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The road to currency internationalization: Global perspectives and chinese experience☆

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ABSTRACT

This paper studies international currency use in financial transactions. A currency becomes international when it circulates outside of its issuing country, and advances to vehicle currency status if used by non-residents. With currency information from the SWIFT dataset, we estimate a gravity model to explain the geographical distribution of international currency use. A higher level of economic integration and stable macroeconomic conditions increase the international use of major currencies such as USD and EUR. Merchandise trade and portfolio investment are most helpful in increasing the direct use of currency, while foreign direct investment (FDI) has a stronger effect on promoting vehicle use. Merchandise trade improves the intensity of the global use of the Chinese renminbi (RMB), while FDI increases the number of its users. The policy effect on RMB internationalization is significant only in enhancing the intensity of direct use. Furthermore, the global use of RMB is decreasing by distance, implying that its role is more regional. We recommend outward FDI through the Belt and Road Initiative to further promote RMB internationalization.

1. Introduction

The reform of the international monetary system received a great deal of attention after the global financial crisis in 2008. The exorbitant privilege of the U.S. dollar (USD) has been extensively discussed and severely questioned, with many proposals exploring

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the possibility of multiple reserve currencies (e.g. Eichengreen, 2011; Taylor, 2013). Against this background, RMB internationalization (RMBI) is natural and necessary given China's large economy and huge volume of international trade. Since 2009, the People's Bank of China (PBOC) has taken proactive measures to accelerate this process. Any reform plan in this field requires a good understanding of the determinants of international currency choiceâ€″that is, why a certain currency is selected to settle a cross-border transaction. If a multi polar system proves desirable, how can a previously national currency like the RMB be made more popular worldwide? For China, how did the PBOC's favorable policies affect RMBI progress thus far? This paper quantitatively investigates these questions with a dataset from the Society for Worldwide Interbank Financial Telecommunication (SWIFT). The answers to these questions have become increasingly important with the RMB's accession into the Special Drawing Right (SDR) currency basket and the launch of the Belt and Road Initiative (BRI). A comprehensive evaluation of this issue could smooth the world's transition into the next international monetary system.

By definition, a currency becomes international when it circulates outside of its issuing country, and it becomes an international vehicle currency if it is used by non-residents. For example, the USD plays the role of a vehicle currency if it is used to settle international trade between China and Japan. The economic literature has a long history on the discussion of international currency (e.g. Cohen, 1971; Krugman, 1980; Matsuyama et al., 1993; Goldberg and Tille, 2008; Zhang, 2014) and provides many important insights. We take advantage of the detailed currency information in the SWIFT dataset and contribute to the literature in three dimensions.

First, we explore international currency use in financial transactions, which makes up the biggest part of cross-border trading activities but which has been largely ignored thus far. There is already a well-established body of literature on trade invoicing currency, and the macro, micro, and strategic determinants proposed in previous studies (e.g. Bacchetta and Van Wincoop, 2005; Goldberg and Tille, 2016; Chung, 2016) have been generally verified with country-level and firm-level datasets. The literature on international currency choice for financial transactions, however, remains relatively scant. We follow the pioneering work in Batten and Szilagyi (2016) and He et al. (2016) to further explore this area.

Second, we distinguish between the direct and vehicle uses of international currency to better evaluate their respective drivers. A truly international currency, such as the USD, features prominently in vehicle use to settle merchandise trade and financial transactions (Woo, 2013). The key determinants of international vehicle currency therefore deserve greater attention, especially for countries such as China that are trying to promote the internationalization of their home currency. Previous empirical studies failed to identify the vehicle use of international currency because the counter-party information is absent in most datasets. However, the SWIFT dataset documents the counter-party country for each entry, which helps us determine whether an international currency is directly used or plays the role of a vehicle currency.

Third, we evaluate the policy effect on RMBI. Since its launch in 2009 (Zhou, 2009), RMBI has made considerable progress due to the PBOC's favorable policies, such as establishing offshore clearing houses and signing currency swap agreements with other central banks. A systematic evaluation of these policy effects would shed light on the agenda of future initiatives. As shown in detail later in this paper, there were many new entries of RMB users during our sample period of October 2010 to August 2014, so we rely on the richness of the SWIFT dataset to assess the policy effects on both the extensive and intensive margins of RMB use, i.e., whether the favorable policies of the PBOC made foreign countries begin to adopt the RMB for cross-border transactions and whether the intensity of global RMB use improved significantly due to these policies.

Our main empirical results can be summarized as follows. For major currencies such as the USD and EUR, a higher level of economic integration and stable macroeconomic conditions increase international use. Specifically, international trade and portfolio investment are particularly helpful in increasing direct use, while foreign direct investment (FDI) has a strong effect in promoting vehicle use. A 1% increase in bilateral FDI increases vehicle currency use by 3.54%, so FDI is an important channel for boosting the vehicle use of an international currency. International trade improves the intensity of the RMB's global use, and FDI increases the number of its users. The policy effect on RMBI is significant only in enhancing the intensity of the RMB's direct use. Additionally, global use of the RMB is decreasing in terms of geographical distance, which implies that its role was more regional during the sample period.

Our empirical findings have rich implications for policy. The reform of the RMB exchange rate regime in August 2015, together with the subsequent currency depreciation and capital outflow, interrupted and even reversed RMBI to some degree. There has also been a great deal of controversy regarding whether China should continue to liberalize its capital account to promote RMBI (Yu, 2014). The recent discussion on trilemma and dilemma (e.g. Passari and Rey, 2015; Rey, 2015) indicated that capital account liberalization might lead to the loss of monetary policy independence. With these factors in mind and based on our empirical results, we recommend outward FDI through the BRI to increase the vehicle use of RMB and make it truly international.

The related literature covers reserve currency, peg currency, and trade invoicing currency.[1] Studies on reserve currency mainly rely on the Currency Composition of Official Foreign Exchange Reserves (COFER) database from IMF. Its long time span allows a careful examination of structural breaks and regime shifts, especially after the extension in Eichengreen et al. (2016). Many issues have been discussed in a series of studies, including Chinn and Frankel (2007), Liu and Li (2008), Frankel (2012), Huang et al. (2014) and Ito et al. (2015). Large GDP, high levels of trade share and macroeconomic stabilities have been generally verified to promote the status of reserve currency. Other vital factors include path dependence, economic freedom and government policy on capital flow. Another strand of literature discusses the choice of peg currency. The theory of Optimal Currency Area (OCA) predicts that countries

[1] On theory, there's a large literature on trade invoicing currency. Interested readers could refer to Liu et al. (2017) for review. Theoretical literature on the currency choice for financial transaction is rare, and the information theory in Lyons and Moore (2009) is one noticeable exception.

with higher levels of economic integration and more positive correlations in their business cycles tend to use the same currency, and this has been confirmed in many empirical studies. For example, Meissner (2005) adopted the duration model to discuss the diffusion of the gold standard in Europe after 1870, and the trade link proved important in explaining this phenomenon. Meissner and Oomes (2009) used the multinomial logit model to explain the anchor currency choice between 1980 and 1998 and found the network externality operating through trade and financial market to be a key determinant. More recently, empirical literature on trade invoicing currency has prospered due to improved data availability. A series of cross-country studies[2] revealed that the key determinants were trade share, financial market development, macroeconomic stability, and capital account liberalization. In addition, firm-level investigations such as Goldberg and Tille (2016) and Chung (2016) emphasized the crucial role of industry structure and bargaining power between exporters and importers.

However, the studies above did not cover international currency choice in financial transactions, which makes up the majority of cross-border trading activities. To the best of our knowledge, Batten and Szilagyi (2016) were the first to use the SWIFT dataset on this topic. Their estimation based on the capital asset pricing model showed that the RMB did not reach the tipping point of becoming an international currency by 2012. Our research takes advantage of the more recent SWIFT dataset from 2010 to 2014 and follows the research design of He et al. (2016), who estimated a gravity model to explain the geographical distribution of foreign exchange transactions.

The rest of this paper is organized as follows. Section 2 builds a model of currency exchange to guide our empirical investigation. Section 3 introduces the SWIFT dataset and provides an overview of international currency. Section 4 presents the design of the research framework and the empirical results for both major currencies and the RMB. Section 5 puts forward policy recommendations for RMBI, and Section 6 concludes the paper.

2. The model

In this section, we present a two-country model to guide our empirical study. This model builds on Martin and Rey (2004), and we make two modifications to determine the pattern of currency exchange. First, we introduce a cash-in-advance constraint and transaction cost to necessitate the use of money, following Rey (1999). Second, we add searching friction to capture the degree of economic integration between countries: agents in each country have a probability of traveling abroad for investment. This is a popular assumption in recent literature (Geromichalos and Simonovska, 2014; Zhang, 2014) and has considerable support from empirical studies (Flandreau and Jobst, 2009). The searching friction also helps separate each agent's choice on investment and currency holding.

There are two periods and two countries (A and B) in the world, which are populated with n_A and n_B units of risk-averse agents, who are respectively endowed with w_A and w_B units of a numeraire good for consumption or investment. Country $i \in \{A, B\}$ has a set of risky projects that pay dividend d_i if a certain state occurs, and 0 otherwise. Dividend returns are the only source of consumption in the second period. Agents can make direct investments or buy shares of a risky project. Investment in a risky project must be financed by the host country's home currency. At the beginning of the first period, each country's government issues its own currency, and agents have access to an internationally integrated Foreign Exchange (FX) market. The shock is then realized regarding whether an agent would stay at home to invest in the home asset or travel abroad to purchase a foreign asset. Afterward, a regional over-the-counter (OTC) market opens for agents willing to pay a transaction cost and readjust their currency holdings. Everyone then constructs their portfolios and receives a dividend in the second period. The timing of our model is shown in Fig. 1.

We adopt the linear utility function in Martin and Rey (2004) so that agents maximize the expected utility

$$\mathbb{E}U = C_1 + \beta \mathbb{E}\frac{C_2^{1-1/\sigma}}{1-1/\sigma} \tag{1}$$

where C_t is the consumption level at period t and $\sigma > 1$ captures the degree of risk aversion. Here, we consider a country A agent's optimal decision, and the case for a country B agent would be similar. The agent's budget constraint in the wholesale FX market is

$$C_1 + \phi_A m_A + \phi_B m_B = w_A \tag{2}$$

where ϕ_i is the value of country i currency in terms of the numeraire good and m_i is the currency holding. After the shock is realized, agents readjust currency holding and make investment decision, so the cash-in-advance constraint becomes the following.

$$\text{Home: } \phi_A m_A + \phi_B m_B(1 - t_{BA}) + \sum_{k \in z_A} p_A^k \alpha_A^k \geq f(z_A) + \sum_{i \in S_A} p_A^i s_A^i \tag{3}$$

$$\text{Foreign: } \phi_A m_A(1 - t_{AB}) + \phi_B m_B + \sum_{k \in z_B} p_B^k \alpha_B^k \geq f(z_B) + \sum_{i \in S_B} p_B^i s_B^i \tag{4}$$

If country A agent stays at home with probability η_A, he will pay a transaction cost t_{BA} to convert his foreign currency into home currency. An agent can either sell shares ${\alpha_A}^k$ to market if he develops the risky project z_A at a cost of $f(z_A)$, or buy shares ${s_A}^i$ from others. The ongoing price in terms of the numeraire good is denoted by ${p_A}^k$ and ${p_A}^i$. If a country A agent goes abroad with probability $\eta_B = 1 - \eta_A$, he would have the opportunity to invest in the foreign asset, so all of his holding of the home currency would be

[2] Related papers include Kamps (2006), Goldberg and Tille (2008), Ito and Chinn (2013), Ito and Kawai (2016)

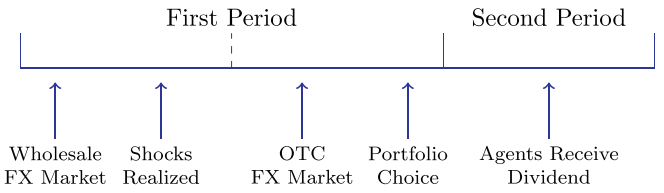

Fig. 1. Model timing.

converted to the foreign currency at a transaction cost of t_{AB}. Everything else is similar in the budget constraint. Given the description of the utility function and the investment decision, the expected utility of the country A agent is as follows.

$$C_1 + \eta_A\left(\frac{\beta\sigma d_A^{1-1/\sigma}}{\sigma-1}\sum_{i\in S_A}(s_A^i)^{1-1/\sigma} + \frac{\beta\sigma d_A^{1-1/\sigma}}{\sigma-1}\sum_{k\in z_A}(1-\alpha_A^k)^{1-1/\sigma}\right) + \eta_B\left(\frac{\beta\sigma d_B^{1-1/\sigma}}{\sigma-1}\sum_{i\in S_B}(s_B^i)^{1-1/\sigma} + \frac{\beta\sigma d_B^{1-1/\sigma}}{\sigma-1}\sum_{k\in z_B}(1-\alpha_B^k)^{1-1/\sigma}\right) \tag{5}$$

Agents choose currency ($\phi_A m_A$, $\phi_B m_B$) and investment project ($\alpha_A{}^k$, $\alpha_B{}^k$, $s_A{}^i$, $s_B{}^i$) to maximize their expected utility in Eq. 5 subject to the budget constraint in Eq. 2 and the cash-in-advance constraint in Eqs. 3 and 4. We can then derive an agent's demand for foreign currency.[3]

$$\begin{aligned}\phi_B m_B &= \frac{\sum_{i\in S_B} p_B^i s_B^i - (1-t_{AB})\sum_{i\in S_A} p_A^i s_A^i}{1-(1-t_{AB})(1-t_{BA})} \\ &= \frac{(\beta\eta_B/\lambda_2)^\sigma \sum_{i\in S_B}(d_B/p_B^i)^{\sigma-1} - (1-t_{AB})(\beta\eta_A/\lambda_1)^\sigma \sum_{i\in S_A}(d_A/p_A^i)^{\sigma-1}}{1-(1-t_{AB})(1-t_{BA})}\end{aligned} \tag{6}$$

where $\lambda_1 \equiv \frac{t_{AB}}{1-(1-t_{AB})(1-t_{BA})}$ and $\lambda_2 \equiv \frac{t_{BA}}{1-(1-t_{AB})(1-t_{BA})}$ capture the transaction cost of currency exchange. Remarkably, the demand for the foreign currency is related with the relative demand for foreign asset. This is because agents could use their home currency to purchase the foreign assets after paying a transaction cost. If there's relatively more demand for the home assets, agents would rather hold more of their home currency even if that brings in larger transaction cost when purchasing the foreign assets. As for the asset demand, it is positively related with the matching probability (η) and the dividend-price ratio (d/p), but it is decreasing in the transaction cost (λ). This result implies that economic integration and financial development promote currency internationalization. We are also able to derive the agent's demand for the home currency.

$$\begin{aligned}\phi_A m_A &= \frac{\sum_{i\in S_A} p_A^i s_A^i - (1-t_{BA})\sum_{i\in S_B} p_B^i s_B^i}{1-(1-t_{AB})(1-t_{BA})} \\ &= \frac{(\beta\eta_A/\lambda_1)^\sigma \sum_{i\in S_A}(d_A/p_A^i)^{\sigma-1} - (1-t_{BA})(\beta\eta_B/\lambda_2)^\sigma \sum_{i\in S_B}(d_B/p_B^i)^{\sigma-1}}{1-(1-t_{AB})(1-t_{BA})}\end{aligned} \tag{7}$$

As in Martin and Rey (2004) and He et al. (2016), the total supply of country B currency to finance its investment project is $n_B p_B s_B$ and country A agent's total demand for country B currency is $n_A \phi_B m_B$. The logarithm of bilateral currency flow is therefore

$$\log(\mathrm{TC}_A^B) = \log(n_B p_B s_B) + \log(n_A) + \log(p_B s_B - (1-t_{AB})p_A s_A) - \log(1-(1-t_{BA})(1-t_{AB})) \tag{8}$$

where the first two items measure the economic size of two countries and the third item denotes the relative demand for country B assets, which is related with economic integration and financial development. The last item captures transaction cost in currency exchange.

In sum, we propose three key drivers for international currency. First, a higher level of economic integration through channels such as merchandise trade, FDI, and portfolio investment can promote currency internationalization. Second, a stable macroeconomic environment such as a large GDP and low inflation helps a currency become more popular in cross-border transactions. Third, geographical and institutional factors such as distance, financial market development, and the rule of law have important effects on transaction cost. The following sections empirically test the validity of these hypotheses using the SWIFT dataset.

[3] We assume agent's proceeding from issuing stock is equal to the fixed cost of direct investment. This assumption makes our result straightforward and intuitive, while keeping the importance of economic integration and financial development. We have also derived the result for three-country model. Interested reader could refer to appendix for detail.

3. Data and measurement

3.1. Dataset overview

The currency information in our paper comes from SWIFT, which documents interbank financial business over 200 countries and territories. SWIFT is a standard message system that facilitates communication among banks and financial institutions. The specific transaction types include cross-border payments (with message types MT 103 and MT 202), interbank foreign exchange transactions (MT 300), and trade finance (MT 400 and MT 700). Other types of messages are dropped because the data coverage might not be suitable for research purposes according to SWIFT. The frequency of the dataset is aggregated monthly from October 2010 to August 2014, and each entry shows the country name, counter-party country name, message type, settlement currency, number, and value for messages sent and received. The currency in the SWIFT dataset refers to the settlement currency, i.e., the actual currency used to complete the transaction, which might be different from the invoicing currency, although this difference should be tiny, as discussed in Friberg and Wilander (2008). For confidentiality, transaction values are recorded as 0 if the bilateral monthly number is less than or equal to 4. The direction of each message is consistent with that of the fund flow. In this paper, we consider the value share of the currency in our benchmark regression and leave the count share for the robustness test. The transactions among Euro-zone members are treated as domestic and are therefore dropped, whereas the activities between mainland China, Hong Kong, Macao, and Taiwan are categorized as cross-border.[4]

We now focus on the currencies in the SDR basket, i.e., US dollar (USD), euro (EUR), British pound (GBP), Japanese yen (JPY), and Chinese yuan (CNY or RMB). Our sample spans October 2010 to August 2014. First, we consider each currency's value share in cross-border transactions. As shown in Fig. 2, the USD enjoyed exorbitant privilege, making up over half of all international currency use. Although a drastic decline occurred in August 2011, probably due to the downgrading of U.S. treasury bonds by Standard & Poor, the USD quickly recovered afterward and attained an even more obvious advantage.[5] The EUR ranked second with a share around 20%, although it experienced a downward trend after 2011. The JPY and GBP had stable shares around 5%, whereas the RMB made little progress in this field, with a minimal share of less than 1%.

Next we consider the popularity of each currency, i.e., the number of countries or territories adopting a certain currency to settle their cross-border transactions. This could be interpreted as the extensive margin of international currency. Fig. 3 shows the prominence of the USD, which has wide usage in over 200 countries and territories. The EUR and GBP have worldwide popularity close to that of the USD, whereas the JPY was stuck at a lower level, around 160. The rise of the RMB is perhaps the most notable feature here, with its user number nearly doubling from 44 to 84 during the sample period. This should not be surprising given the PBOC's proactive measures, including currency swap agreements, trade settlement agreements, and many other favorable policies.

Next, we show the geographical distribution of international currency use. Fig. 4 plots the value share of the USD in each country's cross-border transactions in August 2014, and once again, the prominence of the USD in international monetary system is confirmed. In addition, the intensity of USD use in some countries is even higher than the U.S. level. This has occurred in Latin American countries such as Chile and Peru, which have a history of dollarization, and in some African countries. In contrast, the global use of the EUR shown in Fig. 5 is concentrated in European regions and other countries with former colonial ties. The GBP and JPY have been adopted less extensively and intensively across the world, so their figures are relegated to the appendix for simplicity.

Finally, we talk about the global use of RMB in Figs. 6 and 7. The transaction activities of RMB were tiny and thin with levels generally less than 1%, so the scale in figure is adjusted to illustrate more variation. We plot two figures for the observation of October 2010 and August 2014, because there were many new entries of RMB users. It should come as no surprise that these new entries mainly consist of Latin America and South Africa countries, who have established solid relationship with China through currency swap agreement or foreign direct investment. Meanwhile, the upward trend of RMB transaction in euro, South Asia and Australia is also noteworthy, probably due to the offshore RMB centers in these regions.

We present the global use of the RMB in Figs. 6 and 7. The transaction activities of the RMB were tiny and thin, with levels generally less than 1%, so the scale in the figures is adjusted to better show the variation. We plot two figures for the observations for October 2010 and August 2014 because there were many new entries of RMB users. It is not surprising that these new entries mainly consist of Latin American and southern African countries that have established solid relationships with China through currency swap agreements or foreign direct investment. Also noteworthy is the upward trend of RMB transactions in Europe, south Asia, and Australia, which is probably due to the offshore RMB centers in these regions.

3.2. Measurement of currency internationalization

Before proceeding to the econometric analysis, we require a proper variable to measure currency internationalization. As mentioned, a currency becomes international when it circulates outside of the issuing country, and it becomes an international vehicle currency if it is used by non-residents. It is therefore necessary to distinguish between the direct use of a currency, where the parties in the transaction include the issuing country, and the vehicle use of currency, where the participants do not include the issuing country. The SWIFT dataset records both parties in a cross-border transaction, enabling us to identify the type of currency use. Based on the definition above, we construct the following variable to measure currency internationalization.

[4] Interested reader could refer to Batten and Szilagyi (2016) for more detailed introduction on SWIFT dataset.
[5] Figure A.9 in appendix shows a dramatic increase of CAD during this period.

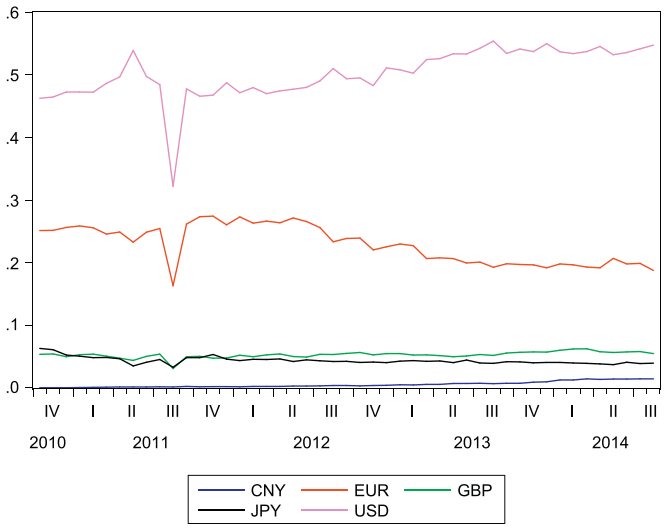

Fig. 2. Value share of international currency. Source: SWIFT BI Watch

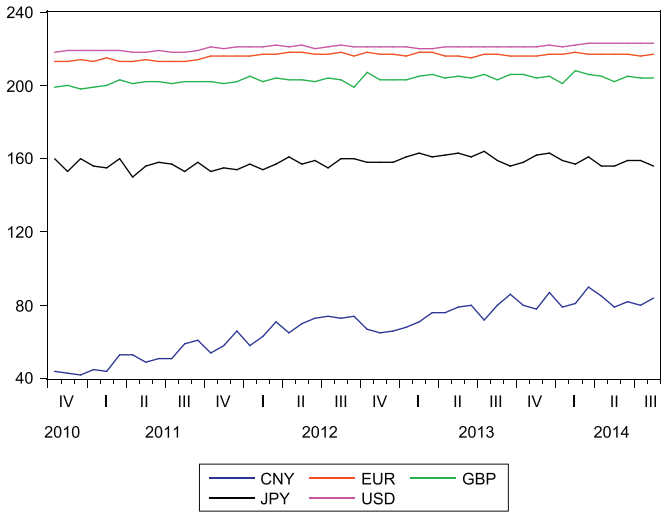

Fig. 3. Popularity of international currencies. Source: SWIFT BI Watch

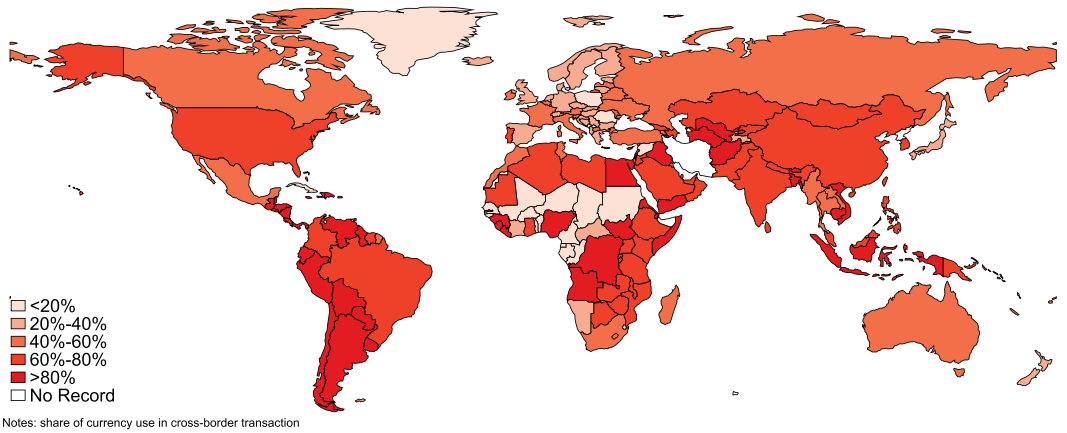

Fig. 4. Global use of USD, August 2014. Source: SWIFT BI Watch

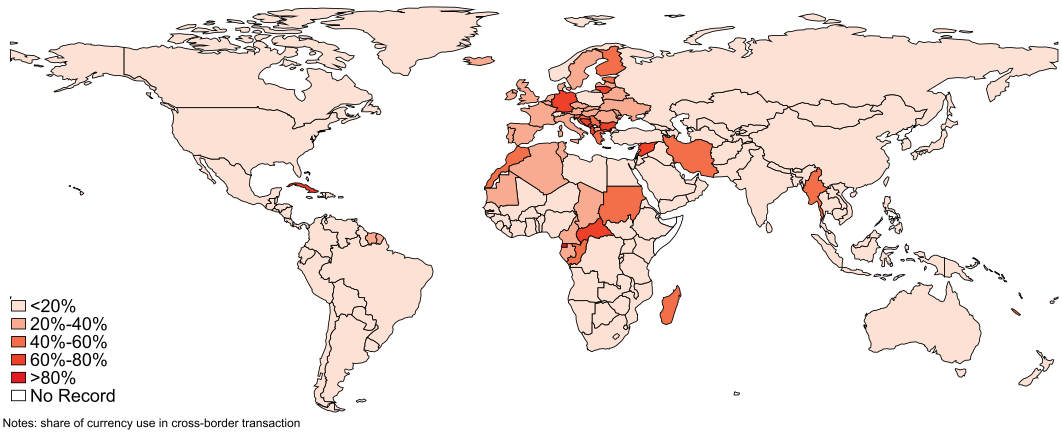

Fig. 5. Global use of EUR, August 2014. Source: SWIFT BI Watch

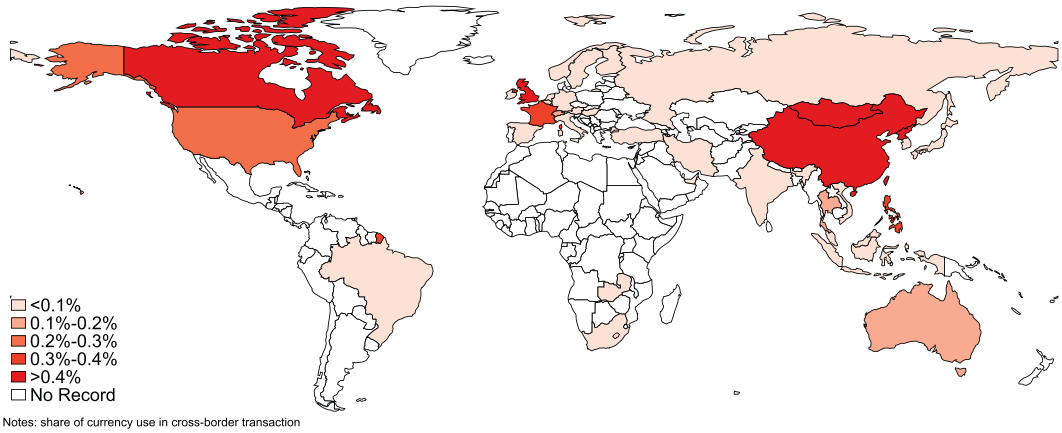

Fig. 6. Global use of CNY, October 2010. Source: SWIFT BI Watch

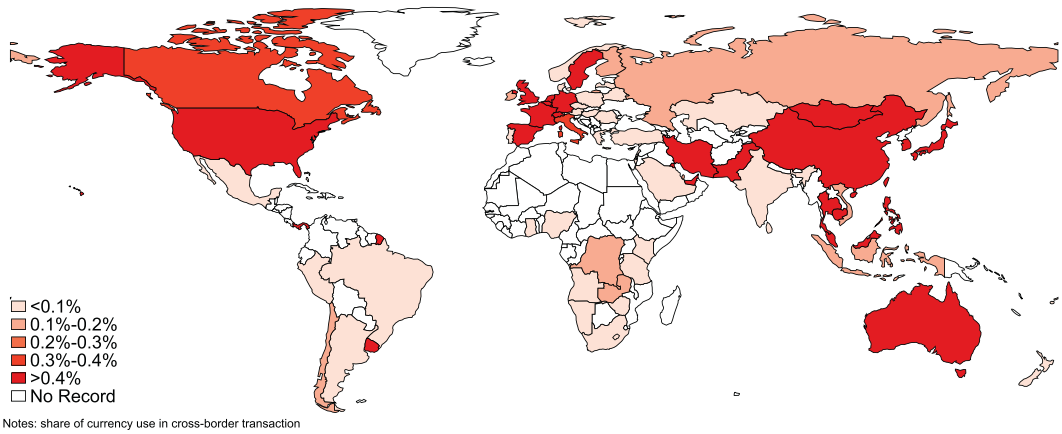

Fig. 7. Global use of CNY, August 2014. Source: SWIFT BI Watch

$$S_{ijt}^{k} \equiv \frac{v_{ijt}^{k}}{V_{jt}^{k}}, \quad k \in \{\text{Aggregate, Direct, Vehicle}\} \tag{9}$$

The notation is as follows: i indicates the issuing country of the international currency, j is the destination country adopting the international currency, t is the time period, and k is the type of currency use, including aggregate, direct, and vehicle use. Additionally, $v_{ijt}{}^{k}$ denotes the value of country j's cross-border transaction settled by country i's currency with type k use at time t. We

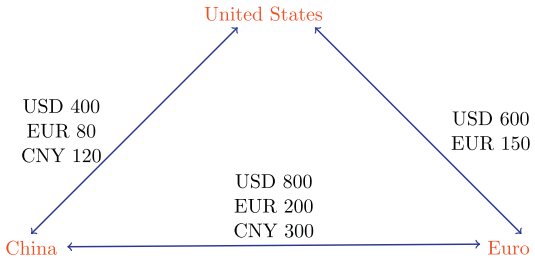

Fig. 8. Construction of currency share.

construct v_{ijt}^{k} by adding up the message values that are sent and received by country j, so it measures the sum of fund inflow and outflow. Similarly, V_{jt}^{k} is the total value of country j's cross-border transactions at time t with type k use of all currencies. The value share of the international currency S_{ijt}^{k} is the ratio between v_{ijt}^{k} and V_{jt}^{k}.

We calculate the currency share in this way for several reasons. First, it is the value share rather than the count share, as we believe that transaction value is a better proxy for the degree of international influence. The settlement currency of some frequent yet tiny transactions is less related to normal economic activities. Second, we distinguish between the aggregate, direct, and vehicle uses of international currency because we emphasize vehicle use as an important feature of international currency. Our econometric analysis in the next section focuses on its determinants. Lastly, we did not use the same denominator when calculating the currency share to reflect the degree of currency internationalization in different fields. The implications of our currency share would be complicated if we measured it in the following way.

$$s_{ijt}^{\text{Vehicle}} \equiv \frac{v_{ijt}^{\text{Vehicle}}}{V_{jt}^{\text{Aggregate}}} = \frac{V_{jt}^{\text{Vehicle}}}{V_{jt}^{\text{Aggregate}}} \times \frac{v_{ijt}^{\text{Vehicle}}}{V_{jt}^{\text{Vehicle}}}$$

This alternative measurement includes not only the currency share in vehicle use, but also the share of vehicle use in the aggregate amount, which would make interpretation very difficult.

We provide a three-country example to better illustrate our methodology. Assume the following currency composition of cross-border transactions. The flow between the U.S. and China is USD 400, EUR 80, and CNY 120. The flow between Europe and China consists of USD 800, EUR 200, and CNY 300. The flow between the U.S. and Europe is USD 600 and EUR 150. Fig. 8 shows the currency composition in this three-country case. To calculate the value share of each currency, we denominate all currency use in USD with exchange rates of $E_{\text{EUR/USD}} = 0.5$, $E_{\text{CNY/USD}} = 6$, and $E_{\text{CNY/EUR}} = 12$. The choice of denomination currency makes no difference within a given period. For simplicity, we take China as the destination country and calculate the share of USD and EUR in China's cross-border transactions. Using our definition, we can obtain the value of China's cross-border transactions with different types of currency use.

- Aggregate value $= V_{\text{China},t}^{\text{Aggregate}} = (400 + 800) + (80 + 200)^{*}2 + (120 + 300)/6 = 1830$
- Direct value $= V_{\text{China},t}^{\text{Direct}} = 400 + 200^{*}2 + (120 + 300)/6 = 870$
- Vehicle value $= V_{\text{China},t}^{\text{Vehicle}} = 80^{*}2 + 800 = 960$

Note that the aggregate value includes all transactions related to China regardless of settlement currency. However, the direct and vehicle values follow our previous definition. We can then measure the share of USD in each type of currency use. Note that the amount of direct USD use is 400 for trade between U.S. and China, whereas the vehicle USD use is 800 for trade between China and Europe.

- USD value in aggregate use $= v_{\text{USD, China},t}^{\text{Aggregate}} = 400 + 800 = 1200$
- USD share in aggregate use $= S_{\text{USD, China},t}^{\text{Aggregate}} = v_{\text{USD, China},t}^{\text{Aggregate}} / V_{\text{China},t}^{\text{Aggregate}} = 1200/1830 = 65.57\%$
- USD value in direct use $= v_{\text{USD, China},t}^{\text{Direct}} = 400$
- USD share in direct use $= S_{\text{USD, China},t}^{\text{Direct}} = v_{\text{USD, China},t}^{\text{Direct}} / V_{\text{China},t}^{\text{Direct}} = 400/870 = 45.98\%$
- USD value in vehicle use $= v_{\text{USD, China},t}^{\text{Vehicle}} = 800$
- USD share in vehicle use $= S_{\text{USD, China},t}^{\text{Vehicle}} = v_{\text{USD, China},t}^{\text{Vehicle}} / V_{\text{China},t}^{\text{Vehicle}} = 800/960 = 83.33\%$

We could use a similar procedure to determine the share of EUR in China's cross-border transactions, and we obtain the following result.

$$S_{\text{EUR,China},t}^{\text{Aggregate}} = 30.60\% \quad S_{\text{EUR,China},t}^{\text{Direct}} = 45.98\% \quad S_{\text{EUR,China},t}^{\text{Vehicle}} = 16.67\%$$

4. Empirical analysis

4.1. Research framework

In this section, we design our research framework to investigate the determinants of international currency use and the policy effect on RMBI. As shown in Fig. 3, major international currencies such as the USD and EUR enjoyed a great deal of stability, so OLS regression is fitting and proper. In contrast, the RMB experienced dramatic expansion since 2010, necessitating the exploration of both the extensive and intensive margins of its international use. We therefore use a two-step Heckit regression for the RMB.[6]

For the selection of international currency, we follow He et al. (2016) and take the USD, EUR, GBP, JPY, Australian dollar (AUD), and Swiss franc (CHF) as the major international currencies.[7] To match the frequency of macroeconomic data, we aggregate the original SWIFT dataset to the annual level between 2011 and 2013. This short time span means that the variation in our sample comes mainly from cross-section differences rather than time-series dynamics. We estimate the following gravity model to explain the geographical distribution of these major international currencies.

$$S_{ijt}^{k} = \beta_0 + \beta_1 E_{ijt} + \beta_2 X_{ijt} + \beta_3 G_{ij} + C + \varepsilon_{ijt}^{k} \tag{10}$$

Here, i is the source country issuing the international currency and j is the destination country adopting the international currency. Superscript k corresponds to a type of currency use including aggregate, direct, and vehicle use. The dependent variable $S_{ijt}{}^{k}$ is the currency share as defined in the last section.[8] For the independent variables, vector E_{ijt} is a proxy for the economic integration between the source and destination country measured by merchandise trade, FDI, and portfolio investment. We expect these variables to have positive signs in the estimation, i.e., a higher level of economic integration should increase international currency use. X_{ijt} represents the macroeconomic condition of the source and destination countries, such as exchange rate, inflation, real GDP, and financial development.[9] Our theoretical model predicts that currency flow is correlated with relative asset demand, so we take the macroeconomic difference between the source and destination countries as our independent variable. In addition, vector G_{ij} involves a set of geographical and institutional factors such as distance and border.[10] For the estimation equation, we also add the fixed effect for the destination country and year to control for other unobserved factors. As argued in Portes and Rey (2005), a panel regression with either a fixed or random effect is inappropriate in this setting, and adding a country-pair fixed effect would affect several bilateral time-invariant regressors such as geographical distance, so we adhere to the OLS estimation with destination country and time fixed effect. We calculate heteroskedasticity-robust standard errors in the estimation.

Because we emphasize economic integration as an important determinant of international currency choice, the construction of trade share, FDI, and portfolio investment requires further explanation. For trade, we follow the established theory of trade invoicing currency in Bacchetta and Van Wincoop (2005) and Goldberg and Tille (2008) by measuring it as the share of country i's export of country j's total imports. A large value of this variable implies better economic integration through trade. Our empirical results remain robust if we add alternative measures of trade share. For FDI and portfolio investment, we mainly follow the procedure in Portes and Rey (2005) and He et al. (2016) by calculating them as the sum of the bilateral flows in the logarithm.[11] Increases in these variables indicate a closer economic relationship between the source and destination countries. Descriptions of and construction methods for the dependent variables are presented in Table 1.

Fig. 3 shows the rapid expansion of the RMB during this period. We adopt the two-step estimation procedure in Heckman (1979) to better evaluate the determinants of global RMB use. The estimation equation is as follows.

[6] There are indeed several currencies, such as JPY, CHF and AUD, that might qualify for two-step Heckit regression, since their user number is much less than USD and EUR. However, we maintain OLS estimation for them due to the following reasons. (i) The direct and portfolio investment data from CPIS and CDIS are quite incomplete for these the issuing country of these countries. If we keep the independent variables in baseline regression, Heckit regression is infeasible because the remaining observations show that all destination countries use JPY, CHF and AUD. (ii) If we drop the direct and portfolio investment, Heckit regression is feasible for AUD, and Table A.17 presents the outcome in appendix. The economic integration through merchandise trade remain important for both the intensive and extensive margin of international currency use.

[7] Canadian dollar (CAD) is not included since part of its macroeconomic and financial data during sample period is incomplete for our regression.

[8] Here we follow Eichengreen et al. (2016) and He et al. (2016) by directly taking the share $S_{ijt}{}^{k}$ as our dependent variable. The main reason for this choice is the considerable variation in $S_{ijt}{}^{k}$. Frankel (2012) took a logistic transformation of currency share because a non-linear relationship was observed between currency share and country's relative GDP. But that's not the case for major currencies in our sample. In addition, Eichengreen et al. (2016) also argued that, if there's zero observation for some small countries, non-linear transformation of dependent variable might lead the error term to depend on regressors, violating the assumption for OLS consistency. Notice that the logistic transformation we apply in the second step of Heckit regression wouldn't affect the consistency of estimation since the selection effect is already taken care of in the first-step Probit regression.

[9] For EUR, the independent variable is Euro-zone aggregation for trade, FDI, portfolio investment, real GDP and sample average for financial development and inflation.

[10] We would also like to add the lag of dependent variable to discuss inertia and path dependence, but the short sample period made that impossible.

[11] Another consideration for this kind of variable construction is because of the data source. Our bilateral trade data is from UN comtrade, which has a comprehensive coverage of bilateral flows and merchandise trade. Calculating our trade share with this dataset is reliable. In contrast, our data of FDI and portfolio investment are from CDIS and CPIS, two voluntary surveys by IMF reporting each country's outstanding stock of both investments. These two datasets are relatively incomplete because some countries could not or would not report the accurate value of their foreign investment, so a direct calculation of share would be improper.

Table 1
Data source and description.

Variable	Description	Source
Trade share	The ratio of trade between source and destination country, over the total trade of destination country	UN Comtrade
Direct investment	Outstanding position of inward and outward direct investment between country i and j, denominated in USD	IMF CDIS
Portfolio investment	Outstanding position of asset and liability between country i and j, denominated in USD	IMF CPIS
Exchange rate	Nominal exchange rate of country i currency per country j currency	IMF IFS
Exchange rate volatility	Coefficient of variance for monthly nominal exchange rate	IMF IFS
Real GDP	In constant 2005 USD	World Bank, WDI
Inflation	YoY change of consumer price index	IMF IFS
Financial development	Private credit over GDP	
Difference between source and destination country	World Bank, WDI	
Offshore finance center	Dummy variable, equal to 1 if destination country is offshore center	IMF
Distance	Greater circle distance between capital cities, in log	Kristian Skrede Gleditsch
Border, common language, former colonial relation	Dummy variable	Andrew Rose dataset
Capital account	Normalized between 0 and 1	Chinn and Ito (2006)
Liberalization	Difference between source and destination country	
Peg to USD/EUR	dummy variable, equal to 1 if destination country currency de facto pegged to USD/EUR or has pre-announced currency board	IMF
Policy	PBOC's policy to promote RMB internationalization	People's Bank of China (2015)
Rule of law	Percentile ranking	
	Difference between source and destination country	World bank, WGI

$$z_{jt}^{k} = \beta_0 + \beta_1 x_{jt} + \beta_2 \text{ Policy}_{jt} + F_t + \varepsilon_{1jt}^{k} \tag{11}$$

$$y_{jt}^{k} = \beta_3 + \beta_4 x_{jt} + \beta_5 \lambda_{jt}^{k} + \beta_6 \text{ Policy}_{jt} + F_t + \varepsilon_{2jt}^{k}, \quad y_{jt}^{k} \equiv \log\left(\frac{S_{\text{RMB},jt}^{k}}{1 - S_{\text{RMB},jt}^{k}}\right) \tag{12}$$

Eq. 11 is the first-step Probit estimation for the selection effect. The dependent variable $z_{jt}{}^{k}$ is equal to 1 if the destination country j has type k use of the RMB in period t, and equal to 0 otherwise. The independent variable x_{jt} involves most of the key regressors in Eq. 10, with the exception of portfolio investment, which was not published until 2015 during China's effort to join the SDR. We keep the time fixed effect but drop the country fixed effect because it is already captured by geographical distance.

Moreover, we investigate PBOC's policy effect on RMBI by constructing Policy_{jt}, which includes most of PBOC's favorable policies detailed in Table A.13. The existent literature such as Eichengreen and Lombardi (2015) mainly focused on the amount of China's currency swap agreement with other countries. One potential issue with such measurement is that the swap agreement might be just symbolic and never get activated. Another drawback is the limited coverage on PBOC's policy initiatives. Instead, our policy variable is constructed as.

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$$\text{Policy}_{jt} \equiv P_{1,jt} + P_{2,jt} + P_{3,jt} + P_{4,jt} + P_{5,jt} \tag{13}$$

where $P_{1,\,jt}$ is the dummy for the currency swap agreement, which is equal to 1 if country j had a currency swap agreement with China in period t. Similarly, $P_{2,\,jt}$ is the dummy of the settlement agreement, $P_{3,\,jt}$ the dummy for the direct trade of currency in foreign exchange market, $P_{4,\,jt}$ the dummy for RMB Qualified Foreign Institution Investor (RQFII), and $P_{5,\,jt}$ the dummy for the establishment of offshore clearing house. We choose this form of dummy variable because it is an aggregation of various policy tools. Because the PBOC mainly promoted the RMB as a trade settlement currency between 2011 and 2013, we expect this policy dummy to be significant in encouraging the direct use of RMB.

Eq. 12 is the second-step regression to explain the intensity of RMB use. RMB use was generally less than 1% during sample period, so we follow Frankel (2012) and apply the logistic transformation to $S_{jt}{}^{k}$ and get the new dependent variable $y_{jt}{}^{k}$, which is observed only when $z_{jt}{}^{k} = 1$. For independent variables, $\lambda_{jt}{}^{k}$ is the inverse Mills ratio estimated from the Eq. 11 to ensure the consistency of estimator. Specifically, the inverse Mills ratio is defined as

$$\lambda_{jt}^{k} \equiv \frac{\phi(\tilde{z}_{jt}^{k})}{\Phi(\tilde{z}_{jt}^{k})} \tag{14}$$

Table 2
Summary statistics.

Variables	Mean	sd	Min	Max	Median
Currency share (aggregate, %)	17.31	25.00	0.004	99.65	4.75
Currency share (direct, %)	15.72	24.71	0.00	99.84	3.71
Currency share (vehicle, %)	20.78	26.37	0.002	99.59	7.33
Trade share	10.86	14.76	0.0738	92.34	92.34
Portfolio investment	21.32	3.308	10.65	28.31	28.31
FDI	21.40	2.859	10.52	27.65	27.65
Exchange rate	−2.233	3.059	−10.26	5.028	5.028
Exchange rate volatility	−0.00360	0.0318	−0.411	0.0590	0.0590
Financial development	0.854	0.759	−0.772	3.663	3.663
Inflation	−3.064	5.393	−65.41	6.520	6.520
Real GDP	3.352	2.737	−3.407	11.06	11.06
Offshore finance center	0.176	0.381	0	1	1
Distance	8.539	0.907	5.746	9.801	9.801

where $\phi(\cdot)$ stands for the standard normal density function, $\Phi(\cdot)$ for the standard normal cumulative distribution function, and $\tilde{z}_{jt}^{k}$ for the prediction from regression 11. Given that $\tilde{z}_{jt}^{k}$ is a predicted variable in regression and our sample size is quite small, we bootstrap 10,000 times to get the standard error and confidence interval. Table 2 shows the summary statistics of both dependent and independent variables in our baseline estimation.

Eq. 12 is the second-step regression used to explain the intensity of RMB use. RMB use was generally less than 1% during the sample period, so we follow Frankel (2012) and apply the logistic transformation to ${S_{jt}}^{k}$ to obtain the new dependent variable ${y_{jt}}^{k}$, which is observed only when ${z_{jt}}^{k} = 1$. For the independent variables, ${\lambda_{jt}}^{k}$ is the inverse Mills ratio estimated from Eq. 11 to ensure the consistency of the estimator. The inverse Mills ratio is defined as

$$\lambda_{jt}^{k} \equiv \frac{\phi(\tilde{z}_{jt}^{k})}{\Phi(\tilde{z}_{jt}^{k})} \tag{15}$$

where $\phi(\cdot)$ is the standard normal density function, $\Phi(\cdot)$ the standard normal cumulative distribution function, and $\tilde{z}_{jt}^{k}$ the prediction from regression 11. Given that $\tilde{z}_{jt}^{k}$ is a predicted variable in the regression and our sample size is quite small, we bootstrap 10,000 times to obtain the standard error and confidence interval. Table 2 shows the summary statistics of the dependent and independent variables in our baseline estimation.

4.2. Empirical result

4.2.1. Baseline result for major international currencies

Table 3 presents the baseline outcomes for the major international currencies. The coefficients for trade, FDI, and portfolio investment are mostly positive and significant, which is consistent with our expectation that economic integration promotes the international use of currency. However, these factors differ in magnitude: trade and portfolio investment are more effective at promoting the direct use, whereas FDI works better at increasing vehicle use. For example, a 1% increase in bilateral portfolio investment would boost direct currency use by 2.69% but vehicle use by only 0.80%. In contrast, a 1% increase in FDI raises direct use by only 0.57% but greatly improves vehicle use by 3.54%.

One potential explanation for the magnitude difference is control power. FDI enables domestic parent firms to gain control power over foreign subsidiaries, which could become platforms to facilitate business relationships with other countries. Multinational enterprises also have more incentive to use the home currency in accounting and pricing to hedge exchange rate risk. Without such control power over foreign counter-parties, trade and portfolio investment exert less influence on the vehicle use of the home currency.

For macroeconomic variables, the outcome is also consistent with our expectation that a stable macroeconomic environment accelerates currency internationalization and that this effect is more pronounced for vehicle use. For the exchange rate, nominal appreciation and less volatility make the currency more attractive. Meanwhile, a high level of inflation discourages currency internationalization, particularly vehicle use. For financial development, a currency supported by a deep and liquid financial market enjoys more popularity. With respect to real GDP, the positive and significant estimation result means that a large economy is better able to project its economic power into foreign countries and to persuade others to use its currency.

The performance of the geographical factors is not always as expected. The coefficient estimation for border is positive but insignificant, which indicates that neighboring countries do not necessarily increase currency use. The dummy for offshore financial center is negative and significant, different from the literature, which implies the decreased use of international currencies in these countries and territories. One interesting observation concerns the death of distance: the estimated coefficient of distance is positive and significant, which means that when destination countries choose among the international currencies in our sample, they prefer the currency with a longer distance (such as the USD and EUR) over other currencies whose issuing countries might be closer to them. Regarding the relationship between geographical distance and international currency use, there are at least two opposing mechanisms. On one hand, a longer distance brings a higher level of transaction cost and information asymmetry, reducing people's

Table 3
Determinants of international currency use, 2011–2013.

	(1)	(2)	(3)
	Aggregate use	Direct Use	Vehicle Use
Trade share	0.92***	1.02***	0.43***
	(0.08)	(0.07)	(0.08)
FDI	1.69***	0.57	3.54***
	(0.51)	(0.50)	(0.61)
Portfolio investment	2.22***	2.69***	0.80
	(0.62)	(0.66)	(0.54)
Exchange rate	−5.22***	−4.77***	−5.91***
	(0.40)	(0.42)	(0.38)
Exchange rate volatility	−48.53*	−43.02	−57.64**
	(28.18)	(32.50)	(25.68)
Financial development	51.01***	51.45***	45.83***
	(3.71)	(3.87)	(3.55)
Inflation	−0.86**	−0.66*	−1.22***
	(0.39)	(0.39)	(0.42)
Real GDP	6.21***	4.47***	10.93***
	(0.72)	(0.76)	(0.71)
Offshore finance center	−21.02**	−25.05**	5.71
	(9.57)	(11.04)	(11.03)
Distance	6.37***	5.09***	8.62***
	(0.67)	(0.69)	(0.72)
Border	2.28	2.70	5.13*
	(2.90)	(2.53)	(3.04)
Constant	−243.24***	−203.64***	−314.35***
	(14.61)	(16.69)	(17.14)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	903	898	903
R-squared	0.76	0.75	0.74

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from MT 103, MT 103+, MT 103R, MT 202, MT 300, MT 400, and MT 700 in SWIFT BI Watch dataset. The fixed effects for destination country and year are omitted. Column (1) for aggregate use, (2) for direct use, and (3) for vehicle use. Robust standard error in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

willingness to adopt the corresponding currency. On the other hand, distant countries have a better chance to be in a different business cycle, thus providing more hedging and diversification opportunities. Given the network of interbank business, transaction cost and information asymmetry are obviously dwarfed by the benefits of hedging and diversification. Our finding is distinct from He et al. (2016), who observed that international currency is weightless and that its use is not affected by geographical distance. We attribute this difference to our more recent sample period and the unique nature of interbank financial transactions.

In sum, the benchmark regression for major international currencies reveals the importance of economic integration and macroeconomic stability. With respect to integration, trade and portfolio investment work better at increasing direct use, while FDI has a greater effect on vehicle use. Stable macroeconomic performance helps promote currency internationalization, and this effect is more pronounced for vehicle currency use.

4.2.2. Policy effect on RMB internationalization

In this section, we present the regression outcome for RMB. Table 4 is the baseline outcome, with the estimation of the first-step selection equation in columns 2, 4, and 6 and the second-step intensity equation in columns 1, 3, and 5. Our primary focus is on the PBOC's policy effect, which shows statistical significance only in the intensive margin of direct RMB use. The following interpretation is in order. First, it is only in direct use that the PBOC's policy becomes significant. Table A.13 shows that the PBOC's main policy between 2011 and 2013 was to encourage RMB use as a trade settlement currency, and the results for major international currencies in Table 3 shows that merchandise trade is more effective in cultivating the direct use of currency. More favorable policies on financial development and capital account liberalization such as RQFII might be beneficial to the vehicle use of RMB.

Second, the policy effect is significant only for the intensity of direct RMB use rather than its selection equation, which means that the PBOC's policy effort cannot do the ground-breaking work of persuading other countries to adopt RMB in cross-border transactions. In contrast, the coefficients of FDI are positive and significant in the selection function for all types of currency use, indicating its unique power in fostering new entries of RMB users.

Finally, in promoting the intensity of direct RMB use, the policy effect is more symbolic than practical. For example, currency swap agreements used to be an important channel for the Fed to act as a lender of last resort and provide USD liquidity to other countries in times of financial crisis. The PBOC's currency swap lines with developing and neighboring countries, however, have more

Table 4
Policy effect on RMB internationalization, 2011–2013.

	Aggregate		Direct		Vehicle	
	Intensity	Selection	Intensity	Selection	Intensity	Selection
Trade share	0.17***	0.02	0.10***	0.02	0.14***	0.03
	(0.03)	(0.02)	(0.03)	(0.02)	(0.03)	(0.02)
FDI	0.25*	0.34***	0.10	0.30***	0.22	0.24***
	(0.15)	(0.06)	(0.15)	(0.06)	(0.14)	(0.05)
Exchange rate	0.04	0.04	−0.02	0.01	0.10	0.04
	(0.09)	(0.06)	(0.14)	(0.05)	(0.13)	(0.05)
Exchange rate volatility	0.16	−0.06	0.24	−0.01	−0.13	−0.00
	(0.38)	(0.12)	(0.31)	(0.12)	(0.45)	(0.11)
Inflation	−0.04	−0.02	−0.01	−0.02	−0.02	−0.00
	(0.03)	(0.03)	(0.11)	(0.03)	(0.04)	(0.02)
Real GDP	−0.54***	−0.27***	−0.05	−0.10	−0.01	−0.33***
	(0.21)	(0.06)	(0.19)	(0.07)	(0.31)	(0.07)
Financial development	0.16	−0.00	1.07**	−0.13	0.20	0.04
	(0.37)	(0.15)	(0.50)	(0.15)	(0.46)	(0.17)
Distance	−1.65***	−0.54***	−1.68***	−0.63***	−1.54***	−0.35***
	(0.38)	(0.13)	(0.43)	(0.15)	(0.38)	(0.12)
Border	−1.12	−0.37	−0.89	0.05	−1.74*	−0.34
	(0.91)	(0.38)	(0.92)	(0.38)	(0.96)	(0.36)
Policy	−0.26	−0.11	0.79**	0.28	−0.16	0.23
	(0.39)	(0.47)	(0.39)	(0.29)	(0.52)	(0.43)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	180	291	125	291	162	291

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from MT 103, MT 103+, MT 103R, MT 202, MT 300, MT 400, and MT 700 in SWIFT BI Watch dataset. Column (1)–(2) for aggregate use, (3)–(4) for direct use, and (5)–(6) for vehicle use of international currency. Estimated with Heckman two-step regression. Column (2)(4)(6) shows result for the first regression for selection, while column (1)(3)(5) for second-step regression outcome. Year fixed effect and inverse Mills ration omitted. Capital account liberalization is the normalized Chinn-Ito index of destination country. Bootstrap standard errors with 10,000 replications in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

economic and political implications. Many news reports suggest that the actual utilization of currency swap agreements is rare and minimal.[12]

The coefficient estimations of the other independent variables distinguish the RMB from major international currencies. The degree of economic integration continues to play a major role. China's market share in trade shows a positive and significant estimation for the second-step intensity equation, whereas China's FDI proves important mainly in the first-step selection equation. The performance of macroeconomic variables is inconsistent with our expectation given the insignificant results for the exchange rate and inflation. This might be reasonable given China's monetary and foreign exchange system. Between 2011 and 2013, the RMB was still largely pegged to the USD, and capital control reduced RMB liquidity in offshore markets, rendering the exchange rate and its volatility less relevant. Another interesting observation concerns geographical distance, whose coefficient is always negative and significant for the RMB in all specifications. This result differs from the performance of major international currencies shown in Table 3. Eichengreen and Lombardi (2015) discussed the prospect of the RMB as a regional or global currency. Our regression outcome favors the RMB as an influential regional currency between 2011 and 2013. The status of the RMB as a regional currency, however, is likely to change if China seeks to expand the international use of the RMB in the financial market.

4.3. Robustness test

In this section, we conduct robustness tests for major international currencies and the RMB. The empirical results remain robust in various specifications.

4.3.1. Subsample test

The destination country in our sample varies greatly in terms of economic and financial development. Although the destination country fixed effect is added to the baseline estimation, it is appropriate to conduct a robustness test that differentiates between

[12] *Southern Weekly* reported that only Hong Kong, Singapore, and Republic of Korea actually used the currency swap agreement by 2015. For more detail, see http://www.infzm.com/content/107713/. PBOC explained the mechanism of its currency swap agreement in 2015 when the sharp depreciation of Russia Rupee raised public concern on the potential risk and loss for this kind of monetary cooperation. For more detail, see http://www.pbc.gov.cn/huobizhengceersi/214481/214511/214541/2813814/index.html.

Table 5
Robustness test, destination country.

	OECD destination			Non-OECD destination		
	(1)	(2)	(3)	(4)	(5)	(6)
	Aggregate	Direct	Vehicle	Aggregate	Direct	Vehicle
Trade share	0.57***	0.53***	0.55***	0.83***	0.94***	0.35***
	(0.07)	(0.08)	(0.12)	(0.11)	(0.09)	(0.11)
FDI	1.51***	1.14***	2.43***	2.32***	1.53**	3.27***
	(0.43)	(0.42)	(0.64)	(0.82)	(0.72)	(0.98)
Portfolio investment	−0.02	0.40	−1.33*	2.36***	2.94***	1.38**
	(0.77)	(0.79)	(0.75)	(0.67)	(0.68)	(0.67)
Exchange rate	−6.11***	−4.37***	−9.63***	−6.42***	−6.26***	−5.57***
	(0.50)	(0.47)	(0.61)	(0.60)	(0.64)	(0.60)
Exchange rate volatility	14.93	24.04	−18.62	−82.70***	−80.13**	−70.92***
	(26.03)	(25.17)	(35.98)	(30.11)	(37.98)	(23.68)
Financial development	41.02***	28.97***	64.00***	62.08***	64.40***	48.10***
	(4.36)	(4.44)	(5.03)	(4.29)	(4.31)	(4.64)
Inflation	−3.55***	−2.04***	−6.53***	−0.53	−0.42	−0.71**
	(0.45)	(0.42)	(0.59)	(0.34)	(0.38)	(0.32)
Real GDP	8.66***	5.74***	15.69***	9.18***	7.68***	11.94***
	(0.83)	(0.76)	(1.14)	(0.98)	(1.00)	(0.97)
Offshore finance center	−34.06***	−18.54***	−64.68***	−7.31	−14.26	11.99
	(4.24)	(3.87)	(6.13)	(10.56)	(10.79)	(13.08)
Distance	4.31***	3.07***	6.89***	2.93	2.07	7.16***
	(0.44)	(0.41)	(0.67)	(2.31)	(2.40)	(2.31)
Border	−0.14	2.09	−1.68	16.30***	15.64***	10.83*
	(1.87)	(2.12)	(3.17)	(5.85)	(5.01)	(6.06)
Constant	−83.72***	−72.95***	−101.08***	−277.05***	−253.23***	−317.84***
	(21.27)	(21.78)	(24.40)	(23.88)	(24.04)	(28.64)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	333	333	333	570	565	570
R-squared	0.80	0.72	0.84	0.80	0.81	0.73

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from SWIFT BI Watch dataset, with the message type of MT 103, MT 103+, MT 103R, MT 202, and MT 300. Country and year fixed effect omitted. Column (1) to (3) for OECD destination countries, and column (4) to (6) for non-OECD countries. Robust standard errors in parentheses. Source: SWIFT BI Watch.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

developing and developed countries. Yu (2015) shows that the degree of international risk sharing remains imperfect and that low-income countries are less financially integrated with the rest of the world. We expect the determinants of international currency use to vary across different groups of destination countries. Table 5 shows the results of the subsample test that splits the destination country into OECD and others, and several interesting findings are noteworthy. For economic integration, merchandise trade and FDI continue to promote international currency use, but portfolio investment works only for non-OECD countries with positive and significant estimations. For macroeconomic variables, the exchange rate does not matter for OECD countries, and the effect of inflation is insignificant for non-OECD countries; these results thus reflect the different landscapes in the international financial system. Additionally, the death of distance applies more to OECD destinations, implying their superior ability to overcome transaction costs and information asymmetry. Therefore, the determinants of international currency vary greatly across countries, but economic integration through trade and investment continues to matter.

We also check the robustness of our finding in different types of transactions. The message information in the SWIFT dataset includes cross-border payments, foreign exchange, and trade finance. In the appendix, Tables A.14, A.15, and A.16 show the results of subsample robustness tests according to these message types for major international currencies. The findings in the benchmark regression remains robust in most cases: trade and portfolio investment help more in the direct use of currency, while FDI has a greater effect on vehicle use; strong and stable macroeconomic conditions facilitate the international use of currency; and the death of distance remains a prominent feature for the interbank financial transaction.

4.3.2. Valuation effect and additional control

The original SWIFT dataset denominated all transactions in USD, leading to a potential problem of a valuation effect, i.e., the variation of the dependent variable is mainly from the change in the exchange rate rather than the actual use of international currency. The negative and significant coefficient estimation for the exchange rate is potential evidence for this effect.

In this part, we first deal with the valuation effect by calculating the quantity share of international currency, which is possible because each entry in the SWIFT dataset documents the number of transactions sent and received. The quantity share of each

Table 6
Robustness test, valuation effect.

	Count share			2011 USD as numeraire		
	(1)	(2)	(3)	(4)	(5)	(6)
	Aggregate	Direct	Vehicle	Aggregate	Direct	Vehicle
Trade share	1.14***	1.19***	0.78***	0.93***	1.02***	0.43***
	(0.08)	(0.07)	(0.10)	(0.08)	(0.07)	(0.09)
FDI	1.27***	1.01**	2.04***	1.68***	0.56	3.55***
	(0.45)	(0.44)	(0.59)	(0.51)	(0.49)	(0.61)
Portfolio investment	2.88***	3.02***	1.96***	2.19***	2.67***	0.77
	(0.58)	(0.61)	(0.62)	(0.62)	(0.66)	(0.54)
Exchange rate	−4.45***	−4.14***	−6.26***	−5.10***	−4.68***	−5.77***
	(0.40)	(0.41)	(0.45)	(0.40)	(0.42)	(0.38)
Exchange rate volatility	−25.81	−22.21	−47.43	−48.78*	−43.63	−56.38**
	(29.75)	(29.06)	(32.63)	(27.74)	(32.10)	(25.24)
Financial development	39.45***	38.24***	49.07***	50.11***	50.69***	44.62***
	(3.56)	(3.66)	(3.99)	(3.71)	(3.87)	(3.57)
Inflation	−0.68*	−0.57*	−1.07**	−0.83**	−0.64*	−1.19***
	(0.37)	(0.34)	(0.51)	(0.38)	(0.39)	(0.41)
Real GDP	4.12***	3.12***	9.52***	6.13***	4.39***	10.88***
	(0.72)	(0.72)	(0.85)	(0.72)	(0.76)	(0.71)
Offshore finance center	−19.56***	−20.74**	−0.74	−20.77**	−24.96**	6.74
	(7.54)	(8.03)	(10.21)	(9.62)	(11.10)	(11.11)
Distance	6.09***	5.26***	9.40***	6.23***	4.97***	8.49***
	(0.63)	(0.63)	(0.76)	(0.67)	(0.69)	(0.72)
Border	7.07***	7.43***	10.23***	2.34	2.70	5.34*
	(2.50)	(2.50)	(3.14)	(2.91)	(2.54)	(3.04)
Constant	−213.24***	−193.24***	−308.56***	−238.81***	−199.78***	−310.78***
	(14.26)	(14.79)	(17.56)	(14.64)	(16.72)	(17.24)
Country FE	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	903	898	903	903	898	903
R-squared	0.79	0.79	0.75	0.75	0.75	0.74

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from the count data in SWIFT BI Watch dataset, in the message type of MT 103, MT 103+, MT 103R, MT 202, and MT 300. Destination country and year fixed effect omitted. Robust standard errors in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

currency is generated as follows.

$$S_{ijt}^{k} = \frac{q_{ijt}^{k}}{Q_{jt}^{k}} \tag{16}$$

With similar notation as for the value share, i indicates the source country, j is the destination country, t is the period, and k is the type of currency used. The only difference comes from the measurement of currency use: ${q_{ijt}}^{k}$ is the number of transactions between countries i and j, and ${Q_{jt}}^{k}$ is the total number of transactions involving country j. Our new measure can deal with the valuation effect if the transaction number is not completely affected by exchange rate movement. The literature normally deals with this issue by choosing a numeraire currency and year. See Wong (2007) for a more detailed discussion. We follow this procedure and take the 2011 USD as our numeraire to eliminate any valuation effect. Table 6 is the result. The dependent variable in column (1)–(3) is calculated from transaction number, while the rest is from numeraire conversion. In both specifications, the impact of economic integration remains positive and significant. The magnitude difference also holds after adjusting for the valuation effect: trade and portfolio investment promote more direct use, while FDI has a larger effect on increasing vehicle use. The performance of other independent variables is similar to the baseline estimation with the exceptions of the exchange rate volatility and the border dummy.

To further check the robustness of our empirical finding, we follow He et al. (2016) by adding other economic and institutional factors. Table 7 shows the results.

The previous findings on FDI, macroeconomic performance, and the death of distance endure, but the result for the new controls is not always consistent with intuition. Common language and colonial ties do not help increase currency use, but the rule of law and currency pegging would promote currency internationalization. Based on the empirical result in this and the above section, the impact of economic integration on currency use remained robust in most specifications.

4.3.3. Other tests for major currencies

In this section, we conduct several other tests for major currencies to further confirm our empirical findings. For the death of

Table 7
Robustness test: additional control variables.

	(1)	(2)	(3)
	Aggregate sample	Direct use	Vehicle use
Trade share	0.79***	0.89***	0.33***
	(0.08)	(0.07)	(0.09)
Direct investment	1.80***	0.58	3.65***
	(0.49)	(0.49)	(0.57)
Portfolio investment	2.31***	2.50***	1.03*
	(0.62)	(0.65)	(0.53)
Exchange rate	−4.36***	−3.80***	−5.20***
	(0.45)	(0.49)	(0.45)
Exchange rate volatility	−16.02	−12.55	−26.38
	(23.84)	(27.90)	(21.87)
Financial development	39.27***	41.40***	35.99***
	(4.51)	(4.69)	(4.69)
Real GDP	10.43***	8.89***	13.85***
	(0.98)	(1.01)	(1.05)
Inflation	−0.67**	−0.43	−0.97***
	(0.33)	(0.34)	(0.34)
Offshore finance center	10.99	6.82	30.42*
	(12.76)	(14.29)	(16.31)
Distance	4.09***	2.56***	7.23***
	(0.74)	(0.78)	(0.82)
Border	5.91**	6.12**	7.73**
	(2.93)	(2.63)	(3.10)
Common language	−2.31	−2.18	0.63
	(1.67)	(1.66)	(1.77)
Colonial relation	−11.80***	−9.63***	−14.19***
	(1.50)	(1.60)	(1.74)
Capital account liberalization	−30.40***	−33.92***	−20.68***
	(6.27)	(6.61)	(6.73)
Peg to USD	8.80	0.39	12.89
	(9.03)	(7.22)	(8.34)
Peg to EUR	−38.64***	−47.80***	5.81
	(6.72)	(8.47)	(12.15)
Rule of law	1.22***	1.27***	0.91***
	(0.23)	(0.24)	(0.27)
Constant	−281.14***	−236.48***	−346.51***
	(17.52)	(19.54)	(20.91)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	888	883	888
R-squared	0.79	0.78	0.77

*, ** and *** stand for 10%, 5% and 1% confidence level.

Table 8
Robustness test, death of distance.

	(1)	(2)	(3)	(4)	(5)	(6)
	Aggregate	Aggregate	Direct	Direct	Vehicle	Vehicle
Distance	2.98***	2.06**	1.45	1.46*	7.52***	4.27***
	(1.02)	(0.83)	(0.99)	(0.81)	(1.11)	(0.84)
Border	22.34***	17.51***	22.30***	17.93***	20.18***	13.79***
	(2.82)	(2.91)	(2.76)	(3.05)	(3.05)	(2.67)
Constant	6.09	−1.50	26.09*	1.96	−61.83***	−16.65**
	(12.32)	(7.15)	(14.50)	(7.02)	(10.23)	(7.05)
Country FE	Yes	No	Yes	No	Yes	No
Year FE	Yes	No	Yes	No	Yes	No
Observations	903	903	898	898	903	903
R-squared	0.27	0.03	0.29	0.03	0.29	0.02

Notes: Robust standard errors in parentheses; column 1 and 2 for aggregate use; column 3 and 4 for direct use; column 5 and 6 for vehicle use of currency.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Table 9
Comparing direct and vehicle use.

Estimation model&sample	Trade	FDI	Portfolio investment
Baseline	Yes	Yes	Yes
OECD destination country	Yes	Yes	Yes
Non-OECD destination country	Yes	Yes	Yes
Cross-border payment	Yes	No	Yes
FX transaction	Yes	Yes	Yes
Trade finance	Yes	Yes	Yes
Valuation	Yes	Yes	Yes
Additional control	Yes	Yes	Yes

Notes: this table shows the result of *Z*-test of comparing the coefficient estimation in direct and vehicle currency use. Row 1 for the baseline estimation in Table 3. Row 2 and 3 for robustness test of destination country in Table 5. Row 4 to 6 for robustness test of transaction type in Table A.14, A.15, and A.16. Row 7 for robustness test of valuation effect in Table 6. Row 8 for additional control in Table 7. The null hypothesis is that the coefficients in two regressions are the same, and column (2) to (4) show "Yes" if the null hypothesis could be rejected at 5% confidence level.

distance, we conduct a robustness test (Table 8), where the independent variables include only the distance, border, and constant. The death of distance is quite robust in various specifications, with most of the coefficients of distance positive and significant, and this is more prominent for vehicle currency use. Note that our research framework means that among the major international currencies in our sample, the destination country prefers the currency issued by a distant country. As shown in the geographical distribution of international currencies in Figs. 4 and 5, this phenomenon is more likely for the USD and EUR. The positive and significant coefficient estimation would disappear if we exclude the USD and EUR from our sample. Therefore, it is safer to conclude that only the USD and EUR experienced the death of distance during our sample period.

We also need to test whether the coefficient estimations, especially those of trade share, FDI, and portfolio investment, are statistically different between the regressions for the direct and vehicle currency use. Essentially, we test whether the factors in economic integration have distinct effects on the international use of currency. Here we use the following statistics proposed by Clogg et al. (1995)

$$Z = \frac{\beta_D - \beta_V}{\sqrt{(\mathrm{SE}_D)^2 + (\mathrm{SE}_V)^2}} \tag{17}$$

where β_D and SE_D are coefficient estimation and its standard error in the regression for direct currency use. Similarly, β_V and SE_V are coefficient estimation and its standard error in the regression for vehicle currency use. In a large sample, Z should follow a normal distribution. Table 9 shows the result, and the coefficient estimation is mostly different between the regression for the direct and vehicle use of currency.

4.3.4. Robustness test for RMB internationalization

This part presents the robustness test for RMBI. First, we replace the aggregate variable Policy_{jt} with individual policies to show their respective influences. Moreover, we add the index of economic policy uncertainty from Baker et al. (2016), which is constructed from news report in South China Morning Post. A higher value of this index indicates more uncertainty of China's economic policy. We expect a negative effect of policy uncertainty on global RMB use, and Table 10 is the regression outcome. Our empirical findings on trade and FDI remain robust. For specific policies, the PBOC's currency swap agreement with other central banks is the only one effective in promoting direct RMB use. As discussed previously, this kind of agreement facilitates RMB as trade settlement currency, thus improving its direct use. Other favorable policies related to financial openness are still at their initial stage of implementation during the sample period, so they are largely insignificant in the estimation. Economic policy uncertainty has a negative effect on the intensive margin of RMB use, which is consistent with our expectation.

We then add more control variables to the baseline estimation in Table 4, and Table 11 shows the result for the two-step Heckit estimation.[13] The policy effect remains significant only in the intensity equation of direct RMB use, which confirms our finding that the PBOC's policy between 2011 and 2013 mainly focused on the direct use of the RMB as trade settlement currency, and that such policy could not persuade foreign countries to begin to adopt the RMB. The impact of economic integration displays some divergence from the baseline estimation. Trade share has positive and significant coefficient estimations not only in all three intensity equations but also in the selection equation of vehicle currency use. The impact of FDI remains exclusively on the selection effect. The power of macroeconomic variables continues to be absent for global RMB use given that no significant estimation could be found for the exchange rate, inflation, real GDP, or financial development. The death of distance also does not apply to RMB, confirming its role largely as a regional currency during the sample period. None of the additional control variables shows a consistently significant estimation. However, the result for capital account liberalization should be taken with caution. We use the Chinnâ€"Ito index as an approximate measure of the degree of capital account openness, but this index remains at a low level for China between 2011 and

[13] Ideally, we would also like to do subsample robustness test like the major currencies in Table A.14, but that's infeasible due to the limited observation number during sample period. Future research with richer information would have more potential to solve this issue.

Table 10
Policy effect on RMB internationalization, specific policies.

	Aggregate		Direct		Vehicle	
	Intensity	Selection	Intensity	Selection	Intensity	Selection
Trade share	0.18***	0.04	0.12***	0.02	0.16***	0.06**
	(0.03)	(0.03)	(0.03)	(0.02)	(0.04)	(0.03)
Direct investment	0.69***	0.28***	0.41	0.25***	0.89***	0.16***
	(0.19)	(0.06)	(0.25)	(0.07)	(0.23)	(0.06)
Exchange rate	−0.06	0.05	−0.10	0.01	−0.01	0.06
	(0.10)	(0.05)	(0.17)	(0.05)	(0.13)	(0.06)
Exchange rate volatility	0.14	−0.12	0.22	−0.04	−0.18	−0.07
	(0.39)	(0.13)	(0.36)	(0.13)	(0.45)	(0.13)
Inflation	−0.03	0.01	−0.02	−0.02	−0.00	0.04
	(0.04)	(0.04)	(0.10)	(0.04)	(0.07)	(0.04)
Real GDP	−0.29	−0.36***	0.01	−0.15*	0.21	−0.46***
	(0.28)	(0.08)	(0.23)	(0.08)	(0.36)	(0.10)
Financial development	0.39	0.03	0.95*	−0.14	0.67	0.10
	(0.39)	(0.15)	(0.50)	(0.16)	(0.44)	(0.16)
Distance	0.47	−1.09***	−0.61	−1.04***	1.18*	−1.09***
	(0.64)	(0.42)	(0.67)	(0.38)	(0.67)	(0.39)
Border	0.41	−0.84	0.39	−0.42	0.13	−0.91*
	(1.05)	(0.62)	(1.25)	(0.54)	(1.11)	(0.53)
Currency swap agreement	0.08	−0.57	1.80**	0.20	0.13	−0.44
	(0.84)	(0.48)	(0.74)	(0.39)	(0.86)	(0.41)
Settlement agreement	−1.16	3.27	0.65	5.76	−0.97	3.84
	(1.16)	(5.46)	(0.83)	(7.54)	(1.02)	(6.63)
Direct exchange of currency	0.30	6.98	−0.22	−0.02	0.50	9.51
	(1.67)	(7.48)	(1.99)	(8.36)	(1.80)	(6.70)
RQFII	0.26	0.18	0.62	1.11	0.24	0.48
	(3.88)	(7.62)	(3.46)	(8.14)	(3.62)	(9.18)
Offshore clearing house	−2.16	9.20	−1.39	15.74	−1.65	11.39
	(6.22)	(25.65)	(5.23)	(45.98)	(4.52)	(30.16)
Economic policy uncertainty	−0.17***	0.04	−0.10*	0.03	−0.23***	0.05**
	(0.05)	(0.03)	(0.05)	(0.02)	(0.06)	(0.02)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	180	291	125	291	162	291

*, ** and *** stand for 10%, 5% and 1% confidence level.

2013. Therefore, it is premature to draw a conclusion on the effectiveness of capital account liberalization. In sum, from the result of the robustness test with additional control variables, the effect of the PBOC's policy is still limited to the intensity of direct use, and the degree of economic integration continues to promote RMBI.

5. Policy implication for RMB internationalization

RMBI experienced considerable fluctuation and setback with the reform of the RMB exchange rate regime during August 2015. The subsequent currency depreciation and capital outflow interrupted and even reversed RMBI to some degree. Our empirical findings in this paper support a more stable approach to promoting RMBI by FDI, especially through the BRI.

It is undeniable that the PBOC's favorable policies since 2009 have substantially facilitated the international use of the RMB. According to the People's Bank of China (2017), 25.2% of China's cross-border transactions were settled using the RMB during 2016. However, this progress mainly reflects the direct use of the RMB between China and foreign countries, whereas the vehicle use of RMB still requires improvement. This is also shown in Table 4, where the policy effect is positive and significant only in boosting the intensity of direct RMB use. However, as we mentioned earlier, the vehicle use among non-residents of the issuing country is the hallmark of a truly international currency, so the next question is how to promote the vehicle use of RMB in a safe and sound way.

One popular recipe is capital account liberalization, which can increase the cross-border portfolio investment and enhance the popularity of RMB in offshore financial markets. Admittedly, the elimination of capital account restriction is a necessary condition for any international currency, and China has gradually lifted regulations with programs such as RQFII and the Shenzhen-Hong Kong Stock Connect Program. The benefit of capital account liberalization, however, remains a controversial issue. As discussed in Chinn and Ito (2006) and Klein and Olivei (2008), financial openness does not necessarily lead to economic growth, and one of the prerequisites is a sufficient level of financial development, for which China still has a great deal of room to improve. Moreover, the recent debate on trilemma and dilemma (e.g. Passaria and Rey, 2015; Rey, 2015) revealed that capital account liberalization leads to the loss of monetary policy independence. A premature liberalization of capital accounts, together with China's backward financial development, could result in excessive volatility and speculative attacks. Therefore, capital account liberalization could be disastrous if handled inappropriately, whereas its benefits on RMBI could prove elusive and negligible.

Alternatively, the PBOC could resort to FDI as a more stable approach to further promoting RMBI. Our empirical findings have

Table 11
Policy effect on RMB internationalization, additional control.

	Aggregate		Direct		Vehicle	
	Intensity	Selection	Intensity	Selection	Intensity	Selection
Trade share	0.22***	0.02	0.14***	0.01	0.20***	0.05**
	(0.03)	(0.02)	(0.04)	(0.02)	(0.04)	(0.02)
Direct investment	0.19	0.31***	0.24	0.32***	0.17	0.23***
	(0.13)	(0.07)	(0.20)	(0.08)	(0.13)	(0.06)
Exchange rate	−0.04	−0.01	0.00	0.02	−0.04	0.02
	(0.11)	(0.06)	(0.19)	(0.06)	(0.14)	(0.06)
Exchange rate volatility	0.18	0.06	0.31	0.05	−0.18	0.14
	(0.40)	(0.14)	(0.39)	(0.12)	(0.45)	(0.15)
Inflation	−0.07	−0.04	−0.02	−0.03	−0.03	−0.02
	(0.04)	(0.03)	(0.10)	(0.03)	(0.05)	(0.03)
Real GDP	−0.80***	−0.32***	−0.36	−0.09	−0.38	−0.31***
	(0.27)	(0.10)	(0.24)	(0.10)	(0.31)	(0.09)
Financial development	0.45	0.23	0.65	0.07	0.34	0.15
	(0.42)	(0.21)	(0.55)	(0.24)	(0.51)	(0.23)
Distance	−1.70***	−0.53***	−2.07***	−0.71***	−1.53***	−0.43***
	(0.34)	(0.15)	(0.51)	(0.18)	(0.35)	(0.13)
Border	−1.21	0.27	−0.98	0.29	−2.11*	−0.06
	(0.88)	(0.66)	(1.01)	(0.47)	(1.09)	(0.45)
Policy	−0.41	−0.08	0.86**	0.27	−0.70	0.38
	(0.46)	(0.47)	(0.43)	(0.34)	(0.56)	(0.38)
Offshore financial center	0.66	−0.09	1.03	0.42	1.77	−1.34***
	(0.91)	(0.51)	(0.91)	(0.61)	(1.21)	(0.50)
Rule of law	0.01	−0.02	0.05**	−0.01	0.02	−0.02*
	(0.02)	(0.01)	(0.02)	(0.01)	(0.02)	(0.01)
Capital account liberalization	−2.20**	−0.74	−1.47	−0.24	−1.09	−0.85*
	(0.98)	(0.48)	(0.99)	(0.48)	(1.09)	(0.44)
Peg to USD	1.47	0.24	−2.70	−2.65**	3.58*	0.43
	(2.09)	(3.28)	(2.42)	(1.22)	(2.15)	(3.14)
Peg to EUR	1.29**	0.16	1.30*	−0.65*	2.40***	0.29
	(0.56)	(0.43)	(0.68)	(0.33)	(0.75)	(0.42)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	175	282	121	282	158	282

*, ** and *** stand for 10%, 5% and 1% confidence level.

unveiled the unique role of FDI: for major international currencies, it is effective in promoting vehicle use, while for the RMB, it is powerful in persuading foreign countries to begin adopting the RMB, which is crucial in reducing the transaction cost through economies of scale and network externality. Furthermore, with the launch of the BRI, the RMB could play a major role in financing China's outward FDI and fostering the foreign subsidiaries of Chinese firms. In contrast to the risky capital flows in portfolio investment, the direct investment on infrastructure and public utility, which is the focus of the BRI, provides more stability and predictability. It is therefore easier for the PBOC to make a coordinated effort based on FDI and the OBORI to further increase the vehicle use of the RMB worldwide.

6. Conclusion

This paper empirically studies currency use in financial transactions using the SWIFT dataset from October 2010 to August 2014. A higher level of integration and stable macroeconomic conditions help increase the global use of major international currencies. Specifically, merchandise trade and portfolio investment are more helpful in raising the direct use of a currency, while FDI has a stronger effect in promoting its vehicle use. For the RMB, trade improves the intensity of its use, and FDI fosters new entries by RMB users. In addition, the PBOC's policy during this period is effective only in enhancing the intensity of direct RMB use. Another interesting observation is the death of distance for major international currencies such as the USD and EUR, whereas RMB use is decreasing with geographical distance, meaning that the RMB remained regional rather than global before 2014. Several sets of robustness tests, such as the tests of the subsample, adjustment for the valuation effect, and additional control variables, confirm the validity of our empirical findings. Based on these results, we suggest expanding the global use of the RMB by outward FDI through the OBORI.

This empirical project could be continued with more recent SWIFT data to better evaluate the drivers of international currency use and the policy effect on RMBI. In particular, it would be interesting to study the international use of RMB after its accession into the SDR basket in October 2016. Relative to the established theory on trade invoicing currency, there is a vacuum regarding how to explain the currency choice in financial transactions, and an advanced theoretical framework is urgently needed to fill the gap. Of course, a closely related question is why a country wants to make its currency international. The welfare implication of international currency is also to be carefully studied. Should a country open its capital account to make its currency more widely used in trade and

financial transactions? Should central banks worry about the nominal exchange rate if most of their external positions are denominated in the home currency? We leave these interesting and important questions to future research

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Appendix

A.1. Maximization problem for agent

Given the expected utility in Eq. 5, the budget constraint in Eq. 2, and the cash-in-advance constraint in Eqs. 3 and 4, we can write the Lagrange problem as follows.

$$\begin{aligned}\mathbb{L}(s_A^i, s_B^i, \alpha_A^i, \alpha_B^i, m_A, m_B) &= w_A - \phi_A m_A - \phi_B m_B \\ &+ \eta_A\left(\frac{\beta\sigma d_A^{1-1/\sigma}}{\sigma-1}\sum_{i\in S_A}(s_A^i)^{1-1/\sigma} + \frac{\beta\sigma d_A^{1-1/\sigma}}{\sigma-1}\sum_{k\in z_A}(1-\alpha_A^k)^{1-1/\sigma}\right) \\ &+ \eta_B\left(\frac{\beta\sigma d_B^{1-1/\sigma}}{\sigma-1}\sum_{i\in S_B}(s_B^i)^{1-1/\sigma} + \frac{\beta\sigma d_B^{1-1/\sigma}}{\sigma-1}\sum_{k\in z_B}(1-\alpha_B^k)^{1-1/\sigma}\right) \\ &+ \lambda_1\left(\phi_A m_A + \phi_B m_B(1-t_{BA}) + \sum_{k\in z_A} p_A^k\alpha_A^k - f(z_A) - \sum_{i\in S_A} p_A^i s_A^i\right) \\ &+ \lambda_2\left(\phi_A m_A(1-t_{AB}) + \phi_B m_B + \sum_{k\in z_B} p_B^k\alpha_B^k - f(z_B) - \sum_{i\in S_B} p_B^i s_B^i\right) \\ &+ \lambda_3\phi_A m_A + \lambda_4\phi_B m_B \end{aligned} \tag{A.1}$$

Here we consider the interior solution for currency holding when both $\phi_A m_A$ and $\phi_B m_B$ are positive, so that $\lambda_3 = \lambda_4 = 0$. Asset demand is available from FOC.

$$p_A^i s_A^i = \left(\frac{\beta\eta_A}{\lambda_1}\right)^{\sigma}\left(\frac{d_A}{p_A^i}\right)^{\sigma-1} \quad p_B^j s_B^j = \left(\frac{\beta\eta_B}{\lambda_2}\right)^{\sigma}\left(\frac{d_B}{p_B^j}\right)^{\sigma-1}, \; i\in S_A, j\in S_B \tag{A.2}$$

$$p_A^i(1-\alpha_A^i) = \left(\frac{\beta\eta_A}{\lambda_1}\right)^{\sigma}\left(\frac{d_A}{p_A^i}\right)^{\sigma-1} \quad p_B^j(1-\alpha_B^j) = \left(\frac{\beta\eta_B}{\lambda_2}\right)^{\sigma}\left(\frac{d_B}{p_B^j}\right)^{\sigma-1}, \; i\in z_A, j\in z_B \tag{A.3}$$

$\lambda_1 \equiv \frac{t_{AB}}{1-(1-t_{AB})(1-t_{BA})}$ and $\lambda_2 \equiv \frac{t_{BA}}{1-(1-t_{AB})(1-t_{BA})}$ are related with the transaction cost in OTC market. Intuitively, agent's demand for both direct investment and portfolio investment are increasing in matching probability and dividend-price ratio, but decreasing in transaction cost. We could pin down currency demand from agent's cash-in-advance constraint.

$$\phi_A m_A = \frac{(f(z_A) + \Sigma_{i\in S_A} p_A^i s_A^i - \Sigma_{k\in z_A} p_A^k\alpha_A^k) - (1-t_{BA})(f(z_B) + \Sigma_{i\in S_B} p_B^i s_B^i - \Sigma_{k\in z_B} p_B^k\alpha_B^k)}{1-(1-t_{AB})(1-t_{BA})} \tag{A.4}$$

$$\phi_B m_B = \frac{(f(z_B) + \Sigma_{i\in S_B} p_B^i s_B^i - \Sigma_{k\in z_B} p_B^k\alpha_B^k) - (1-t_{AB})(f(z_A) + \Sigma_{i\in S_A} p_A^i s_A^i - \Sigma_{k\in z_A} p_A^k\alpha_A^k)}{1-(1-t_{AB})(1-t_{BA})} \tag{A.5}$$

To streamline our analysis below, we assume agent's revenue from issuing stock is equal to the cost of developing risky project at equilibrium, i.e., $\Sigma_{k\in z_A} {p_A}^k {\alpha_A}^k = f(z_A)$ and $\Sigma_{k\in z_B} {p_B}^k {\alpha_B}^k = f(z_B)$. Then we have the currency demand in Eqs. 6 and 7. Also note the constraint imposed on asset demand for the case of interior solution. Specifically, for the demand of both currencies to be strictly positive, we need the following.

$$1 - t_{BA} < \frac{\sum_{i\in S_A} p_A^i s_A^i}{\sum_{j\in S_B} p_B^j s_B^j} < \frac{1}{1-t_{AB}} \tag{A.6}$$

The condition above means the relative asset demand should lie in an intermediate range so as to keep the demand for both currencies strictly positive. If there's relatively excessive demand for country A asset and $\frac{\sum_{i\in S_A} p_A^i s_A^i}{\sum_{j\in S_B} p_B^j s_B^j} > \frac{1}{1-t_{AB}}$, only country A currency

would be needed since agents are willing to pay transaction cost to readjust their currency holding, given that the demand for country A asset is huge. Similarly, if $\frac{\sum_{i\in S_A} p_A^i s_A^i}{\sum_{j\in S_B} p_B^j s_B^j} < (1 - t_{BA})$, only country B currency would be needed. In this way, economic integration and financial development would affect both the intensive and extensive margin of international currency.

A.2. Three-country model

Now consider agent's currency demand in a three-country model. There are two periods and three countries (A, B and C) now. We make the following assumptions to simplify our analysis and get analytical solutions. (i) We assume the transaction cost in OTC FX market is the same all over the world, i.e. $t_{ij} = t, \forall i, j \in \{A, B, C\}$, $i \neq j$. This assumption helps us focus on the impact of economic integration and financial development. (ii) We maintain the previous assumption that agent's revenue from issuing stock is equal to the cost of developing risky project at equilibrium, i.e., $\Sigma_{k\in z} p_i^k \alpha_i^k = f(z_i), \forall i \in \{A, B, C\}$. We could derive country A agent's asset demand as

$$p_A^i s_A^i = \left(\frac{\beta\eta_A}{\lambda}\right)^{\sigma}\left(\frac{d_A}{p_A^i}\right)^{\sigma-1} \quad p_B^j s_B^j = \left(\frac{\beta\eta_B}{\lambda}\right)^{\sigma}\left(\frac{d_B}{p_B^j}\right)^{\sigma-1} \quad p_C^k s_C^k = \left(\frac{\beta\eta_C}{\lambda}\right)^{\sigma}\left(\frac{d_C}{p_C^k}\right)^{\sigma-1} \tag{A.7}$$

$\forall i \in S_A$, $j \in S_B$, $k \in S_C$. Here η_A, η_B and η_C denote the probability for country A agent to stay at home, travel to country B and country C, all related with the degree of economic integration. The transaction cost in currency exchange is $\lambda \equiv \frac{1}{3-2t}$. Similar to the two-country model, we get agent's currency demand related with the relative demand for asset.

$$\phi_A m_A = \frac{2-t}{t(3-2t)}\left(\sum_{i\in S_A} p_A s_A^i\right) - \frac{1-t}{t(3-2t)}\left(\sum_{i\in S_B} p_B s_B^i + \sum_{i\in S_C} p_C s_C^i\right) \tag{A.8}$$

$$\phi_B m_B = \frac{2-t}{t(3-2t)}\left(\sum_{i\in S_B} p_B s_B^i\right) - \frac{1-t}{t(3-2t)}\left(\sum_{i\in S_A} p_A s_A^i + \sum_{i\in S_C} p_C s_C^i\right) \tag{A.9}$$

$$\phi_C m_C = \frac{2-t}{t(3-2t)}\left(\sum_{i\in S_C} p_C s_C^i\right) - \frac{1-t}{t(3-2t)}\left(\sum_{i\in S_A} p_A s_A^i + \sum_{i\in S_B} p_B s_B^i\right) \tag{A.10}$$

The requirement for agent's holding of three currencies to be strictly positive is

$$\min\left\{\sum_{i\in S_A} p_A^i s_A^i, \sum_{i\in S_B} p_B^i s_B^i, \sum_{i\in S_C} p_C^i s_C^i\right\} > \frac{1-t}{3-2t}\left(\sum_{i\in S_A} p_A s_A^i + \sum_{i\in S_B} p_B s_B^i + \sum_{i\in S_C} p_C s_C^i\right) \tag{A.11}$$

The equation above states the condition for agents to be willing to holding all three currencies: the demand for each asset must reach a threshold value share in total asset demand. If the value share for one country's asset is less than $(1-t)/(3-2t)$ in the aggregate asset demand, agents would not be willing to hold that country's currency.

A.3. Table

Table A.12
List of destination country in baseline regression.

Country name	ISO 3-letter code	Sample period	Currency used
Albania	ALB	2011,2012,2013	EUR, GBR
Algeria	DZA	2011,2012,2013	EUR
Australia	AUS	2011,2012,2013	USD, EUR, GBP, JPY, CHF
Argentina	ARG	2011,2012,2013	USD, EUR, GBP, CHF, AUD
Armenia	ARM	2011,2012,2013	EUR
Austria	AUT	2011,2012,2013	USD, GBP, CHF
Azerbaijan	AZE	2011,2012,2013	EUR
Bahamas	BHS	2011,2012,2013	USD, EUR, GBP
Bahrain	BHR	2011,2012,2013	EUR, GBP, USD
Bangladesh	BGD	2011	EUR, GBP, USD
Belgium	BEL	2011,2012,2013	USD, JPY, GBP, CHF, AUD
Belarus	BLR	2011, 2012, 2013	EUR, USD
Belize	BLZ	2011, 2012, 2013	EUR, USD
Bolivia	BOL	2011,2012,2013	USD, GBP, CHF
Botswana	BWA	2011, 2012, 2013	USD, EUR
Brazil	BRA	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Bulgaria	BGR	2011,2012,2013	USD, EUR, GBP, CHF
Burkina Faso	BFA	2011, 2013	EUR

(*continued on next page*)

Table A.12 (*continued*)

Country name	ISO 3-letter code	Sample period	Currency used
Burundi	BDI	2011, 2012, 2013	EUR
Cabo Verde	CPV	2011, 2012, 2013	EUR
Cambodia	KHM	2011, 2012, 2013	EUR
Cameron	CMR	2011, 2012	USD, EUR
Central African Republic	CAF	2011, 2012	EUR
Chile	CHL	2011,2012,2013	USD, EUR, GBP, AUD, CHF
Hong Kong, China	HKG	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
China	CHN	2011, 2012, 2013	USD, EUR, JPY, GBP, CHF, AUD
Colombia	COL	2011,2012,2013	USD, EUR, GBP, CHF
Costa Rica	CRI	2011,2012,2013	USD, EUR, GBP, CHF
Croatia	HRV	2011, 2012, 2013	USD, EUR, CHF
Cyprus	CYP	2011,2012,2013	USD, GBP
Czech Republic	CZE	2011,2012,2013	USD, EUR, GBP, AUD, CHF
Denmark	DNK	2011,2012,2013	USD, EUR, GBP, AUD, CHF
Dominican	DOM	2011, 2012, 2013	USD, EUR, GBP
Ecuador	ECU	2011, 2012, 2013	USD, EUR, CHF
Egypt	EGY	2011,2012,2013	USD, EUR, GBP, CHF
El Salvador	SLV	2011, 2012, 2013	USD, EUR, GBP
Estonia	EST	2011,2012	USD, GBP
Fiji	FJI	2011, 2012	EUR, GBP
Finland	FIN	2011,2012,2013	USD, GBP, AUD, CHF
France	FRA	2011,2012,2013	USD, GBP, JPY, AUD, CHF
Gambia	GMB	2011, 2012, 2013	EUR
Georgia	GEO	2011, 2012, 2013	USD, EUR
Germany	DEU	2011,2012,2013	USD, GBP, JPY, AUD, CHF
Ghana	GHA	2011, 2012, 2013	USD, EUR
Greece	GRC	2011,2012,2013	USD, GBP, CHF
Guatemala	GTM	2011, 2012, 2013	USD, EUR, GBP
Honduras	HND	2011, 2012, 2013	USD,EUR
Hungary	HUN	2011,2012,2013	USD, EUR, GBP, AUD, CHF
Iceland	ISL	2011,2012,2013	USD, EUR, GBP
India	IND	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Indonesia	IDN	2011,2012,2013	USD, EUR, JPY, AUD, CHF
Iran	IRN	2011	EUR, GBP
Iraq	IRQ	2012, 2013	EUR
Ireland	IRL	2011,2012,2013	USD, GBP, AUD, CHF
Israel	ISR	2011,2012,2013	USD, EUR, GBP, CHF
Italy	ITA	2011,2012,2013	USD, GBP, JPY, AUD, CHF
Jamaica	JAM	2011, 2012, 2013	USD, EUR
Japan	JPN	2011,2012,2013	USD, EUR, GBP, AUD, CHF
Jordan	JOR	2011, 2012, 2013	USD, EUR
Kazakhstan	KAZ	2011,2012,2013	USD, EUR, GBP
Kenya	KEN	2013	EUR, CHF
Republic of Korea	KOR	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Kuwait	KWT	2013	EUR
Kyrgyz	KGZ	2011, 2012, 2013	EUR
Latvia	LVA	2011,2012,2013	EUR, GBP
Lebanon	LBN	2011,2012,2013	EUR,GBR
Lesotho	LSO	2011, 2012	USD
Lithuania	LTU	2011,2012,2013	EUR, GBP
Luxembourg	LUX	2011,2012,2013	USD, GBP, JPY, AUD, CHF
Macedonia	MKD	2011, 2012, 2013	USD, EUR
Madagascar	MDF	2011, 2012, 2013	USD, EUR
Malawi	MWI	2011, 2012, 2013	EUR
Malaysia	MYS	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Malta	MLT	2011,2012,2013	USD, GBP
Mauritius	MUS	2011,2012,2013	USD, EUR, GBP, AUD, CHF
Mali	MLI	2011	EUR
Malta	MLT	2011, 2013	USD, GBP
Mauritania	MRT	2011, 2012	EUR
Mauritius	MUS	2011, 2012, 2013	USD, EUR, GBP, AUD
Mexico	MEX	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Moldova	MDA	2011, 2012, 2013	USD, EUR
Mongolia	MNG	2013	EUR
Morocco	MAR	2011, 2012, 2013	USD, EUR, CHF, GBP
Mozambique	MOZ	2011, 2012, 2013	EUR, GBP
Namibia	NAM	2011, 2012, 2013	USD, EUR
Netherlands	NLD	2011,2012,2013	USD, GBP, JPY, AUD, CHF

(*continued on next page*)

Table A.12 (*continued*)

Country name	ISO 3-letter code	Sample period	Currency used
Nicaragua	NIC	2011, 2012, 2013	EUR
Niger	NER	2011, 2012, 2013	EUR
Nigeria	NGA	2011, 2012, 2013	EUR, GBP, CHF
Oman	OMN	2011, 2012, 2013	EUR
Pakistan	PAK	2011,2012,2013	USD, EUR, GBP, CHF
Panama	PAN	2011,2012,2013	USD, EUR, GBP
Paraguay	PRY	2011, 2012, 2013	USD, EUR
Peru	PER	2011, 2012, 2013	USD, EUR, CHF
Philippines	PHL	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Poland	POL	2011,2012,2013	USD, EUR, GBP, CHF
Portugal	PRT	2011,2012,2013	USD, GBP, AUD, CHF
Qatar	QAT	2011, 2012, 2013	EUR, GBP
Russia	RUS	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Saudi Arabia	SAU	2011,2012,2013	JPN, EUR, CHE
Sao Tome and Principe	STP	2011	EUR
Senegal	SEN	2011, 2012, 2013	EUR
Singapore	SGP	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Slovak Republic	SVK	2011,2012,2013	USD, GBP, CHF
Slovenia	SVN	2011,2012	USD, GBP
South Africa	ZAF	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Spain	ESP	2011,2012,2013	USD, GBP, JPY, AUD, CHF
Sri Lanka	LKA	2011, 2012, 2013	USD, EUR, GBP, CHF
Sudan	SDN	2012	EUR
Suriname	SUR	2013	EUR
Sweden	SWE	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Switzerland	CHE	2011,2012,2013	USD, EUR, GBP, JPY, AUD
Tanzania	TZA	2011, 2012, 2013	EUR
Thailand	THA	2011,2012,2013	USD, EUR, GBP, JPY, AUD, CHF
Togo	TGO	2011, 2012,2013	EUR
Tunisia	TUN	2011, 2012, 2013	USD, EUR, CHF
Turkey	TUR	2011,2012,2013	USD, EUR, GBP, CHF
Uganda	UGA	2011, 2012, 2013	USD, EUR, GBP
Ukraine	UKR	2011,2012,2013	USD, EUR, CHF
United Kingdom	GBR	2011,2012,2013	USD, EUR, JPY, AUD, CHF
United States	USA	2011,2012	EUR, GBP, JPY, AUD, CHF
Uruguay	URY	2011,2012,2013	USD, EUR, CHF
Venezuela	VEN	2011,2012,2013	USD, EUR, CHF
Vietnam	VNM	2011, 2012, 2013	USD, EUR, JPN, CHF

Data source: SWIFT BI Watch dataset.

Table A.13
Policy list on RMB internationalization, by Dec 2014.

Policy category	Time	Partner
Currency swap agreement	2009 Feb	Malaysia
Currency swap agreement	2009 Mar	Belarus
Currency swap agreement	2009 Mar	Indonesia
Currency swap agreement	2009 Apr	Argentina
Currency swap agreement	2009 Apr	Republic of Korea
Settlement agreement	2009 Jul	Hong Kong
Settlement agreement	2010 Mar	Belarus
Currency swap agreement	2010 Jun	Iceland
Currency swap agreement	2010 Jul	Singapore
Bilateral trade of currency	2010 Aug	Malaysia
Bilateral trade of currency	2010 Nov	Russia
Currency swap agreement	2011 Apr	New Zealand
Currency swap agreement	2011 Apr	Uzbekistan
Currency swap agreement	2011 May	Mongolia
Currency swap agreement	2011 Jun	Kazakhstan
Settlement agreement	2011 Jun	Russia
Currency swap agreement	2011 Oct	Republic of Korea
Currency swap agreement	2011 Nov	Hong Kong
offshore clearing house	2011 Nov	Hong Kong
RQFII	2011 Dec	Hong Kong
Currency swap agreement	2011 Dec	Thailand

(*continued on next page*)

Table A.13 (*continued*)

Policy category	Time	Partner
Currency swap agreement	2011 Dec	Pakistan
Currency swap agreement	2012 Jan	United Arab Emirates
Currency swap agreement	2012 Feb	Malaysia
Currency swap agreement	2012 Feb	Turkey
Currency swap agreement	2012 Mar	Mongolia
Currency swap agreement	2012 Mar	Australia
Bilateral trade of currency	2012 Jun	Japan
Currency swap agreement	2012 Jun	Ukraine
Settlement agreement	2012 Aug	Taiwan
Settlement agreement	2012 Sep	Macao
Offshore clearing house	2012 Dec	Taiwan
Offshore clearing house	2013 Feb	Singapore
Currency swap agreement	2013 Mar	Singapore
Currency swap agreement	2013 Mar	Brazil
Bilateral trade of currency	2013 Apr	Australia
RQFII	2013 Jun	Taiwan
Currency swap agreement	2013 Jun	Great Britain
Currency swap agreement	2013 Sep	Hungary
Currency swap agreement	2013 Sep	Iceland
Currency swap agreement	2013 Sep	Albania
Currency swap agreement	2013 Oct	Indonesia
Currency swap agreement	2013 Oct	Euro central bank
RQFII	2013 Oct	Great Britain
RQFII	2013 Oct	Singapore
Bilateral trade of currency	2014 Mar	New Zealand
RQFII	2014 Mar	France
Settlement agreement	2014 Mar	Great Britain
Settlement agreement	2014 Mar	Germany
Currency swap agreement	2014 Apr	New Zealand
Offshore clearing house	2014 Jun	Great Britain
Offshore clearing house	2014 Jun	Germany
Bilateral trade of currency	2014 Jun	Great Britain
Settlement agreement	2014 Jun	France
Settlement agreement	2014 Jun	Luxembourg
Settlement agreement	2014 Jul	Republic of Korea
Offshore clearing house	2014 Jul	Republic of Korea
RQFII	2014 Jul	Republic of Korea
RQFII	2014 Jul	Germany
Currency swap agreement	2014 Jul	Switzerland
Currency swap agreement	2014 Aug	Mongolia
Offshore clearing house	2014 Sep	France
Offshore clearing house	2014 Sep	Luxembourg
Currency swap agreement	2014 Sep	Sri Lanka
Bilateral trade of currency	2014 Sep	Euro central bank
Currency swap agreement	2014 Sep	Republic of Korea
Currency swap agreement	2014 Oct	Russia
Currency swap agreement	2014 Nov	Qatar
Settlement agreement	2014 Nov	Qatar
Offshore clearing house	2014 Nov	Qatar
RQFII	2014 Nov	Qatar
Currency swap agreement	2014 Nov	Canada
Settlement agreement	2014 Nov	Canada
Offshore clearing house	2014 Nov	Canada
RQFII	2014 Nov	Canada
Settlement agreement	2014 Nov	Malaysia
Settlement agreement	2014 Nov	Australia
Offshore clearing house	2014 Nov	Australia
RQFII	2014 Nov	Australia
Currency swap agreement	2014 Nov	Hong Kong
Currency swap agreement	2014 Dec	Kazakhstan
Bilateral trade of currency	2014 Dec	Kazakhstan
Currency swap agreement	2014 Dec	Thailand
Settlement agreement	2014 Dec	Thailand
Currency swap agreement	2014 Dec	Pakistan

Source: People's Bank of China (2015). This is a partial list of policy on RMB internationalization. Repetition of currency swap agreement implies its amendment and continuation. Repetition of RQFII indicates the revision of quota.

Table A.14
Robustness test, cross-border payment.

	(1)	(2)	(3)
	Aggregate use	Direct Use	Vehicle Use
Trade share	1.01***	1.00***	0.73***
	(0.07)	(0.07)	(0.11)
FDI	0.69	0.65	0.66
	(0.55)	(0.55)	(0.68)
Portfolio investment	2.53***	2.82***	0.10
	(0.69)	(0.71)	(0.66)
Exchange rate	−5.60***	−5.48***	−7.19***
	(0.44)	(0.45)	(0.47)
Exchange rate volatility	−60.01*	−58.69*	−57.30*
	(34.06)	(34.88)	(30.71)
Financial development	58.63***	58.62***	57.50***
	(4.04)	(4.07)	(4.13)
Inflation	−0.95**	−0.88**	−1.23***
	(0.42)	(0.41)	(0.48)
Real GDP	6.23***	5.75***	12.37***
	(0.81)	(0.82)	(0.93)
Offshore finance center	−22.49**	−24.78**	16.99
	(9.53)	(10.03)	(14.58)
Distance	6.56***	6.38***	8.73***
	(0.74)	(0.74)	(0.89)
Border	4.72*	5.09*	12.47***
	(2.80)	(2.69)	(3.90)
Constant	−245.39***	−242.61***	−287.34***
	(16.88)	(17.42)	(23.90)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	903	898	901
R-squared	0.75	0.75	0.70

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from MT 103, MT 103+, MT 103R, and MT 202 in SWIFT BI Watch dataset. Country and year fixed effect omitted. Column (1) for aggregate use, (2) for direct use, and (3) for vehicle use of international currency. Robust standard errors in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Table A.15
Robustness test, foreign exchange transaction.

	(1)	(2)	(3)
	Aggregate sample	Direct use	Vehicle use
Trade share	0.35***	0.79***	0.03
	(0.05)	(0.08)	(0.08)
FDI	3.20***	1.69***	4.53***
	(0.43)	(0.56)	(0.63)
Portfolio investment	1.15***	1.17**	0.05
	(0.42)	(0.56)	(0.52)
Exchange rate	−3.98***	−1.33***	−5.51***
	(0.32)	(0.39)	(0.38)
Exchange rate volatility	−16.66	54.92***	−44.23*
	(18.27)	(16.50)	(24.77)
Financial development	23.13***	1.19	35.00***
	(2.76)	(3.71)	(3.58)
Inflation	−0.77***	0.34	−1.22***
	(0.29)	(0.26)	(0.40)
Real GDP	7.37***	−0.22	11.95***
	(0.54)	(0.68)	(0.67)
Offshore finance center	−16.66***	−14.03	2.17
	(6.01)	(17.28)	(10.50)
Distance	5.74***	0.48	8.62***
	(0.54)	(0.55)	(0.70)

(*continued on next page*)

Table A.15 (*continued*)

	(1)	(2)	(3)
	Aggregate sample	Direct use	Vehicle use
Border	4.78**	−1.75	9.23***
	(2.18)	(3.13)	(2.88)
Constant	−199.36***	−23.61	−299.26***
	(11.76)	(17.82)	(15.90)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	898	823	888
R-squared	0.78	0.79	0.73

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from MT 300 in SWIFT BI Watch dataset. Country and year fixed effect omitted. Column (1) for aggregate use, (2) for direct use, and (3) for vehicle use of international currency. Robust standard errors in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Table A.16
Robustness test, trade finance.

	(1)	(2)	(3)
	Aggregate sample	Direct use	Vehicle use
Trade share	0.91***	1.57***	0.61***
	(0.08)	(0.10)	(0.15)
FDI	4.35***	3.01***	5.13***
	(0.71)	(0.75)	(1.01)
Portfolio investment	2.26***	2.02***	0.93
	(0.82)	(0.76)	(1.00)
Exchange rate	−8.39***	−2.46***	−10.86***
	(0.59)	(0.60)	(0.66)
Exchange rate volatility	−95.94*	19.68	−144.09***
	(50.12)	(45.06)	(44.02)
Financial development	79.39***	16.03***	99.98***
	(4.97)	(5.24)	(6.40)
Inflation	−1.17**	−0.13	−1.24**
	(0.57)	(0.48)	(0.55)
Real GDP	9.84***	1.50	15.65***
	(1.03)	(0.97)	(1.44)
Offshore finance center	−11.12	−2.54	−20.57
	(17.86)	(13.51)	(13.91)
Distance	14.30***	5.35***	15.72***
	(0.91)	(0.83)	(1.39)
Border	8.37**	−0.20	7.78
	(3.44)	(3.94)	(5.52)
Constant	−462.89***	−167.07***	−534.41***
	(23.07)	(19.37)	(25.05)
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Observations	791	769	614
R-squared	0.80	0.78	0.83

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from MT 400 and MT 700 in SWIFT BI Watch dataset. Country and year fixed effect omitted. Column (1) for aggregate use, (2) for direct use, and (3) for vehicle use of international currency. Robust standard errors in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

Table A.17

Heckman regression for AUD, 2011–2013.

	Aggregate		Direct		Vehicle	
	Intensity	Selection	Intensity	Selection	Intensity	Selection
Trade share	0.18***	1.39***	0.22***	0.87***	0.09**	1.31***
	(0.04)	(0.49)	(0.04)	(0.24)	(0.04)	(0.44)
Exchange rate	0.08	0.09**	−0.03	0.12***	0.10*	0.06
	(0.07)	(0.04)	(0.07)	(0.04)	(0.06)	(0.04)
Exchange rate volatility	8.31	−29.73***	5.81	−9.41	10.89*	−31.85***
	(7.44)	(7.27)	(5.86)	(7.32)	(5.85)	(6.99)
Financial development	−1.45***	−0.25	−0.74**	−0.59***	−1.17***	−0.25*
	(0.28)	(0.16)	(0.29)	(0.16)	(0.26)	(0.15)
Inflation	−0.02	0.01	−0.06	0.07**	−0.00	0.00
	(0.04)	(0.03)	(0.06)	(0.03)	(0.04)	(0.02)
Real GDP	−0.03	−0.34***	−0.15*	−0.25***	−0.08	−0.33***
	(0.10)	(0.08)	(0.08)	(0.06)	(0.09)	(0.07)
Offshore finance center	0.10	0.21	0.99***	−0.11	−0.15	0.37
	(0.44)	(0.36)	(0.37)	(0.32)	(0.40)	(0.34)
Distance	−0.49***	0.24***	−0.63***	0.26***	−0.37***	0.20***
	(0.04)	(0.05)	(0.04)	(0.04)	(0.03)	(0.04)
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	296	366	253	366	290	366

Notes: Data frequency is annual from 2011 to 2013. Dependent variable calculated from MT 103, MT 103+, MT 103R, MT 202, MT 300, MT 400, and MT 700 in SWIFT BI Watch dataset. Column (1)–(2) for aggregate use, (3)–(4) for direct use, and (5)–(6) for vehicle use of international currency. Estimated with Heckman two-step regression. Column (2)(4)(6) shows result for the first regression for selection, while column (1)(3)(5) for second-step regression outcome. Year fixed effect and inverse Mills ration omitted. Capital account liberalization is the normalized Chinn-Ito index of destination country. Bootstrap standard errors with 10,000 replications in parentheses.

*** $p < 0.01$.

** $p < 0.05$.

* $p < 0.1$.

A.4. Figure (data source: SWIFT BI Watch)

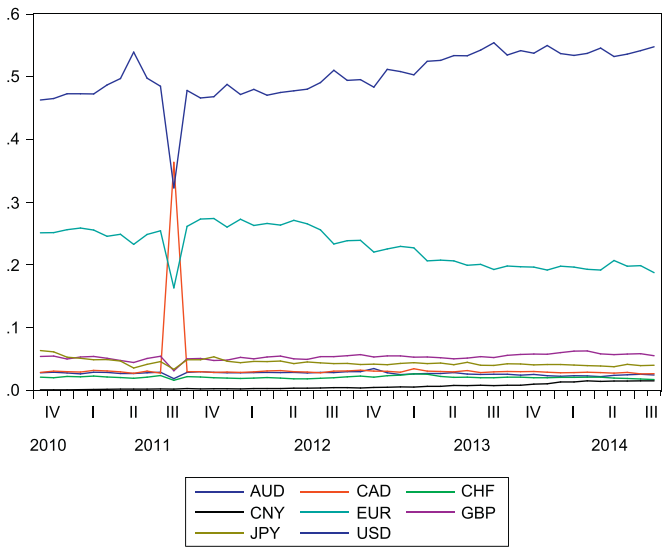

Fig. A.9. Value share of additional currencies.

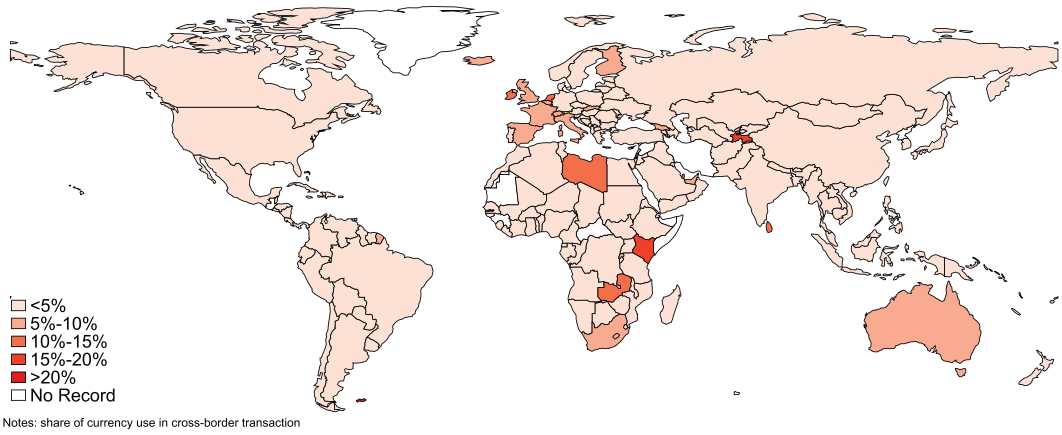

Fig. A.10. Global use of British Pound, August 2014.

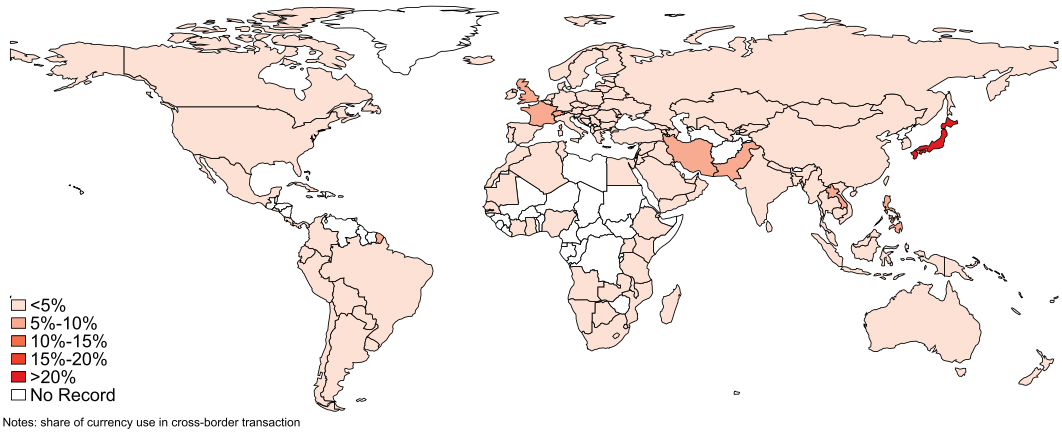

Fig. A.11. Global use of Japanese Yen, August 2014.

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