HONG KONG INSTITUTE FOR MONETARY RESEARCH

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Dong He, Paul Luk and Wenlang Zhang

HKIMR Working Paper No.01/2015

January 2015

Hong Kong Institute for Monetary Research
香港金融研究中心
(a company incorporated with limited liability)

The Internationalisation of the Renminbi as an Investing and a Funding Currency: Analytics and Prospects*

Dong He

International Monetary Fund

and

Paul Luk

Hong Kong Baptist University

Hong Kong Institute for Monetary Research

and

Wenlang Zhang

Hong Kong Monetary Authority

January 2015

Abstract

The use of international currencies in the global financial system is not symmetric: while a few currencies have been primarily used as investing currencies, a few others have mostly served as funding currencies; only a handful have a better balance functioning as both investing and funding currencies. This paper develops a three-currency model to study the determinants of the demand for assets and liabilities denominated in an international currency, and attempts to shed light on the prospects for the renminbi as a budding international currency. We show that interest rate differentials would be only one of the factors shaping the renminbi's position, while other factors, including the correlation between foreign countries' economic growth and their bilateral exchange rates against the renminbi, and the correlation between exchange rates of the renminbi with other international currencies, would also be important. A broad interpretation of these findings is that the renminbi will likely be very attractive to investors from high-income economies and fund-raisers from emerging market economies.

* We thank Bob McCauley for discussions, and seminar participants at the People's Bank of China and the Chinese Academy of Social Sciences and an anonymous referee for comments. Dong He worked on this paper when he was a staff member of the Hong Kong Monetary Authority (HKMA).

1. Introduction

While international use of some currencies has been symmetric (such as the US dollar and the euro), that of others has been somewhat asymmetric or "lopsided" (such as the Japanese yen and the Australian dollar).[1] In the first case, non-residents both invest in a currency and borrow in it, but in the asymmetric case, non-residents mostly borrow (a funding currency) or mostly invest in a currency (an investing currency). The yen has served international investors more as a funding currency than as a vehicle in which to invest, whereas the Australian dollar does not seem to attract any consistent borrowers from outside.

The long or short position of an international currency has important policy implications for the issuing economy because internationalisation of a currency may affect the conduct of domestic monetary policy. In particular, as discussed in He and McCauley (2010), offshore activities in a currency may affect its exchange rate, with the impact ultimately depending on how the long and short positions in the currency in offshore markets balance out. While a long position in the currency would add upward pressures on its exchange rate when capital controls are absent, the opposite is true for a short position in the currency, and the impact would be ambiguous if the position of the currency is largely balanced.[2]

At first appearance, interest rate differentials seem to be the major factor behind the differences in the relative balance between assets and liablities denominated in an international currency. For instance, He and McCauley (2010) argue that, low interest rates in Japan have likely been a major reason for the yen to be a funding currency, while investors have been drawn to the Australian dollar by its high coupons. As China has seen and would likely continue to have higher interest rates than advanced economies, there are concerns that the renminbi may be used mainly as an investing currency by overseas investors along with its internationalisation, which would add appreciation pressure on its exchange rate.

Since 2010, the international use of the renminbi has grown rapidly. On the surface, internationalisation of the renminbi means that the currency is used as a unit of account, medium of exchange, and store of value in international trade and financial transactions. Beneath the surface, it means that non-Chinese residents hold renminbi-denominated assets and liabilities, both on-balance sheet and off-balance sheet (He, 2014). Non-Chinese residents' interest in the renminbi has so far, however, been in holding renminbi-denominated assets, more than renminb-denominated liabilities. In

[1] The phrase 'lopsided internationalisation' was coined by Sakakibara and Kondoh (1984) writing about the Japanese yen in the 1980s.

[2] The experience of the Australian dollar suggests that its role as an international investing currency may have reduced long-term interest rates and appreciated the exchange rate. As firms can obtain funding by issuing Australian dollar-denominated bonds offshore, the domestic monetary policy transmission channel may have weakened, leading to amplification in business cycles. See McCauley (2006) for details. The experience of the Japanese yen as an international funding currency may have led to periods of high exchange rate volatility. In particular, during the 2008 global financial crisis, the unwinding of yen carry trade positions led to a sharp exchange rate appreciation which might have aggravated the domestic downturn.

other words, the renminbi has so far been used more as an investing currency than as a funding currency.

The attractiveness of the renminbi primarily as an investing currency is reflected in the structure of the renminbi banking book of Hong Kong banks, as shown in Table 1, which updates Table 2 of He and McCauley (2012). At present, the renminbi balance sheet of banks in Hong Kong serves as a conduit for net renminbi lending from the rest of the world to the mainland. Through it, non-residents stake renminbi claims on mainland China. Deposits in renminbi by residents of Hong Kong and the rest of the world outside the mainland comprise the main source of funds. On the uses side, banks have claims on entities on the mainland, including the central bank, and some interbank claims and investments in government and corporate bonds.

As things stand, the use of the renminbi as a funding currency by non-Chinese residents appears to be limited. At the end of 2013, loans and advances in renminbi booked by banks in Hong Kong were CNY 116 billion, about 6% of total assets, although a good part of the CNY 824 billion in negotiable debt instruments comprised trade claims on non-banks resident outside the mainland. Renminbi bonds issued by non-banks and held outside the banking system, which are not captured in Table 1, tend also to result in a net renminbi claim of the rest of the world on China. The government, government agencies, banks and firms resident on the mainland probably account for the majority of the ultimate renminbi obligations associated with renminbi bonds issued by entities other than banks resident in Hong Kong.

What would make the renminbi more attractive as a funding currency to non-Chinese residents? Based on the pioneering work of Lane and Shambaugh (2010a) who explore foreign currency exposures of around 90 economies, this paper develops a three-currency model to explore the determinants of an international currency's long and short position. While Lane and Shambaugh (2010a) study the determinants of foreign currency exposure in external balance sheets using a partial equilibrium model that considers only two currencies (a domestic currency and a foreign currency), we extend the model to consider three currencies (a domestic currency and two international currencies) so that we not only consider the relationship between domestic and international currencies but also the interaction between international currencies.

Our model shows that interest rate differentials would be only one of the factors shaping an international currency's position. We identify two additional factors. First, the correlation between an economy's output growth and the bilateral exchange rate against an international currency would also determine whether residents of that economy would use this particular international currency as an investing or funding currency. If an economy's currency appreciates against the international currency when its output growth increases, and depreciates against the international currency when its output growth slows, residents of that economy would long assets in that international currency so as to

smooth the impact generated by fluctuations in GDP growth on their wealth.[3]

Second, the correlation between an international currency's exchange rate with those of other international currencies matters as well. Consider the following example. A Thai investor invests in Thai assets, US dollar-denominated assets and renminbi-denominated assets. As the US dollar and the renminbi are positively correlated, the investor views the two currencies as substitutes. Other things equal, if the investor holds a long position in the US dollar, he would hold a short position in the renminbi. In this case, if, say the Thai bhat appreciates against the US dollar, it is likely to appreciate against the renminbi as well, which means that holding a long position in US dollar-denominated assets leads to a loss while holding a short position in the renminbi leads to a gain. This portfolio hedges the exchange rate risk against foreign currencies.

Our empirical analysis suggests that, for major international currencies (the US dollar, the euro and the yen) as a whole, interest rate differentials have been the least important among the above mentioned three factors determining their use, although interest rate differentials have indeed been a dominant factor for the Japanese yen as a funding currency.

The findings in this paper shed light on whether the renminbi will become predominately an investing currency. Our finding suggests that when investors in an economy choose their position in the renminbi in their portfolio, they consider the correlation between domestic output growth and the bilaterial exchange rate against the renminbi. If the domestic currency tends to depreciate against the renminbi when domestic output growth rises and appreciate against the renminbi when domestic output growth drops, then investors in this economy would have an incentive to use the renminbi as a funding currency, because the market value of renminbi-denominated liabilities would fall just when the domestic economy is not doing well.

There seems to be much heterogeneity across residents of different economies in terms of their demand for the renminbi as an investing/funding currency to hedge against flucutation in their domestic output. We look at the recent exchange rate movements of the renminbi and major international currencies. We find that while the US dollar and Japanese yen have a tendency to depreciate when world output growth rises and appreciate when world output growth slows, there is no clear pattern between the renminbi exchange rate and global output growth. Therefore, we speculate that international investors as a whole may have balanced incentives to use the renminbi as a funding/investing currency as a tool to hedge against output volatilities.

In addition, some emerging economies would likely have even higher interest rates than China, suggesting residents of these economies would also use the renminbi as a funding currency rather than just as investing currency. As such, the renminbi may not necessarily be only used as an investing currency, and its internationalisation is not destined to be lopsided.

[3] This is similar to the findings of Lane and Shambaugh (2010a).

Although the renminbi exchange rate has moved away from pegging to the US dollar, the US dollar's movement against other currencies still appear to be able to explain a large part of the renminbi's movement against other currencies. As such, global investors could regard the US dollar as a substitute of the renminbi, implying that the international position of the renminbi would be dependent on investors' preference for the US dollar as an investing or funding currency. If the renminbi exchange rate becomes more independent of the US dollar in the future, then its position as an funding or investing currency will be more affected by the other two factors – interest rate differentials and the incentive by non-residents to insure against their output fluctuations.

The rest of the paper is organised as follows. The second section describes some stylised facts about the international positions of major international currencies such as the US dollar, the euro, yen, pound sterling, and the swiss franc. The third section presents the three-currency model examining what determines the demand for assets and liabilities denominated in an international currency. The fourth section takes the model to data of major international currencies, and section 5 discusses the implications for the renminbi position along with capital account liberalisation. Section 6 concludes the paper.

2. Stylised Facts of Non-Residents' Positions in Major International Currencies

To shed light on major international currencies' positions, we follow Lane and Shambaugh (2010b) and construct a position index for major international currencies using the international investment position data of 91 economies.[4] Specifically, for each economy i, we define its exposure in currency j in year t as follows:

$$Y_{it}^{j} = \omega_{it}^{j,A}\left(\frac{A_{it}}{A_{it}+L_{it}}\right) - \omega_{it}^{j,L}\left(\frac{L_{it}}{A_{it}+L_{it}}\right), \quad (1)$$

where A_{it} and L_{it} are the total cross-border assets and liabilities of economy i. $\omega_{it}^{j,A}$ is the share of foreign assets denominated in currency j, and $\omega_{it}^{j,L}$ is defined analogously. The currency j exposure would hit its maximum value of 1 when an economy has no foreign liabilities ($L_{it}=0$) and all of its foreign assets are denominated in currency j, such that $\omega_{it}^{j,A}=1$. Analogously, the exposure would hit its minimum at -1 when the economy has no foreign assets and all foreign liabilities are denominated in currency j. The weights of cross-border assets and liabilities capture the valuation effect on foreign assets and liabilities when the exchange rate against currency j moves. In short, currency j is mainly an investing currency if the exposure index is positive, and a funding currency if its exposure index is negative.

[4] Although the Lane and Shambaugh (2010b) data are the best available, they are not without weaknesses. The data does not include derivative positions. Moreover, the offshore balance sheets of multinationals are not included.

The 'Financial Exchange Rates and International Currency Exposures' dataset of Lane and Shambaugh (2010b) provides the fraction of each country's assets denominated in its domestic currency and five major international currencies, namely the US dollar (USD), the euro (EUR), the Japanese yen (JPY), the British pound (GBP) and the Swiss franc (CHF). Using Equation (1), we compute around 90 economies' exposure to these international currencies in 2000.[5] The US dollar plays a dominant role in international financial markets as countries tend to have large positive or negative exposure to it, with the smallest exposure index of -0.64 in 2000 and the largest of 0.34 in the same year. Exposure to the euro and Japanese yen has been smaller, with the smallest and largest exposure index for the euro of -0.42 and 0.13 respectively in 2000, compared with -0.24 and 0.02 for the Japanese yen in the same year. Exposure to the British pound and Swiss franc has been even smaller.

Histograms of the major international currencies' positions are shown in Figure 1. Clearly, the internationalisation of the yen has been asymmetric compared with that of other major currencies. Generally speaking, the exposure indexes for the US dollar, the euro and the yen in 2000 were more or less negatively skewed, suggesting these currencies were used more for funding than for investing that year. However, this is particularly obvious for the Japanese yen, which had a barely positive exposure in 2000. The picture has changed somewhat over time, as suggested by Table 2, which shows the summary statistics of the 91 economies' exposure to major international currencies in 1996, 2000 and 2004. Obviously, the mean of the exposure index was less negative for the three major currencies, but the Japanese yen's position index still features the largest skew in 2004. For the two less important currencies, the Bristish pound and the Swiss franc, the picture remained largely unchanged in 2004.

Figure 2 shows that Australia has had the highest interbank rates in the past two and half decades across international currencies, while Japan has had the lowest rates over the same period. This seems to support the arguement by He and McCauley (2010) that low interest rates in Japan have been a major reason for the yen to be used as a funding currency, while investors have been drawn to the Australian dollar by its high coupons. However, a puzzle is that the UK has had consistently higher interest rates than the US and the euro area, but its currency internationalisation has been largely balanced. This suggests that, besides interest rates, other factors may also have a big role to play in determining international currencies' positions.

3. Determinants of an International Currency's Position: A Partial Equilibrium Model

We extend the framework developed by Davis, Willen and Nalewaik (2001) and Lane and Shambaugh (2010a) to study the determinants of the demand for assets and liabilities denominated in

[5] The pre-euro exchange rates of the euro countries before the creation of the euro in 1999 have been converted to euros using 'euro fixed rates', which is using the official conversion rate at the time of introduction in the country. The US dollar to euro exchange rate before 1999 is proxied by the European currency unit (ECU) rate, also from the IFS.

an international currency. It is a two-period partial-equilibrium model of portfolio choice in a small open economy. In the setup, households in the small open economy receive a state-contingent endowment in period 2 and consume in the same period. The endowment y is given by:

$$y = \bar{y} + \beta_1 S_1 + \beta_2 S_2 + \ldots + \beta_n S_n, \tag{2}$$

where S_i is the period-2 rate of exchange rate depreciation with respect to currency i. S_i's are assumed to be random variables. In period 1, households have a fixed endowment of 0. They buy and sell assets denominated in different currencies i in order to maximise their expected utility. For simplicity, we assume there is one asset denominated in each currency (which includes an asset denominated in the domestic currency). This means that there are $n + 1$ assets in total. The gross return of a foreign asset i is given by:

$$R_i = \alpha_i + \gamma_i S_i + \nu_i, \qquad \gamma_i > 0, \tag{3}$$

where ν is a random component such that $E(\nu_i) = 0, E(\nu_i^2) = \sigma_{\nu i}^2, E(\nu_i \nu_j) = 0$ for $i \neq j$ and $E(\nu_i S_j) = 0$ for $i, j \in \{1,2,..n\}$. The domestic asset offers a fixed gross return of R_D. Households choose the share of assets ($\omega_i's$ and ω_D) so that the period 1 budget constraint is satisfied:

$$\sum_i \omega_i + \omega_D = 0. \tag{4}$$

In period 2 households consume whatever is available as follows:

$$c = y + \sum_i \omega_i R_i + \omega_D R_D. \tag{5}$$

Households choose the optimal asset allocation in period 1 to maximise an exponential expected utility:

$$U = \frac{1}{1+\delta}\left(-\frac{1}{A}\right) E(e^{-Ac}) \tag{6}$$

subject to the endowment process and the budget constraints in the two periods. In the utility function, δ is the discount rate and A is the coefficient of absolute risk aversion.

The first order conditions for exposure to each currency are

$$E(e^{-Ac}(R_i - R_D)) = 0, \qquad \text{for} \quad i = 1,2,\ldots n. \tag{7}$$

By taking a second-order approximation around the stochastic mean of each of the variables, we

show that[6]

$$ACov(c, R_i) = E(R_i) - R_D = RP_i, \qquad \text{for} \quad i = 1,2,\dots n. \tag{8}$$

where RP_i stands for country i's risk premium. This equation indicates that, if the return on asset i is negatively correlated with consumption, this asset would be a good choice for households to hedge against fluctuations in consumption. There is excess demand for this asset unless the premium against the domestic asset is negative.

Substituting the output process into the above asset demand condition and rearranging the terms, we obtain the portfolio allocation equation as follows:

$$\boldsymbol{\omega} = (\boldsymbol{\Gamma} Var(\mathbf{S})\boldsymbol{\Gamma} + \boldsymbol{\Sigma}_v)^{-1}\left[\frac{1}{A}\mathbf{RP} - \boldsymbol{\Gamma} Cov(y, \mathbf{S})\right] \tag{9}$$

where $\boldsymbol{\omega} = [\omega_1, \omega_2, .., \omega_n]'$, $\mathbf{RP} = [RP_1, RP_2, \dots, RP_n]'$, $\mathbf{S} = [S_1, S_2, \dots . S_n]'$, and $\boldsymbol{\Gamma}$ is an $n \times n$ diagonal matrix with $\{\gamma_1, \gamma_2 \dots \gamma_n\}$ as diagonal elements, and $\boldsymbol{\Sigma}_v$ is a diagonal matrix with $\{\sigma_{v1}^2, \sigma_{v2}^2, \dots \sigma_{vn}^2\}$. As the portfolio choice equation (9) does not provide clear analytical insights or guidance for our empirical analysis, in the following subsections, we look at a benchmark case with one foreign currency, and a more realistic case with two foreign currencies.

3.1 Case 1: n=1, A Domestic Currency and One Foreign Currency

The benchmark model developed by Lane and Shambaugh (2010a) simplifies portfolio allocation decisions in the real world, but it helps us to understand the basic rationale for allocating assets across different currencies. The key equation in this case is:

$$\omega_F = \frac{1}{(\gamma^2 Var(S) + \sigma_v^2)}\left(\frac{RP}{A} - \gamma Cov(y, S)\right). \tag{10}$$

This equation indicates that there would be three factors determining the demand for foreign-currency denominated assets. First, it increases with their excess return relative to assets denominated in the domestic currency. Second, it decreases with the covariance between domestic output and domestic currency depreciation. For instance, a negative $Cov(y, S)$ suggests domestic output falls (consumption also falls) when the domestic currency depreciates (S rises). In this case, the return of the foreign-currency denominated assets rises when measured in the domestic currency, and households would have a stronger incentive to hold foreign-currency denominated assets because this would help mitigate the adverse impact of a fall in output. Third, the demand for foreign-currency denominated assets decreases with the volatility of the exchange rate because an increase in exchange rate volatility means a rise in volatility of the return on the foreign-currency denominated assets, which

[6] See Appendix A for the derivation.

makes them less desirable for risk-sharing.[7]

3.2 Case 2: n=2, A Domestic Currency and Two Foreign Currencies

A model with two foreign currencies help us to understand portfolio allocation between the domestic and international currencies as well as between different international currencies. The portfolio formula with $n = 2$ is as follows:

$$\omega_1 = \frac{1}{\Phi} \times \begin{bmatrix} \left(\frac{RP_1}{A} - Cov(y, S_1)\gamma_1\right)(\gamma_2^2 Var(S_2) + \sigma_{v2}^2) \\ -\left(\frac{RP_2}{A} - Cov(y, S_2)\gamma_2\right)\gamma_1\gamma_2 Cov(S_1, S_2) \end{bmatrix}, \tag{11}$$

$$\omega_2 = \frac{1}{\Phi} \times \begin{bmatrix} -\left(\frac{RP_1}{A} - Cov(y, S_1)\gamma_1\right)\gamma_1\gamma_2 Cov(S_1, S_2) \\ +\left(\frac{RP_2}{A} - Cov(y, S_2)\gamma_2\right)(\gamma_1^2 Var(S_1) + \sigma_{v1}^2) \end{bmatrix}, \tag{12}$$

where $\Phi = (\gamma_1^2 Var(S_1) + \sigma_{v1}^2)(\gamma_2^2 Var(S_2) + \sigma_{v2}^2) - (\gamma_1\gamma_2 Cov(S_1, S_2))^2 > 0$.

Similar to the case with only one foreign currency, the above equation indicates that the demand for assets denominated in a particular foreign currency increases with their return relative to the domestic currency, and decreases with the covariance between domestic output and the domestic currency's depreciation against that particular foreign currency. Moreover, a rise in exchange rate volatility vis-a-vis a foreign currency dampens the demand for assets denominated in that foreign currency.[8]

The strength of the model with two foreign currencies is that we can study how interactions between two foreign currencies affect households' portfolio allocation. In other words, it addresses the question of what would make households in the domestic economy prefer assets denominated in one international currency to those denominated in the other. From Equation (11), we know:

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[7] Similarly, non-residents would reduce liabilities in an international currency if its exchange rate volatility increases. In short, non-residents would reduce the demand for assets and liabilities denominated in an international currency if the volatility in its value increases. Note, however, such demand is for longer-term risk-sharing purposes, not for short-term speculative trading, which may be governed by different incentives.

[8] Formally, we obtain these results by differentiating Equation (11) with respect to the quantities of interest. The first derivatives are:

$$\frac{d\omega_1}{dRP_1} = \frac{1}{\Phi}\frac{1}{A}(\gamma_2^2 Var(S_2) + \sigma_{v2}^2) > 0,$$

$$\frac{d\omega_1}{dCov(y, S_1)} = -\frac{1}{\Phi}\gamma_1(\gamma_2^2 Var(S_2) + \sigma_{v2}^2) < 0,$$

$$\frac{d\omega_1}{dVar(S_1)} = -\frac{\gamma_1^2(\gamma_2^2 Var(S_2) + \sigma_{v2}^2)}{\Phi}\omega_1 < 0.$$

$$\frac{\mathrm{d}\omega_1}{dCov(y,S_2)} = \frac{1}{\Phi}\gamma_1\gamma_2^2 Cov(S_1,S_2), \tag{13}$$

with the sign being state dependent. If the two internationalised currencies' exchange rates are positively correlated, then the above derivative would be positive, and vice versa. Let us assume the two internationalised currencies are positively correlated, $Cov(S_1,S_2) > 0$. This means that when investors increase their holdings of assets denominated in currency 2 in the case of a negative correlation between their GDP growth and bilateral exchangte rate against currency 2, then they would reduce their holdings of assets denominated in currency 1 so as to hedge exchange rate risks.

Simply put, households' portfolio allocation between two internationalised currencies depends much on whether the two currencies are substitutes or complements. If $Cov(S_1,S_2) > 0$, the two internationalised currencies may be viewed as substitutes in terms of their role in insuring against consumption fluctuations (See equation (5)), so a more positive position in one internationalised currency leads to a more negative position in the other. In contrast, if $Cov(S_1,S_2) < 0$, the two internationalised currencies may be viewed as complements. In this case, a rise in the demand for assets in one internationalised currency increases the demand for assets denominated in the other internationlised currency. Hence the cross-covariance, $Cov(y,S_2) \times Cov(S_1,S_2)$, captures the tradeoffs faced by the households when they choose from assets denominated in multiple internationalised currencies. We could proceed with more foreign currencies, but little analytical insight can be drawn from a model with more internationalised currencies when $n \geq 3$. Therefore, in the empirical specification, we simplify the real world as one with a domestic currency and two internationalised currencies.

4. The Demand for Assets and Liabilities Denominated in International Currencies: Taking the Model to the Data

4.1 Empirical Framework

This section takes our model to the data based on the experience of major international currencies. Specifically, we run cross-country panel regressions using the following framework:[9]

$$Y_{it} = \alpha + \beta' X_{it} + \gamma' \mathrm{Controls}_{it} + \phi_t + \varepsilon_{it}, \tag{14}$$

where Y_{it} denotes a currency's exposure in economy i in year t as specified in Equation (1), and ϕ_t is a time dummy. The variable Y_{it} is a composite measure which includes the net foreign asset position of both the public and private sectors. One may worry that the official sector does not hold foreign exchange reserves for risk-sharing purposes, as the private sector does, and therefore our portfolio choice model may not be appropriate as a tool to describe holdings by the public sector. We

[9] The econometric framework follows closely Lane and Shambaugh (2010a) and Benetrix, Lane and Shambaugh (2014).

note that Lane and Shambaugh (2010a) decompose the NFA position into foreign exchange reserves and non-reserve NFA position. They show that non-reserve NFA position is the dominant factor, and that central banks do not systematically unwind the position of the private sector.[10] We do not repeat this exercise here.

Given the lack of cross-country variations in exposure to the British pound, the Australian dollar and the Swiss franc, we only consider the positions of the US dollar, the euro and the Japanese yen. The equation to estimate reads

$$\begin{aligned} Y_{it}^{j_1} = \alpha + \beta_1\left(R_{j_1} - R_i\right) + \beta_2 Cov\left(GDP_{it}, S_{i,j_{1t}}\right) + \beta_3 Cov\left(GDP_{it}, S_{i,j_{2t}}\right) \times Cov\left(S_{i,j_{1t}}, S_{i,j_{2t}}\right) \\ +\beta_4 \mathrm{TRADE}_{it} + \beta_5 Var(S_{i,j_{1t}}) + \beta_6 Var(GDP_{it}) + \beta_7 Var(\pi_{it}) + \gamma' \mathrm{Controls}_{it} + \phi_t + \varepsilon_{it}, \end{aligned} \quad (15)$$

for $j_1, j_2 \in \{\mathrm{USD}, \mathrm{EUR}, \mathrm{JPY}\}$, and $j_2 \neq j_1$. $S_{i,jt}$ denotes currency j's nominal exchange rate against country i's currency. GDP_{it} denotes country i's real per capita GDP, while π_{it} denotes domestic inflation. When we run regressions with exposure to j_1, say the US dollar, in the cross-covariance, we take j_2 as either the euro or the yen but not both, to keep our empirical analysis consistent with the theoretical framework (so we have 6 pairs of currencies in total). We first run regressions with all observations pooled together to overcome possible problems caused by limitations in the length in the data series and also because we would like to see whether the theory holds for international currencies in general. In the second step, we run the regressions for the three currencies separately to see to what extent the results differ.

We also consider the impact of other variables on international currency positions following the theoretical portfolio choice literature. For instance, Engel and Matsumoto (2008) and Coeurdacier and Rey (2013) show that trade openness affects equity and bond portfolios. As households consume foreign goods, they care about exchange rate movements, and holding foreign currency denominated assets can insure against exchange rate risks. Devereux and Sutherland (2008, 2011) find that the portfolio decision also depends on the relative volatilities of the endowment shocks and the nominal shocks, because nominal shocks make nominal bonds less effective in hedging against the fluctuations in real quantities. So we include the variance of inflation and output to capture such effects.

Following Lane and Shambaugh (2010a), we also take into account institutional and policy factors as well as other more general control variables. The first institutional factor is institutional quality, which may affect investors' desire to hold a country's assets. Countries with better institutions have a higher share of foreign liabilities denominated in the domestic currency (or lower share of foreign liabilities denominated in the foreign currency). The second is capital controls, which may hinder transactions in foreign currency-denominated assets and prevent investors from holding their desired portfolio with

[10] McCauley and Chan (2014) provide some evidence that the co-movement of a given currency with the dollar explains the economy's dollar share of reserves, a characteristic that is also present in international balance sheets of the private sector.

optimal currency denomination. We also consider the possible impact of exchange rate regime since a fixed exchange rate system may reduce currency risks, and investors may be encouraged to hold foreign currency-denominated assets. Two more general control variables are population, and GDP per capita. Population is a proxy for country size, and GDP per capita is used to control for the stage of an economy's development.

The signs of the three coefficients of interest (β_1, β_2 and β_3)and the interpretations are as follows. $\beta_1 > 0$ because, when the return on the foreign-currency denominated asset increases relative to the return on the domestic-currency denominated asset, investors are expected to hold more foreign-currency denominated asset. Lane and Shambaugh (2010a) ignore the impact of relative return in their empirical work. In our regressions, we use differentials of annualised deposit rates as a proxy for the relative return.[11]

The theoretical framework in the previous section suggests that $\beta_2 < 0$. As Lane and Shambaugh (2010a) consider only one foreign currency, they use the nominal effective exchange rate (NEER) to measure the exchange rate, and their empirical results indeed show that currency exposures are negatively correlated with the covariance between output and the NEER. As our model features two foreign currencies, we expect currency exposures to be negatively correlated with the covariance between output and the *bilateral* exchange rate. The model predicts $\beta_3 > 0$. As discussed before, if $Cov(S_{i,j_1t}, S_{i,j_2t})$ is high, the two international currencies are just like substitutes. If, in addition, holding assets in currency j_2 is a good choice to mitigate the impact of a downturn in the domestic economy (so that $Cov(GDP_{it}, S_{i,j_2t}) < 0$), then domestic investors have an incentive to hold more of currency j_2 and at the same time hold less of currency j_1 to hedge exchange rate risks.[12]

The volatility and covariance measures are computed using the log change of each variable (GDP per capita, bilateral exchange rate and CPI) over a rolling window of 15 years. We use annual data to compute the sample analogues of the second moments since these variables are only available on an annual basis for many developing countries. Specifically, sample covariance is calculated as follows:

$$Cov(x_{1t}, x_{2t}) = \frac{1}{N-1}\sum_{i=1}^{N}\left(x_{1,t-N} - \bar{x_1}\right)\left(x_{2,t-N} - \bar{x_2}\right), \quad (16)$$

where $\bar{x_1} = \sum_{i=1}^{N} x_{1,t-N}/N$, and $\bar{x_2} = \sum_{i=1}^{N} x_{2,t-N}/N$, with $N = 15$. Sample variances are defined in a similar way. This means that for instance the covariances in 2000 and 2004 are computed using the raw data in 1984-1999 and 1988-2003 respectively, and the data in 1988-1999 are used in the computation of both covariance. A 15 –year window is chosen to balance two effects: The sample is

[11] Alternatively, we use the differentials of annualised short term government bond yields. The results are similar.

[12] The sign of β_5 is state-dependent. If the net asset position in foreign currency is positive, it should be positive. If the net asset position in foreign currency is negative (in liability in net terms), it should be negative. Overall, it would likely be insignificant in the regressions because we do not separate positive net assets from negative net assets.

long enough to reduce idiosyncrasies caused by a single outlier but not so long that it aggrevates the problem of the overlapping use of data across time thereby reducing the time-series variability of these covariance variables. (We have experimented with *N=10* or 12 years. Our main results hold qualitatively.)

We run the regressions for the US dollar and the Japanese yen using data from 1996, 2000, 2004 and for the euro with data from 2000 and 2004, keeping a four-year time interval between each observation. Lane and Shambaugh's (2010b) dataset only incorporates foreign currency-denominated assets and liabilities between 1990-2004, with some countries having an even shorter series, while the institutional quality data from the World Bank World Governance Indicators are only available in even years. As we are mainly interested in the longer-run determinants of currency positions in addition to individual country characteristics that affect its demand for foreign currency-denominated assets, there are two problems arising from using a shorter time interval between each observation (say two years). First, given the way the second moments are constructed, the large overlap in the rolling window would mean small variations in our observations across time. Second, there would be serial correlation in these variables. Details of the data are provided in Appendix B.

4.2 Estimation Results

Our estimates based on data from 91 economies suggest that the experience of the three major international currencies has been largely consistent with the theoretical framework developed in the previous section. Specifically, the three major determinants of currency positions derived from our model, currency's relative return ($R_{j_1} - R_i$), the covariance between GDP and bilateral exchange rate ($Cov(GDP_{it}, S_{i,j_{1t}})$), and the cross covariance ($Cov(GDP_{it}, S_{i,j_{2t}}) \times Cov(S_{i,j_{1t}}, S_{i,j_{2t}})$), are statistically significant with the right signs in the panel regression when the three currencies are pooled together, and in most regressions for individual international currencies. For each set of regressions, we report four specifications.[13] We report the baseline specification without year fixed effects (YFE) in column (1) and the baseline estimates with YFE in column (2). In the last two specifications we use 'area fixed effects' (AFE) by grouping countries into 6 different geographical areas.[14] Column (3) reports the specification with neither institutional factors nor other control variables, while column (4) reports the estimates with area- and year fixed effects, institutional factors as well as other control variables.

For the three major international currencies as a whole, interest rate differentials have been less important than the other two factors in determining their positions. Table 3 reports the estimates from

[13] To be consistent with the theory part of the paper which studies the demand for assets denominated in the domestic currency or each of the two foreign currencies, we drop the countries which issue the international currencies in question. For instance, when we run the regression with USD exposures and the cross-covariance involves EUR exchange rates, we drop observations from the US and euro-zone countries. Unlike Lane and Shambaugh (2010b), we do not consider country fixed effects because the results would be statistically unreliable (there would be around 100 parameters to estimate if country fixed effects are considered, with only 300 observations.

[14] We divide the countries in our dataset according to their geographic locations into six groups, namely (a) Advanced Economies, (b) Central and Eastern Europe, (c) Developing Asia, (d) Latin America and the Caribbean, (e) Middle East, North Africa, Afghanistan, and Pakistan, and (f) Sub-Saharan Africa. The groupings follow the country composition of IMF World Economic Outlook (WEO) groups.

the specifications with the three major international currencies pooled together. The covariance between bilateral exchange rates and output growth exhibits the expected negative sign and is statistically significant at the 5% confidence interval, after controlling for the year- and area fixed effects, and is significant at 1% level when other factors are also taken into account. As the standard deviation of this covariance variable in the sample is 0.008, the estimates in column (4) imply that a one standard deviation reduction in the covariance term increases the foreign currency exposure by 2.9%.[15] The cross-covariance term has positive coefficients in all specifications, and once we control for the year- and area fixed effects and institutional factors, the estimates become statistically significant at the 5% confidence interval. This suggests investors face tradeoffs when they choose to hold assets and liabilities denominated in different international currencies. Specifically, the standard deviation of this cross-covariance variable is 0.01 and the estimates suggest a one standard deviation increase in the cross-covariance in the sample would generate an increase in the foreign currency exposure by 2.3%.

The coefficient for interest rate differentials is statistically significant at the 1% level in the baseline model of Column (1), and is significant at the 5% level when year fixed affects are taken into account, see column (2). It is significant at the 10% level if all control variables are considered in columns (3)-(4). Comparing the coefficients before and after controlling for the area fixed effects, one notices that the coefficients become smaller (but still positive and statistically significant at 10% confidence intervallevel) after controlling for the geographical location. The magnitude of the impact from interest rate differentials is not very large. A one standard deviation of interest rate differentials (8.5%) generates a 0.81% rise in foreign currency exposure, visibly smaller than the impact of the other two variables, as shown in Figure 3.

Institutional and other factors have an impact on international currencies' positions as well (Table 3). Trade openness is positively correlated with foreign currency exposure. Once we control for the area fixed effect, this variable shows small variations across time, and its magnitude drops. Institutional quality is statistically significant with a positive coefficient, suggesting better governance would lead to a rise in foreign currency exposure. Capital controls have a significant negative correlation with foreign currency exposure because they make it hard for investors to purchase foreign currency denominated assets. Finally, the year fixed effects are significant and positive, with the effect in 2004 being bigger than the effect in 2000. This captures the pattern of rising mean exposures to major international currencies over the sample period (Table 2).

Our analysis shows that the regression results differ somewhat across the three currencies, as shown in Tables 5 - 10. The regressions for the US dollar suggest currency relative returns $R_{j_1} - R_i$ are statistically significant with the correct sign no matter whether the euro or the Japanese yen is used as second currency (Tables 4 - 5). The covariance between other economies' GDP and their bilateral exchange rates against the US dollar ($Cov(GDP_{it}, S_{i,j_{1t}})$) is also statistically significant with the correct

[15] This result is quantitatively similar with the result found in Lane and Shambaugh (2010a). In their paper they look at foreign currency exposure as an aggregate measure. We instead look at each international currency individually.

sign when either the euro or the Japanese yen is used as second currency (Tables 5-6). The cross covariance ($Cov(GDP_{it}, S_{i,j_{2t}}) \times Cov(S_{i,j_{1t}}, S_{i,j_{2t}})$) is statistically insignificant in the first thee specifications but significant when area- and year-fixed effects, institutional factors and other control variables are all taken into account.

The regressions for the Japanese yen suggest that, relative return is significant (Tables 9 - 10) in all specifications, but the covariance between foreign economies' GDP and their bilateral exchange rates against the yen ($Cov(GDP_{it}, S_{i,j_{1t}})$) and the cross covariance ($Cov(GDP_{it}, S_{i,j_{2t}}) \times Cov(S_{i,j_{1t}}, S_{i,j_{2t}})$) is generally insignificant. This appears to support the arguments by He and McCauley (2010) that low interest rates have been a major factor driving the lopsided internalisation of the Japanese yen, which has been used mainly as a funding currency rather than investing currency. The regressions for the euro, however, indicate none of the three major variables are statistically significant (Tables 6 - 7), likely because of the lack of observations since we only use two years of data for the regression.

5. Would the Renminbi be Used for Investing and/or Funding?

The possibility that the renminbi may continue to have higher interest rates than advanced economies has raised concerns that non-residents may use it mainly as an investing currency going forward, and its internationalisation would be lopsided. As shown in Figure 4, the 3-month interbank rate of the renminbi has been higher than that of the US dollar, euro, Japanese yen, Swiss franc and British pound since the global financial crisis and even higher than that of the Australian dollar in the past couple of years. Going forward, interest rates of the renminbi are expected to remain higher than in most advanced economies with financial liberalisation. For instance, an analysis by He et al. (2014) suggests equilibrium real interest rates of the renminbi are likely to rise by 2-3 percentage points if restrictions on interest rates are removed.

However, the above analysis suggests the impact from other factors, such as the correlation between foreign economies' GDP growth and their bilateral exchange rates against the international currrency could be equal, if not more, important in determining the demand for assets and liabilities denominated in an international currency. In particular, an international currency that appreciates in good times and depreciates in bad times is an attractive choice as a funding currency (Having a short position in this international currency insures against domestic income fluctuations because a depreciation of the international currency in bad times transfers wealth from foreign lenders to domestic borrowers.) Judging from recent exchange rate trends and conditional on other things being equal, the renminbi seems to have some potential to be a funding currency. The renminbi exchange rate appreciated against major international currencies during 2005-2008 when the global economy was booming. During the global financial crisis in late 2008, the CNY/USD exchange rate stabilised while the Japanese yen appreciated against the US dollars.

To further substantiate this argument, Table 4 shows the correlations between output growth of selected countries and their bilateral exchange rates against major international currencies and the

renminbi during the period 2005 Q3 -2013 Q1.[16] A positive correlation indicates that the international currency tends to depreciate when world GDP growth rate rises and appreciate when world GDP growth rate declines. In this case, our model suggests that investors would have an incentive to use this international currency as an investing currency.

Table 4 indicates that is much heterogeneity in these correlations across countries. For the US dollar and Japanese yen, the correlations are mostly positive. For the renminbi, we find that there is a more balanced mix between positive and negative correlations across countries, suggesting the demand for the renminbi as a funding/investing currency can be quite balanced . A further piece of evidence is that while the USD, EUR and JPY's exchange rates are positively correlated with world output growth, in contrast, the correlations between the renminbi NEER and world GDP growth rate is slightly negative, at -0.01. This suggests that international investors as a whole may have balanced incentives to use the renminbi as a funding and investing currency for hedging fluctuations in their output.

Meanwhile, as interest rates in China would still be lower than those of some emerging market economies, investors from these economies would have an incentive to use the renminbi as a funding currency. As shown in Figure 5, the renminbi interbank rate has been lower than that of the Indonesian rupiah, Indian rupee, Russian ruble and Brazilian real, and would likely remain below the interest rates of some of these economies going forward. According to the International Monetary Fund, interest rates in Brazil could even rise somewhat in the medium term.

Of course, whether investors of these economies would actually use the renminbi for funding activities will depend on the comparative advantage of using the renminbi versus other international currencies. Other key factors, including the institutional arrangement of currency markets and the macroeconomic sturcture of China, would be important as well, as our empirical analysis indicates.

Our analysis also indicates global investors may have regarded the US dollar as a substitute of the renminbi. Indeed, the correlation coefficient between year-on-year changes in the US dollar NEER and the renminbi NEER has been 0.86 over the past five years (September 2009-August 2014). According to our model, if investors choose to use the US dollar as a funding currency, they would have an incentive to use renminbi as an investing currency as a means of insuring against exchange rate risk, and vice versa. This implies that the international position of the renminbi will in part depend on investors' preference for the US dollar as an investing or funding currency. Going forward, if the Chinese business cycle becomes less synchronised with the business cycles in the US, it is likely that the covariance with the US dollar exchange rates will fall, so that the other two factors – relative interest rates and the correlation between non-residents' domestic output growth and their bilateral

[16] We compute the correlations using quarterly data of bilateral exchange rates and GDP growth rates from 2005q3-2013q1. For the world, advanced economies, and emerging and developing economies, we use the negative of nominal effective exchange rates so that the signs of the numerical values are consistent with those computed using bilateral exchange rates. All exchange rates are first-differenced before empirical correlations are computed, consistent with the specification of the empirical model.

exchange rates against the renminbi – will become more important in the determination of the renminbi's international position .

6. Concluding Remarks

The main findings of this paper are summarised as follows.

- While some currencies' internationalisation has been largely balanced, that of others has been somewhat lopsided. Specifically, non-residents both borrow and invest in the US dollar and the euro, but they have used the yen mainly as a funding currency and the Australian dollar as an investing currency. Some researchers argue that interest rate differentials have been a major factor explaining these developments.

- As Mainland China has seen and would continue to see relatively higher interest rates than most advanced economies, there have been concerns that the renminbi may be used mainly as an investing currency by overseas investors along with its internationalisation, thereby leading to appreciation pressure.

- We develop a three-currency model to study the determinants of an international currency's position. Our analysis suggests that interest rate differentials would be only one of the factors shaping an international currency's position. Other factors, including the correlation between foreign economies' GDP growth and their bilateral exchange rates against the international currency, would be important as well.

- We find that the first-differenced renminbi effective exchange rate has a low correlaton with global economic growth, with much heterogeneity in the correlation between other economies' output growth and their bilateral exchange rates against the renminbi. This suggests that international investors may be attracted to the use of the renminbi both as funding and investing currencies .

- In addition, some emerging economies would likely have higher interest rates than China, suggesting that residents of these economies would have an incentive to use the renminbi as a funding currency rather than just as an investing currency. So although China would see relatively higher interest rates than advanced economies, the renminbi may not necessarily evolve as an investing currency only.

- Although the framework for the renminbi exchange rate has moved from targetting the US dollar to a broader basket of currencies, it still has a fairly high correlation with the US dollar, with global investors likely regarding the US dollar as a substitute of the renminbi. For the renminbi position to be less affected by the US dollar position, it needs to become more independent of the US dollar.

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Table 1. Renminbi Balance Sheet of Banks in Hong Kong, End-2013

Unit: In billions of renminbi

Assets		Liabilities	
Due from banks	898.5	Deposits	860.5
Of which: due from overseas banks	164.5	Personal	271.6
Loans and advances	115.6	Corporate	588.9
Negotiable debt instruments	823.8	Negotiable debt instruments	192.5
Other assets	115.7	Due to banks	284.7
		Of which: due to overseas banks	166.0
		Other liabilities	615.9
Total	**1953.6**	**Total**	**1953.6**
Memo: US dollar equivalent	**322.7**		

"Overseas banks" means banks from areas outside Hong Kong SAR and mainland China. Other assets/other liabilities include items such as amount receivable/payable under reverse repos/repos, unrealised mark-to-market gains/loss of derivatives and the amount to balance a single currency balance sheet, which is a subset of the balance sheet of all currencies. The end-2013 renminbi/dollar rate was 6.0537, according to the Federal Reserve G.5A release.

Source: Hong Kong Monetary Authority.

Table 2. Descriptive Statistics of Currency Position Indexes

	Mean	Median	Std. dev.	Skewness	Min	Max
			Year = 1996			
USD	-0.13	-0.11	0.21	-0.32	-0.62	0.34
EUR	-0.06	-0.03	0.12	-1.96	-0.57	0.11
JPY	-0.05	-0.03	0.07	-1.58	-0.29	0.01
GBP	0.00	0.00	0.03	-0.09	-0.16	0.17
CHF	0.00	0.00	0.02	-2.90	-0.16	0.09
			Year = 2000			
USD	-0.13	-0.10	0.22	-0.26	-0.64	0.34
EUR	-0.02	0.00	0.10	-1.93	-0.42	0.13
JPY	-0.04	-0.02	0.06	-1.75	-0.24	0.02
GBP	0.00	0.00	0.04	0.78	-0.19	0.23
CHF	-0.00	0.00	0.02	-6.28	-0.21	0.07
			Year = 2004			
USD	-0.07	0.00	0.21	-0.53	-0.65	0.29
EUR	-0.02	0.01	0.10	-1.59	-0.44	0.21
JPY	-0.03	-0.01	0.05	-2.12	-0.23	0.02
GBP	0.01	0.01	0.03	0.14	-0.16	0.19
CHF	-0.0019	0.00	0.02	-7.68	-0.20	0.01

Sources: Lane and Shambaugh (2010b) and authors' estimates.

Table 3. Determinants of International Positions for Major Currencies as a Whole

	(1)	(2) YFE	(3) AFE,YFE	(4) AFE,YFE
Trade	0.052**	0.050**	0.029**	0.028**
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(GDP)$	-928.133**	-857.250**	143.644	620.987*
	(242.13)	(240.52)	(256.05)	(253.26)
$Cov(GDP, S_{FC1})$	-346.462**	-282.171*	-265.792*	-367.664**
	(111.87)	(111.81)	(115.86)	(112.63)
Cross-Cov.	166.854+	112.595	170.869+	234.119*
	(96.33)	(96.20)	(96.57)	(93.75)
$R_{FC} - R_D$	0.188**	0.130*	0.110+	0.095+
	(0.05)	(0.05)	(0.06)	(0.06)
$Var(\pi)$	-0.004	-0.004	-0.003	0
	(0.00)	(0.00)	(0.00)	(0.00)
$Var(S_{FC1})$	2.169	1.736	1.583	-0.993
	(2.81)	(2.79)	(2.73)	(2.64)
Institutions				6.083**
				(0.79)
Ex-rate regime				1.118
				(0.91)
Capital controls				-0.522**
				(0.10)
POP				0.010**
				(0.00)
GDP per capita				-0.001
				(0.00)
y2000		2.330*	2.819**	1.847+
		(1.11)	(1.07)	(1.06)
y2004		5.262**	5.966**	5.495**
		(1.13)	(1.10)	(1.07)
Constant	-8.612**	-11.763**	-18.131**	-16.957**
	(0.97)	(1.27)	(1.45)	(1.56)
Obs.	1,216	1,216	1,216	1,216
R^2	0.071	0.089	0.16	0.228

+ indicates significance at the 10% level

* indicates significance at the 5% level

** indicates significance at the 1% level

Sources: Lane and Shambaugh (2010b) and authors' estimates.

Table 4. Correlations of Bilateral Exchange Rates and Country Growth Rates

GDP Growth	USD	Euro	JPY	Renminbi
US	n.a	-0.07	0.16	-0.27
Germany	0.10	n.a	0.03	0.03
France	0.18	n.a	0.15	0.10
Italy	0.12	n.a	0.03	0.04
Spain	0.21	n.a	0.15	0.12
Japan	0.02	0.02	n.a	-0.02
UK	0.18	-0.03	0.14	0.07
Canada	-0.13	-0.02	-0.07	-0.18
Australia	-0.04	-0.10	0.03	0.09
Switzerland	0.10	0.03	0.12	0.01
Russia	0.21	0.11	0.13	0.10
India	0.34	0.14	0.20	0.22
Brazil	-0.02	0.06	-0.08	-0.09
Turkey	0.02	0.01	0.02	-0.03
Korea	0.04	-0.00	0.02	-0.05
Philippines	0.28	0.26	0.26	0.25
Singapore	0.28	0.22	0.01	0.18
Malaysia	0.21	0.30	0.10	0.08
Indonesia	-0.25	-0.04	-0.12	-0.32
Thailand	0.21	0.13	0.28	0.13
World	0.15	0.20	0.09	-0.01
Advanced Economies	0.16	0.19	0.15	-0.03
Emerging and Developing Economies	0.17	0.06	-0.02	0.01

Sources: IMF, IFS and authors' estimates.

Table 5. USD Currency Exposure (EUR is the second foreign currency)

	(1)	(2) YFE	(3) AFE,YFE	(4) AFE,YFE
Trade	0.122**	0.119**	0.073**	0.062**
	(0.03)	(0.02)	(0.02)	(0.02)
$Var(GDP)$	-2,485.842**	-2,433.682**	-86.853	884.193
	(733.22)	(730.63)	(707.80)	(670.55)
$Cov(GDP, S_{USD})$	-1084.507**	-1058.814**	-729.312*	-844.731**
	(358.49)	(358.41)	(337.71)	(316.56)
Cross-Cov(EUR)	484.205	454.529	401.93	557.605*
	(312.46)	(312.09)	(284.34)	(264.98)
$R_{US} - R_D$	0.411**	0.424**	0.377*	0.314*
	(0.15)	(0.16)	(0.16)	(0.15)
$Var(\pi)$	0	0.001	0.001	0.005
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(S_{USD})$	-2.492	-2.78	-1.225	-2.174
	(9.07)	(9.01)	(7.96)	(7.49)
Institutions				11.937**
				(2.10)
Ex-rate regime				0.18
				(2.53)
Capital controls				1.195
				(0.91)
POP				0.017*
				(0.01)
GDP per capita				0.005
				(0.01)
y2000		-3.536	-2.341	-2.426
		(3.20)	(2.81)	(2.61)
y2004		3.336	5.121+	4.541+
		(3.21)	(2.82)	(2.64)
Constant	-16.702**	-16.462**	-32.803**	-27.877**
	(2.84)	(3.47)	(3.71)	(3.89)
Obs.	231	231	231	231
R^2	0.215	0.232	0.431	0.528

+ indicates significance at the 10% level

* indicates significance at the 5% level

** indicates significance at the 1% level

Table 6. USD Currency Exposure (JPY is the second foreign currency)

	(1)	(2) YFE	(3) AFE,YFE	(4) AFE,YFE
Trade	0.124**	0.123**	0.078**	0.066**
	(0.02)	(0.02)	(0.02)	(0.02)
$Var(GDP)$	-2,856.029**	-2,817.420**	-125.65	753.712
	(666.06)	(662.96)	(656.98)	(627.40)
$Cov(GDP, S_{USD})$	-1,045.212**	-1,039.955**	-747.301*	-864.799**
	(334.26)	(333.56)	(312.48)	(297.44)
Cross-Cov(JPY)	463.38	451.545	431.818	578.393*
	(309.63)	(308.84)	(280.51)	(264.06)
$R_{US} - R_D$	0.439**	0.469**	0.358*	0.285*
	(0.14)	(0.14)	(0.14)	(0.14)
$Var(\pi)$	0.001	0.001	0.002	0.006
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(S_{USD})$	-3.713	-3.782	-1.545	-3.202
	(8.42)	(8.37)	(7.35)	(6.99)
Institutions				10.631**
				(1.86)
Ex-rate regime				0.345
				(2.07)
Capital controls				0.93
				(0.82)
POP				0.016**
				(0.01)
GDP per capita				0.003
				(0.01)
y2000		-4.2	-2.728	-2.692
		(2.80)	(2.45)	(2.29)
y2004		2.025	3.913	3.594
		(2.80)	(2.44)	(2.30)
Constant	-15.057**	-14.154**	-32.569**	-28.319**
	(2.51)	(3.01)	(3.37)	(3.51)
Obs.	264	264	264	264
R^2	0.245	0.261	0.458	0.54

+ indicates significance at the 10% level

* indicates significance at the 5% level

** indicates significance at the 1% level

Table 7. EUR Currency Exposure (USD is the second foreign currency)

	(1)	(2) YFE	(3) AFE,YFE	(4) AFE,YFE
Trade	0.002	0.002	-0.005	-0.01
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(GDP)$	-766.899+	-765.414+	-292.471	-41.449
	(407.11)	(408.24)	(434.34)	(450.25)
$Cov(GDP, S_{EUR})$	189.922	196.539	-112.893	-87.132
	(181.21)	(182.29)	(193.14)	(198.70)
Cross-Cov(USD)	-135.849	-141.727	-112.893	-87.132
	(141.39)	(142.37)	(144.60)	(146.28)
$R_{EU} - R_D$	0.015	0.004	-0.099	-0.14
	(0.11)	(0.11)	(0.13)	(0.13)
$Var(\pi)$	-0.004	-0.004	-0.005	-0.004
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(S_{EUR})$	1.367	1.318	1.422	1.018
	(4.24)	(4.25)	(4.26)	(4.35)
Institutions				2.541+
				(1.37)
Ex-rate regime				0.283
				(1.66)
Capital controls				0.462
				(0.57)
POP				0.002
				(0.00)
GDP per capita				-0.001
				(0.00)
y2004		0.623	0.977	1.007
		(1.38)	(1.36)	(1.37)
Constant	0.809	0.446	-3.638+	-2.598
	(1.51)	(1.72)	(2.07)	(2.41)
Obs.	154	154	154	154
R^2	0.033	0.035	0.113	0.146

+ indicates significance at the 10% level

* indicates significance at the 5% level

** indicates significance at the 1% level

Table 8. EUR Currency Exposure (JPY is the second foreign currency)

	(1)	(2) YFE	(3) AFE,YFE	(4) AFE,YFE
Trade	0.003	0.003	-0.003	-0.008
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(GDP)$	-769.919+	-768.969+	-308.444	-26.533
	(404.98)	(406.11)	(432.63)	(446.80)
$Cov(GDP, S_{EUR})$	188.879	195.709	190.767	158.254
	(182.56)	(183.73)	(195.07)	(200.32)
Cross-Cov(JPY)	-145.828	-152.353	-125.091	-88.912
	(153.09)	(154.23)	(156.90)	(158.32)
$R_{EU} - R_D$	0	-0.011	-0.115	-0.163
	(0.11)	(0.11)	(0.13)	(0.13)
$Var(\pi)$	-0.004	-0.004	-0.005	-0.004
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(S_{EUR})$	1.339	1.288	1.346	0.728
	(4.22)	(4.24)	(4.24)	(4.32)
Institutions				2.770*
				(1.36)
Ex-rate regime				0.384
				(1.65)
Capital controls				0.386
				(0.57)
POP				0.002
				(0.00)
GDP per capita				-0.002
				(0.00)
y2004		0.604	0.961	1.036
		(1.38)	(1.36)	(1.37)
Constant	0.61	0.254	-3.792+	-2.857
	(1.51)	(1.72)	(2.07)	(2.40)
Obs.	154	154	154	154
R^2	0.032	0.034	0.112	0.152

+ indicates significance at the 10% level

* indicates significance at the 5% level

** indicates significance at the 1% level

Table 9. JPY Currency Exposure (USD is the second foreign currency)

	(1)	(2) YFE	(3) AFE,YFE	(4) AFE,YFE
Trade	-0.001	-0.002	-0.004	0.001
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(GDP)$	417.458*	431.456*	660.036**	823.865**
	(209.50)	(208.53)	(189.53)	(179.65)
$Cov(GDP, S_{JPY})$	42.248	73.76	24.153	-40.248
	(99.09)	(99.68)	(84.06)	(78.68)
Cross-Cov(USD)	55.984	28.566	59.796	85.32
	(83.48)	(83.99)	(69.18)	(64.40)
$R_{JP} - R_D$	0.213**	0.184**	0.205**	0.177**
	(0.04)	(0.05)	(0.04)	(0.04)
$Var(\pi)$	-0.005	-0.005	-0.004	-0.003
	(0.00)	(0.00)	(0.00)	(0.00)
$Var(S_{JPY})$	4.825+	4.498+	2.024	0.289
	(2.57)	(2.56)	(2.06)	(1.95)
Institutions				1.248*
				(0.53)
Ex-rate regime				1.058+
				(0.59)
Capital controls				-0.463+
				(0.24)
POP				0.010**
		(0.02)		(0.00)
GDP per capita				-0.002+
				(0.00)
y2000		0.799	0.747	0.876
		(0.88)	(0.70)	(0.65)
y2004		1.986*	1.838*	2.130**
		(0.92)	(0.74)	(0.69)
Constant	-3.180**	-4.283**	-3.727**	-4.946**
	(0.86)	(1.03)	(1.06)	(1.09)
Obs.	264	264	264	264
R^2	0.109	0.126	0.467	0.554

+ indicates significance at the 10% level

* indicates significance at the 5% level

** indicates significance at the 1% level

Table 10. JPY Currency Exposure (EUR is the second foreign currency)

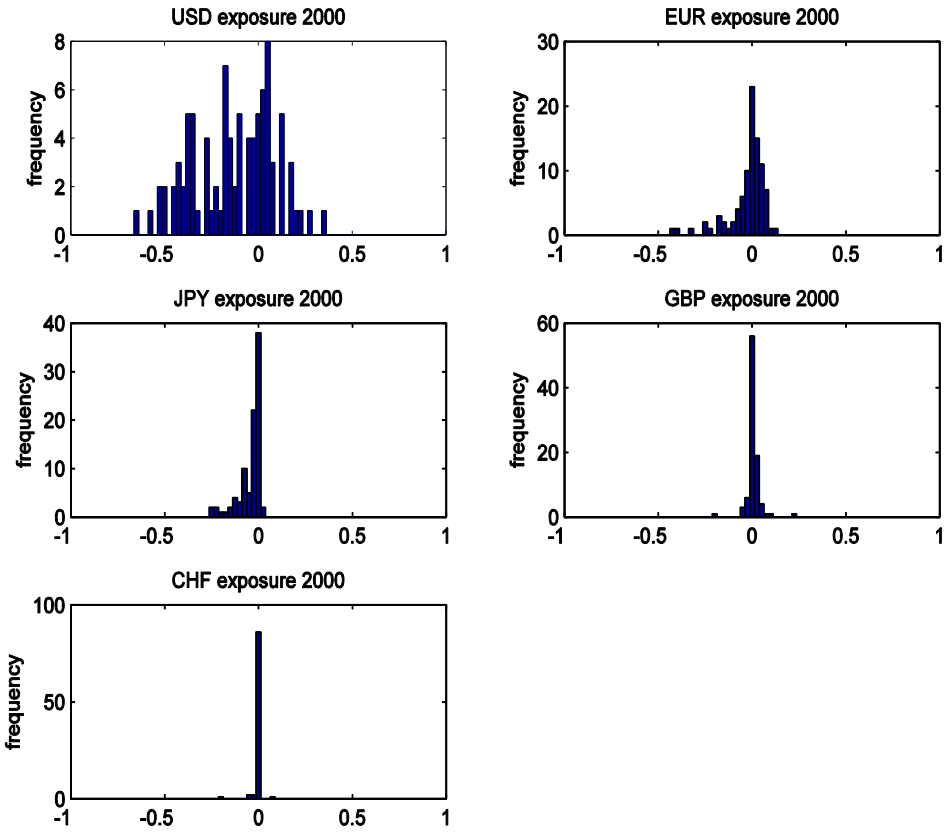
	(1)	(2) YFE	(3) AFE,YFE	(4) AFE,YFE
Trade	-0.004	-0.005	-0.007	-0.001
	(0.01)	(0.01)	(0.01)	(0.01)
$Var(GDP)$	532.125*	561.337*	672.559*	831.085*
	(227.91)	(226.88)	(202.28)	(192.01)
$Cov(GDP, S_{JPY})$	34.91	72.852	19.328	-45.331
	(106.35)	(107.06)	(91.17)	(85.24)
Cross-Cov(EUR)	67.451	35.503	65.181	92.066
	(92.17)	(92.69)	(77.03)	(71.80)
$R_{JP} - R_D$	0.192**	0.157**	0.203**	0.172**
	(0.05)	(0.05)	(0.04)	(0.04)
$Var(\pi)$	-0.005	-0.005	-0.004	-0.003
	(0.00)	(0.00)	(0.00)	(0.00)
$Var(S_{JPY})$	5.013+	4.689+	1.954	0.306
	(2.75)	(2.74)	(2.22)	(2.09)
Institutions				1.173+
				(0.61)
Ex-rate regime				1.238+
				(0.72)
Capital controls				-0.440+
				(0.26)
POP				0.010**
				(0.00)
GDP per capita				-0.003+
				(0.00)
y2000		1.012	0.836	1.044
		(0.99)	(0.79)	(0.74)
y2004		2.312*	1.909*	2.305**
		(1.05)	(0.85)	(0.80)
Constant	3.682**	-5.062**	-3.631**	-5.103**
	(0.97)	(1.19)	(1.16)	(1.21)
Obs.	231	231	231	231
R^2	0.101	0.12	0.455	0.546

+ indicates significance at the 10% level

* indicates significance at the 5% level

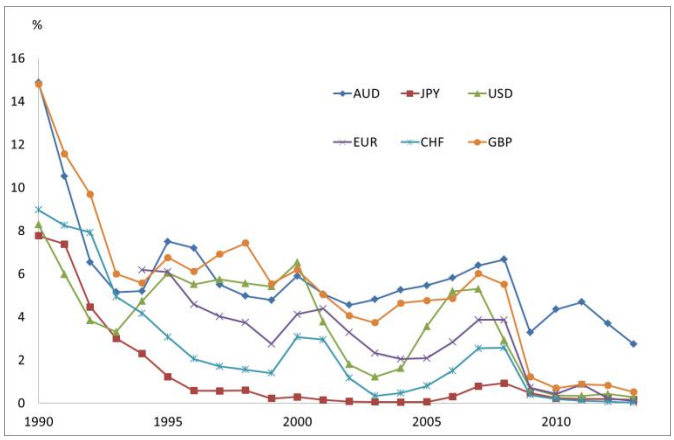
** indicates significance at the 1% level

Figure 1. Histograms of Major International Currency Positions in 2000



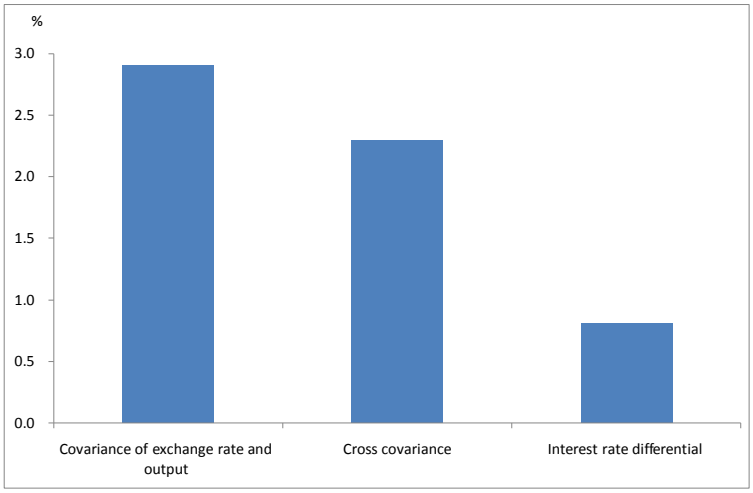
Sources: Lane and Shambaugh (2010b) and authors' calculations.

Figure 2. Interbank Interest Rates across Major Currencies



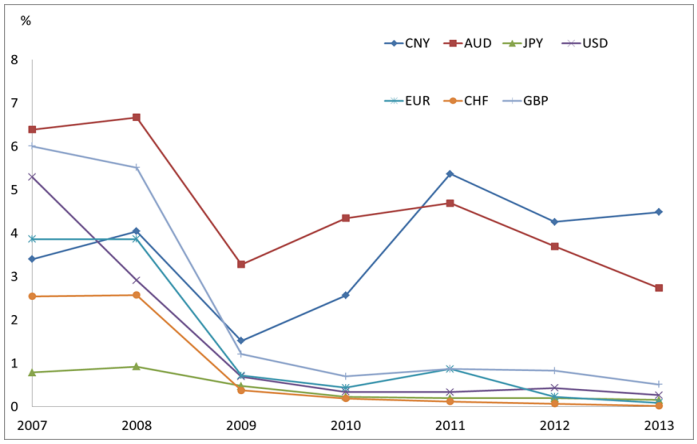
Sources: Bloomberg and CEIC.

Figure 3. Impact of One Standard Deviation Change in Major Variables on International Currency Positions



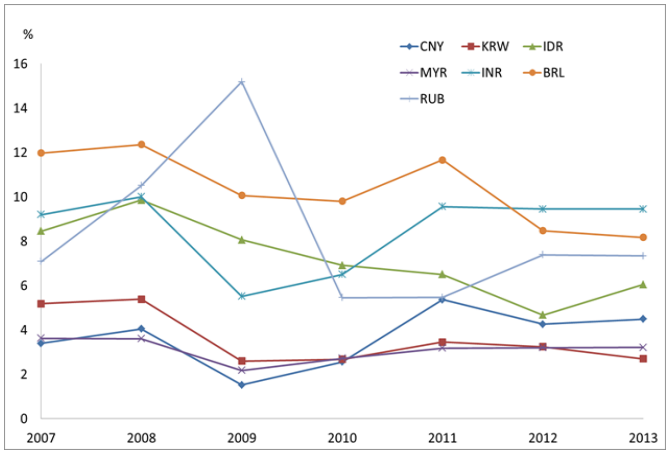
Sources: Lane and Shambaugh (2010b) and authors' calculations.

Figure 4. Interest Rates in China and Advanced Economies



Sources: Bloomberg and CEIC.

Figure 5. Interest Rates in Major Emerging Market Economies



Sources: Bloomberg and CEIC.

Appendix A. Deviation of Equation 7

We re-write Equation (7) as:

$$E(e^{Ac}R_i) = E(e^{Ac}R_D). \tag{17}$$

We take a second-order approximation of the left hand side of Equation (17) around the stochastic steady state for each foreign asset $i \in \{1,2,\dots,n\}$.

$$E(e^{Ac}R_i) = e^{AE(c)}E\left(E(R_i) + (-A)(c - E(c))(R_i - E(R_i)) + \frac{1}{2}E(R_i)(-A)^2(c - E(c))^2\right) + O(3). \tag{18}$$

Note that all first order terms are zero because $E(X - E(X)) = 0$. Similarly, the second-order approximation of the right hand side of Equation (17) is as follows:

$$E(e^{Ac}R_D) = e^{AE(c)}E\left(R_D + \frac{1}{2}R_D(-A)^2(c - E(c))^2\right) + O(3). \tag{19}$$

Substituting these expressions into Equation (17):

$$e^{AE(c)}\left(E(R_i) - R_D + (-A)Cov(c, R_i) + \frac{1}{2}(E(R_i) - R_D)(-A)^2(c - E(c))^2\right) = 0$$

We assume the excess return is small so that the last term is of third-order. Hence, the second-order accurate approximation of the first order condition is:

$$ACov(c, R_i) = E(R_i) - R_D. \tag{20}$$

Appendix B. Data

The dataset comprises 91 economies. These are Algeria, Argentina, Australia, Austria, Bangladesh, Belgium, Benin, Bolivia, Botswana, Brazil, Burkina Faso, Cameroon, Canada, Chad, Chile, China, P.R., Colombia, Rep. of Congo, Cote d'Ivoire, Denmark, Dominican Republic, Egypt, El Salvador, Ethiopia, Fiji, Finland, France, Gabon, Germany, Ghana, Greece, Guatemala, Haiti, Honduras, Hong Kong SAR of China, Hungary, Iceland, India, Indonesia, Islamic Republic of Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Republic of Korea, Madagascar, Malawi, Malaysia, Mali, Mexico, Morocco, Mozambique, Nepal, Netherlands, New Zealand, Niger, Nigeria, Norway, Oman, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Rwanda, Senegal, Singapore, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syrian Arab Republic, Tanzania, Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, United Kingdom, United States, Uruguay, Venezuela, Zambia.

Below we describe how the data used in the empirical analysis are constructed:

- Currency exposures: Data constructed using Equation (1). The share of foreign assets and liabilities denominated in currency-j are obtained from the 'Financial Exchange Rates and International Currency Exposures' dataset (Lane and Shambaugh, 2010b). The total cross-border assets and liabilities are obtained from the updated and extended version of the 'External Wealth of Nation' dataset constructed by Lane and Milesi-Ferretti (2007).

- Trade openness: annual data obtained from World Bank World Development Indicator (WDI).

- GDP per capita: 'Gross domestic product per capita, constant prices' series in World Bank World Development Indicator (WDI). In ten thousands when used as a standalone control variable.

- Exchange rate data: bilateral nominal exchange rates obtained in International Financial Statistics (IFS), IMF. The pre-euro exchange rates of the euro countries before the creation of the euro in 1999 have been converted to euros using 'euro fixed rates', that is using the official conversion rate at the time of introduction in the country. The US dollar to euro exchange rate before 1999 is proxied by the European currency unit (ECU) rate, also obtainable from IFS.

- Interest rate: we use country deposit rates to proxy the return on asset in that country. As a robustness check, we use the treasury bill rate. Interest rate data are retrieved from IMF, International Financial Statistics.

- Inflation: IMF, International Financial Statistics.

- Institutional quality: Government Effectiveness series from the World Bank's Worldwide Goverance Indicators database.

- Exchange rate regime: Shambaugh (2004) 'Exchange Rate Regime Classification' dataset.

- Capital controls: we use the Chinn-Ito index (Chinn and Ito, 2006) to measure a country's degree of capital account openness.

- Population: In millions. Obtained from World Bank World Development Indicator (WDI).

- Area fixed effects (AFE): We divide the countries in our data according to their geographic locations into six groups, namely (a) Advanced Economies, (b) Central and Eastern Europe, (c) Developing Asia, (d) Latin America and the Caribbean, (e) Middle East, North Africa, Afghanistan, and Pakistan, and (f) Sub-Saharan Africa. The groupings follow the country composition of IMF World Economic Outlook (WEO) groups. Details of the compositions can be found in: http://www.imf.org/external/pubs/ft/weo/2013/02/weodata/groups.htm.

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