	0.00	-0.00	-0.00**	0.01	-0.00*
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.01	-0.01	-0.01	0.01	-0.01	0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Exchange rate	-0.09***	-0.09***	-0.02***	0.03***	0.06***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	0.01	-0.01	-0.01	0.01	-0.02	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Private credit over GDP	0.13***	0.06*	0.18***	-0.02	-0.18***	0.03
	(0.02)	(0.03)	(0.03)	(0.02)	(0.04)	(0.03)
Chinn-Ito index	0.22***	0.10***	0.02	-0.05**	-0.15***	-0.08***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.04)	(0.03)
Distance	-0.11***	-0.04	-0.09***	-0.20***	-0.08**	-0.31***
	(0.02)	(0.04)	(0.02)	(0.02)	(0.04)	(0.04)
Product differentiation	0.58***	0.32***	0.37***	0.17***	0.40***	0.06
	(0.07)	(0.10)	(0.08)	(0.06)	(0.13)	(0.08)
GDP	0.05***	-0.02*	-0.02**	-0.01	-0.03**	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
N	8,373	3,355	5,018	8,319	3,429	4,890
N (uncensored)	1,584	1,282	302	1,158	409	749
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Dependent variable is the value share of PCP in column (1)-(3), and the share of LCP in column (4)-(6), calculated from MT 700 and MT 400 message in SWIFT dataset. Sample covers only cross-border trade. US not included. The trade within Euro zone not included. The trade among mainland China, Hong Kong, and Taiwan treated as cross-border. Data frequency is annual from 2011 to 2013. Econometric method is random-effect panel Tobit, since SWIFT dataset is restricted for confidentiality purpose: if the monthly transaction number for a country pair is less than or equal to 4, it's recorded as 0. Column (2) and (5) covers the subsample when exporter is OECD country, whereas column (3) and (6) for non-OECD exporter. Constant and Fixed effect for year and destination region are omitted.

Table 18: Determinants of currency use in trade, additional control

	PCP			LCP		
	Total	OECD	Non-OECD	Total	OECD	Non-OECD
Market share	1.18***	2.03***	1.70***	-0.03	0.37	0.09
	(0.33)	(0.55)	(0.28)	(0.45)	(0.88)	(0.63)
Inflation	-0.00	0.00	-0.00	-0.00**	0.01	-0.01**
	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)	(0.00)
Inflation volatility	-0.01	-0.01	-0.01	0.00	-0.01	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Exchange rate	-0.08***	-0.10***	-0.03***	0.05***	0.08***	0.03***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	-0.00	-0.02*	-0.01	0.00	-0.02	0.00
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.02)
Private credit over GDP	0.17***	0.14***	0.18***	-0.06**	-0.23***	0.01
	(0.02)	(0.03)	(0.03)	(0.03)	(0.05)	(0.04)
Chinn-Ito index	0.26***	0.17***	0.04	-0.11***	-0.19***	-0.12***
	(0.02)	(0.03)	(0.02)	(0.02)	(0.05)	(0.03)
Distance	-0.13***	-0.05	-0.10***	-0.21***	-0.11**	-0.32***
	(0.02)	(0.04)	(0.02)	(0.03)	(0.04)	(0.05)
Product differentiation	0.61***	0.30***	0.35***	0.18***	0.47***	0.03
	(0.07)	(0.10)	(0.08)	(0.06)	(0.14)	(0.08)
GDP	0.04***	-0.00	-0.02**	-0.02**	-0.04***	-0.02
	(0.01)	(0.01)	(0.01)	(0.01)	(0.02)	(0.01)
Border	-0.20**	0.03	-0.05	-0.07	-0.19	-0.00
	(0.10)	(0.14)	(0.09)	(0.10)	(0.15)	(0.14)
Former colonial relationship	0.35***	0.19*	0.10	0.45***	0.51***	0.44***
	(0.09)	(0.11)	(0.10)	(0.09)	(0.14)	(0.13)
Common language	-0.20***	-0.31***	0.16***	-0.04	-0.00	0.02
	(0.05)	(0.08)	(0.05)	(0.06)	(0.10)	(0.08)
GDP per capita	-0.08***	-0.18***	-0.02	0.12***	0.11**	0.08**
	(0.03)	(0.03)	(0.03)	(0.03)	(0.06)	(0.04)
Peg to USD (i)	-0.37***	.	0.04	0.16	.	0.29*
	(0.10)	.	(0.08)	(0.12)	.	(0.15)
Peg to USD (j)	0.41***	0.29*	-0.06	0.28**	0.12	0.45**
	(0.12)	(0.16)	(0.20)	(0.11)	(0.15)	(0.19)
N	7,942	3,237	4,705	7,890	3,309	4,581
N (uncensored)	1,546	1,250	296	1,120	401	719
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Region FE	Yes	Yes	Yes	Yes	Yes	Yes

Note: Dependent variable is the value share of PCP in column (1)-(3), and the share of LCP in column (4)-(6), calculated from MT 700 and MT 400 message in SWIFT dataset. Sample covers only cross-border trade. US not included. The trade within Euro zone not included. The trade among mainland China, Hong Kong, and Taiwan treated as cross-border. Data frequency is annual from 2011 to 2013. Econometric method is random-effect panel Tobit, since SWIFT dataset is restricted for confidentiality purpose: if the monthly transaction number for a country pair is less than or equal to 4, it's recorded as 0. Column (2) and (5) covers the subsample when exporter is OECD country, whereas column (3) and (6) for non-OECD exporter. Constant and Fixed effect for year and destination region are omitted. Peg to USD (i) is equal to 1 if exporter's home currency is pegged to USD. Peg to USD (j) is equal to 1 if importer's home currency is pegged to USD.

Table 19: Determinants of currency use in trade, North and South

	PCP			LCP		
	North-North	South-South	North-South	North-North	South-South	North-South
Market share	3.26***	1.07***	1.94***	0.22	0.85*	1.25
	(0.99)	(0.26)	(0.57)	(0.99)	(0.44)	(0.87)
Inflation	-0.03*	-0.00	-0.00	0.03**	0.01**	-0.01***
	(0.02)	(0.00)	(0.00)	(0.02)	(0.00)	(0.00)
Inflation volatility	-0.01	0.00	-0.02**	0.02	-0.02	0.02
	(0.02)	(0.02)	(0.01)	(0.02)	(0.03)	(0.01)
Exchange rate	-0.09***	-0.03**	-0.07***	0.12***	0.03*	0.07***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
Exchange rate volatility	-0.07**	-0.00	0.01	0.03	-0.02	-0.00
	(0.03)	(0.01)	(0.01)	(0.03)	(0.02)	(0.01)
Private credit over GDP	0.20***	0.12***	0.13***	-0.21***	-0.16***	-0.15***
	(0.06)	(0.03)	(0.03)	(0.06)	(0.05)	(0.03)
Chinn-Ito index	0.27***	0.10***	0.18***	-0.24**	-0.03	-0.17***
	(0.10)	(0.03)	(0.02)	(0.10)	(0.04)	(0.03)
Distance	0.00	-0.16***	-0.16***	-0.18***	-0.27***	-0.20***
	(0.04)	(0.03)	(0.03)	(0.04)	(0.05)	(0.03)
Product differentiation	0.09	0.44***	0.47***	0.46***	0.40***	0.11
	(0.19)	(0.12)	(0.09)	(0.17)	(0.15)	(0.08)
GDP	-0.04*	0.00	0.04***	-0.06**	0.01	-0.06***
	(0.02)	(0.01)	(0.01)	(0.02)	(0.02)	(0.01)
N	912	2,775	4,686	932	2,777	4,610
N (uncensored)	299	190	1,095	304	112	3,629

Note: Dependent variable is the value share of PCP in column (1)-(3), and the share of LCP in column (4)-(6), calculated from MT 700 and MT 400 message in SWIFT dataset. Sample covers only cross-border trade. US not included. The trade within Euro zone not included. The trade among mainland China, Hong Kong, and Taiwan treated as cross-border. Data frequency is annual from 2011 to 2013. Econometric method is random-effect panel Tobit, since SWIFT dataset is restricted for confidentiality purpose: if the monthly transaction number for a country pair is less than or equal to 4, it's recorded as 0. Column (1) and (4) covers the subsample for the trade between OECD countries, column (2) and (5) for the trade between Non-OECD countries, and column (3) and (6) for the trade between OECD and Non-OECD countries. Constant omitted.