The Potential of the Renminbi as an International Currency

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Abstract

The potential of the renminbi as an international currency is underpinned by the large and fast growing Chinese economy. We present empirical evidence indicating that the renminbi has already become a significant force impacting the exchange rates of the Asian currencies. We also estimate a reserve currency model and counter-factual simulations, and suggest that the renminbi's potential as a reserve currency would be comparable to that of the Japanese yen and the British pound if the Chinese currency were to become a fully convertible currency today. The evolution of the international role of the remninbi will depend importantly on the pace of the liberalisation of the restrictions on currency convertibility, which is likely to be governed by the authorities' consideration of the associated benefits and costs. In particular, we see a two-way reinforcement of currency internationalisation and financial market developments and opening in China.

JEL Classification: F3, F4, O1
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1. Introduction

China is now the third largest in the world measured both in terms of economic size and trade volume. In particular, China is the largest trading partner of many Asian economies, and has become an increasingly important source of investment in the region. As the rapid economic growth continues and the restrictions on international financial transactions are gradually liberalised, China's importance in the global economy and financial system will likely increase further. Naturally, this begs the question of what role the renminbi will play in international trade and finance, particularly in the Asian region.

There are already early forms of international use of the renminbi. The Chinese currency has been used in the settlement of border trade between China and some neighbouring countries, and renminbi banknotes are accepted by shops in many tourist places in the region. More significantly, banks in Hong Kong started in 2004 to offer renminbi banking services such as deposits, remittance, currency exchange and debit/credit cards. The scope of the renminbi business in Hong Kong has been expanded twice in 2005 and in 2007, with Hong Kong now possessing a renminbi bond market outside Mainland China.

The use of the renminbi in international trade and financial transactions is of course limited when compared with the major currencies such as the US dollar, the euro, the pound sterling and the Japanese yen. But the current situation reflects the limited capital account convertibility of the renminbi and a policy of non-internationalisation pursued by the authorities, and the examples cited above are best seen as pointing to the potential of the renminbi as an international currency. Mainland China's government policies play a role to the extent that the pace of the renminbi attaining full convertibility would affect the ability of residents and non-residents to use the currency in settling international transactions and acquiring renminbi-denominated assets. On the other hand, currency internationalisation would have implications for domestic monetary policy and financial market development, entailing both benefits and risks. Thus, the potential international role of the renminbi would be a significant factor to consider in formulation and implementation of measures on increasing currency convertibility and financial market liberalisations.

There is an increasing literature on the potential of the renminbi as an international currency, the associated benefits and risks and the appropriate government policies in promoting, facilitating or inhibiting the growth of such a role (李稻葵 2006; 刘力臻等 2006; Li 2006; Eichengreen 2005; He and Li 2005; 姜波克 2005; 李瑶 2003; 巴曙松 2003) . This paper considers some these of issues by drawing on the experiences of other major currencies. Specifically, we estimate determinants of the shares of five major currencies (the US dollar, the euro, the British pound, the Japanese yen and the Swiss franc) in reserve holdings of the world's central banks, and the model is then used to gauge the potential demand for the renminbi as official reserves, applying the relevant indicators of the determinants for China. We also examine whether the renminbi is already playing a role in the region in terms of impacting currency movements. Some of the policy issues related to currency internationalisation are then discussed.

The remainder of the paper is organised as follows. The next section provides a definition of an international currency and a brief review of the main determinants of the international currency status that are suggested in the literature. Section 3 estimates a quantitative relationship between the shares of the five international currencies in reserve holdings and the

main determinants such as the size of the economy and financial market, and presents a counterfactual exercise to gauge the potential share of the renminbi in the reserve holdings if the currency were freely convertible. Section 4 provides empirical evidence that the renminbi has already started to influence regional currency movements. Section 5 considers some policy issues in the international use of the renminbi, and the final section concludes.

2. The main determinants of the international use of a currency

An international currency is one that is used outside its home country. The classical three functions of money domestically—medium of exchange, store of value and unit of account—can be transferred to the level of international money, as summarised in Table 1 (Chinn and Frankel 2005), which was originally introduced in Kenen (1983). Under each function, there are examples of how official authorities and private sectors sometimes choose to use a major international currency that is not their own. These functions are distinct from each other, and their respective importance may vary somewhat depending on specific factors. For example, short-term changes in reserve holdings may be influenced by exchange rate and interest rate movements. However, in the longer term, the functions of an international currency are related and determined by more fundamental factors (see below).

Table 1: The International Use of a Currency

	Official Use	**Private Use**
Medium of Exchange	Vehicle currency for foreign exchange intervention	Invoicing international trade and financial transactions
Store of Value	International reserves	International private asset holding
Unit of Account	Anchor for pegging local currency	Denominating international trade and financial transaction

Source: Chinn and Frankel (2005).

Full convertibility is required for a currency to play any significant role in international trade and financial transactions, but it is not a sufficient condition. The international use of a currency is ultimately determined by market forces. What follows briefly discusses four main economic determinants that are often listed in academic research and policy discussions (Lim 2006; Yam 2005, 2007; Eichengreen 2005; Mundell 1998; Talvas & Ozeki 1992; Tavlas 1991).

The size of the economy

International currencies are usually associated with large, competitive economies with far-reaching trade and financial ties. A large domestic economy allows exploitation and reinforcement of economies of scale and scope involved in using a currency over a wider domain. A common measure of the size of an economy is the gross domestic product (GDP). Based on time series estimates, Eichengreen and Frankel (1996) find that every one percent of GDP in the world total leads to 1.33 percent of central bank reserve holdings in the corresponding currency. This is a point estimate rather than an average ratio, and it explains variations in the relative role of a currency such as the US dollar, but not its actual proportion. However, cross-country evidence also confirms a positive relationship between the share of GDP in the world total and the share of central bank reserve holdings in the corresponding

currency, although the relationship is likely to be nonlinear (Chinn and Frankel 2005).

The economic size matters first through the share of the country in international trade. Large scale trade activities usually generate a large market in foreign exchange transactions with at least one leg in the domestic currency. Also, well-diversified economies can often rely on their own currency for settling transactions with non-residents as they offer the latter a high density network of trading relationships potentially involving the same currency, thereby lowering foreign exchange transaction costs. Thus, economic size brings a *de facto* limitation of the convertibility of small economies' currencies.

The economic size of the Euro area is close to that of the US, in terms of GDP as well as population, and share in international trade. Japan is the third largest, but is significantly smaller than the U.S. and the Euro area. Mainland China is the fourth largest economy in terms of market exchange rate measured GDP, but is already the third largest by the measure of purchase power parity (PPP) based exchange rate and in terms of the volume of international trade (Table 2). As China is expected to grow faster than the other more developed economies, her economic weight in the world should continue to increase. Thus, as policy restrictions on the convertibility of the renminbi are increasingly lifted, it would be reasonable to expect the currency to play some role in international trade and finance, even though it is unlikely to challenge the position of US dollar and the euro in the foreseeable future.

Table 2: Currency Share of Reserve Holdings and Determinants: Some Indicators

	US	Euro Area	UK	Japan	Switzerland	Mainland China	Hong Kong SAR	Date
Currency Share in Foreign Reserves (%)	64.6	25.5	4.6	3.1	0.1	N.A.	N.A.	Sept, 2008
Size of economy and financial market								
GDP (US dollar, bn)	13,807	12,306	2,804	4,381	427	3,280	207	2007
GDP (PPP, bn)	13,164	9,969	2,003	4,081	279	6,092	268	2006
Foreign Trade (US dollar, bn)	3,180	4,047	1,056	1,320	318	2,174	712	2007
Stock Market Capitalisation (US dollar, bn)	11,567	4,910	1,758	3,148	762	1,946	1,238	Jan, 2009
Government Bond Outstanding (US dollar, bn)	6,792	8,468	923	7,778	125	1,340	22	Jun, 2008
Foreign Exchange Turnover (Total = 200%)	86.3	37	15	16.5	6.8	0.5	2.8	Apr, 2007
M2 (US dollar, bn)	7,879	10,652	3,001	7,342	386	6,634	775	Oct, 2008
Monetary Stability								
10-year Average Inflation (%)	2.59	1.96	2.75	-0.23	0.84	1.08	-0.76	1998-2007
Exchange Rate volatility	4.49	5.44	5.02	8.15	5.98	4.40	4.58	1997-2007
Average Annual Appreciation of Exchange Rate against SDR (%)	-1.2	2.7	0.7	-0.4	1.4	-1.3	-0.8	1997-2007

Data Sources: World Bank, IMF, BIS, CEIC, Bloomberg, WEF and authors' calculations.

Notes:

1. Government bond outstanding is the outstanding amount of international and domestic debt issued by the governments, and that for the Euro area does not include Luxembourg and Slovenia due to data limitation.
2. Exchange rate volatility is the annualised standard deviation of daily percentage change of the exchange rate against SDR over the 10-year period.
3. For the Euro/SDR exchange rate, the sample period is 1999-2007.

Size and development of financial markets

Size also matters in terms of financial development, and international currencies are usually associated with large, liquid and open financial markets. Large and developed financial markets give access to more investment and borrowing opportunities and allow effective arbitrage owing to low transaction costs. In particular, a deep and liquid secondary market of a wide range of securities would attract international investors, including central banks to allocate assets in their reserve management according to their risk, liquidity and return requirements. Such markets would offer a wide range of financial services, which can help international investors to effectively hedge currency risk and manage their portfolio more efficiently (Greenspan 2001). When an economy's domestic financial market is underdeveloped, it is sometimes more cost effective for some market participants to borrow or invest abroad in an international currency and then exchange the proceeds for domestic currency, rather than conduct the transaction directly at home.

The U.S. financial system is the most advanced one with deep and diversified financial markets, and with New York being a dominant financial centre. This is an important factor underlying the US dollar's position as a reserve currency. The pound sterling used to be the world dominant reserve currency in the late 19th century and early 20th century, and Britain then had the world's most developed financial system and London was the most important financial centre. The introduction of the euro has helped to integrate the financial markets within the euro area, and in particular, the euro area has seen a strong growth of the bond market. The development of China's financial markets lags behind other major economies mainly in two ways. First, the domestic financial markets are still subject to some restrictions including the remaining floors and ceilings on bank lending and deposit interest rates. Second, the market is by large closed to international investors. However, important reform efforts are under way, and the rapid growth of the stock market and short-term corporate bond market in recent years has shown the potential for China to develop into one of the largest financial markets in the world in a not too distant future (see below).

Stable value of the currency

Confidence in the value of a currency is important for an international currency to be held as a store of value. Two possible indicators of currency stability are often considered. One is inflation, the higher the inflation, the bigger the loss in the purchasing power of the currency. Often, a measure of the inflation differential from the average of developed economies is taken to indicate the relative stability of a currency. The other indicator is exchange rate volatility, which is often measured with reference to the SDR. The more volatile the exchange rate, the higher risk it is to hold reserves in that currency.

Over the past ten years, the average annual inflation rate in China was about 1.1%, which is much lower than that of 2.6% in the US, 2.0% in the Euro area and 2.8% in the UK. Japan, on average, recorded a price decline during the period. The renminbi's volatility against the SDR was close to that of the US dollar, and lower than that of the Euro, the British Pound and the Japanese yen. This of course reflects the relatively close link of the renminbi with the US dollar.

Overall, it is probably fair to say that the stability of the renminbi in both the domestic and external value has been comparable to other major currencies in the past decade, following

relatively high inflation and exchange rate depreciation in the earlier reform period.

Network externalities

It is often argued that once a currency becomes an international currency, this status is unlikely to be lost in a short period of time (Greenspan 2001). This can be explained by persistence and network externalities. An international currency is usually associated with a deep and flexible financial market, and a good market infrastructure brings loyalty. Market participants in general would like to stick to the platform that they know well as they have invested substantially over time to accumulate the knowledge of the platform. Another factor that supports the currency status is network externalities. Once more market participants use a currency to conduct transactions, more people will find it convenient to use that currency. This becomes a self reinforcing process, which generates a positive network effect (Eichengreen 2005).

3. Data and Empirical Estimates

3.1 Data and stylised facts

Ideally the international use of a currency should be assessed on each of the functions listed in Table 1. The empirical analysis of this paper focuses on reserve currency holdings, as data are much more limited on indicators of the other international roles. The assumption is that reserve currency holdings are a good proxy for the overall international role of a currency. While interest rate and exchange rate movements may have an impact on the currency allocation of central banks' reserve holdings in the short run, in the longer term, the international roles of a currency tend to be related and jointly determined by more fundamental factors. There are economies of scope in this case. If a currency is widely used to invoice trade, it is more likely to be used to invoice financial transactions. If it is used as a vehicle currency, it is more likely to be used as a currency to which smaller economies peg, and it is more likely to account for a larger share of reserves holdings by the central banks.

The data on reserve holdings are from the IMF Currency Composition of Foreign Exchange Reserves (COFER) database. The currencies identified in the COFER data are the US dollar, euro, pound sterling, Japanese yen, Swiss franc, and a category of all "other currencies". In September 2005, the IMF changed the way it reports the reserve data and released revised statistics extending back to 1995. The main change is to separate the total reserves into allocated reserves and unallocated reserves. Because some member countries choose not to report the currency compositions of their foreign reserves, the IMF used to estimate the currency composition for these countries. After the change, the IMF includes the reserves of these countries in a category called "unallocated reserves", which is the difference between the total world reserves and "allocated reserves". The share of allocated reserves in total world reserves is about 70%[1]. For our purpose, the currency composition of the allocated

[1] All industrial countries report to the COFER database, but some developing countries choose not to do so. Thus, all the unallocated reserves are attributed to developing countries. Currently the allocated reserves account for about 52% of developing countries' total reserves, and the ratio has been declining in recent years. This probably reflects that the foreign reserves of those developing countries choosing not to report to COFER have been increasing. Nevertheless, the allocated reserves still take up a majority share of the total reserves, and the currency shares of the allocated reserves for developing countries is similar to that of industrial countries.

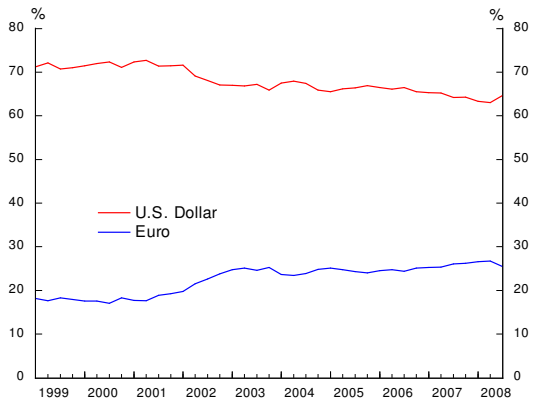
reserves is taken as the variable of reserve currency share.

This study uses quarterly data covering the period of 1999-2006. The relatively short sample period is dictated by the data break due to the introduction of the euro in 1999. In some way, this study is complementary to Chinn and Frankel (2005) who used annual data before 1999. It is noted that the reliability and accuracy of data on reserve currency shares should be much improved in recent years, as an increasing number of central banks have disclosed information on reserve holdings.

The determinant variables discussed above such as an economy's GDP and trade share in the world, inflation differentials and exchange rate volatility are computed using data obtained mainly from the IMF International Financial Statistics (IFS), supplemented by the CEIC and Bloomberg. It is difficult to find a good measure of financial market development that covers all the aspects such as depth, breadth and efficiency of a market. Several measures such as foreign exchange turnover, stock market capitalisation have been used in the literature (Chinn and Frankel 2005). This study makes use of the stock market capitalisation as a share of five major financial centres combined (New York, London, Tokyo, Euronext, and Zurich).[2] It is expected that the stock market capitalisation would be positively related to the share of that market's home currency in total world reserves. The data on stock market capitalisation is obtained from the World Federation of Exchanges (WEF).

As the sample period is short, there is a concern that variations in the data were too limited to derive a significant relationship using a regression analysis. Charts 1 and 2 show that reserve shares of the major currencies did have material changes over the past ten years. The US dollar's share fell from 71.2% to 64.6%, while that of the euro increased from 18.1% to 25.5%. The share of the British pound rose from 2.7% to 4.6%, while that of the yen dropped from 6.0% to 3.1%.[3] Overall, the increase in the share of the euro is mainly at the expense of the US dollar and the Japanese yen.

Chart 1: Reserve currencies shares:
U.S. dollar and euro

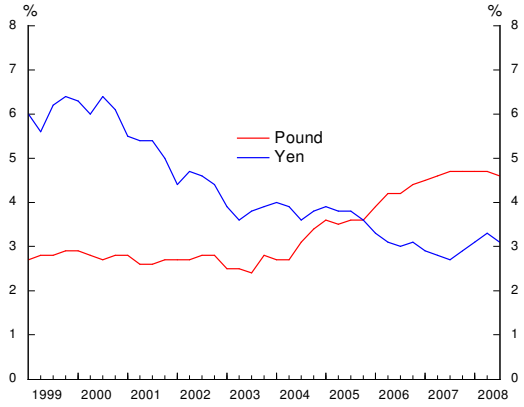


Source: IMF, authors' calculations.

[2] These are the major international financial centres, which correspond to the five major reserve currencies studied in this paper. The total market capitalisation of these five centres accounts for about 80% of the world total.

[3] The Swiss franc's share fell marginally and there was little change in the share of all other currencies.

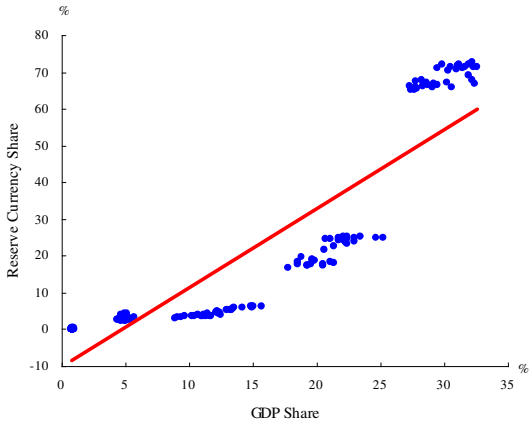
Chart 2: Reserve currencies shares:
British pound and Japanese yen



Source: IMF, authors' calculations

Chart 3 plots the panel data points and shows that a higher reserve currency share is generally associated with a higher GDP share. It is often argued that reserve currency shares are not sensitive to changes in the determinant variables when the share is at a very low or a high level, reflecting the inertia or persistence feature noted above. Only when the reserve currency share reaches a certain threshold level will changes in the determinant variables have a significant impact. To capture this "tipping phenomenon", the logistic transformation of the reserve currency share is used in the literature (Chinn and Frankel 2005)[4]. Chart 4 plots the logistic transformation of the reserve currency share against the GDP share, which also shows a positive relationship.

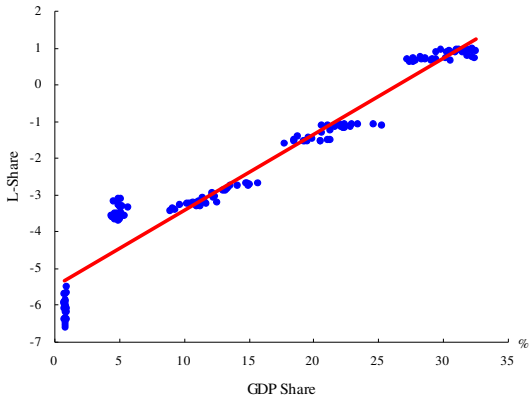
Chart 3: Reserve currency share vs. GDP share



Source: Authors' calculations

[4] The logistic transformation of reserve currency share S is $\log(S/(1-S))$.

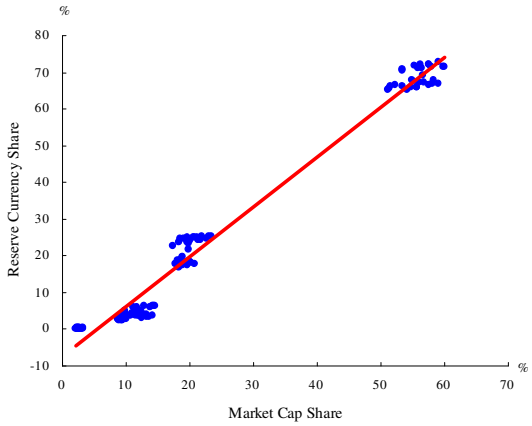
Chart 4: Logistic transformation of reserve currency share vs. GDP share



Source: Authors' calculations

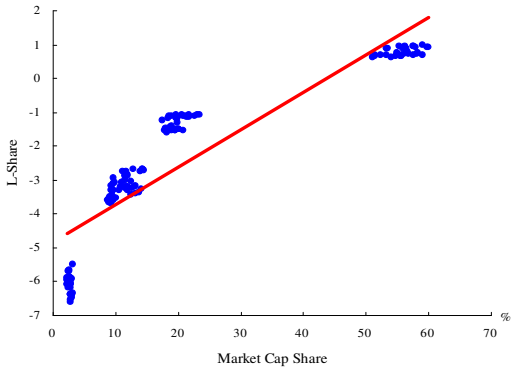
Similarly, the reserve currency share and share of stock market capitalisation are also positively correlated (Charts 5 and 6).

Chart 5: Reserve currency share vs. market cap share



Source: Authors' calculation

Chart 6: Logistic transformation of reserve currency share vs. market cap share



Source: Authors' calculations

The relationship between the reserve currency share and exchange rate volatility and inflation differential (with the average inflation in G-7 economies) is not obvious (Charts A1-4 in the Appendix). This suggests that exchange rate volatility and inflation differential are unlikely to be significant variables in explaining variations in reserve currency shares over time and across currencies in our sample. It probably reflects the limited variation in inflation and exchange rate volatility across currencies and over time during the short period. The logistic transformation of currency shares of reserve holdings seems to be positively correlated with the trade shares, but the relationship seems not as strong as that for the GDP share (Charts A5-6 in the Appendix).

3.2 The empirical model and estimation

The empirical estimation follows closely the model used in Chinn and Frankel (2005). That paper uses annual data from 1973 to 1998 to regress currency shares of reserve holdings on different combinations of explanatory variables, and finds that the share of GDP and inflation differential are statistically significant in explaining variations in the dependent variable.

The model to be estimated can be represented by the following equation

$$\begin{aligned} SHARE_{it} &= \alpha_i + \beta_1 GDP_{it} + \beta_2 INDIFF_{it} \\ &+ \beta_3 MARKET\_CAP_{it} + \beta_4 VOL_{it} \\ &+ \beta_5 TRADE_{it} + \beta_6 SHARE(-1) + \varepsilon_{it} \end{aligned} \qquad (1),$$

where i refers to the different reserve currencies, including the US dollar, euro, Japanese yen, British pound and Swiss franc. *SHARE* denotes a currency's share in the total allocated world reserves. *GDP* and *MARKET_CAP* are GDP share in the world total and the share of stock market capitalisation in the total of five financial centres respectively. *INDIFF* denotes the difference between inflation in a currency and the average inflation of the G-7 economies. *VOL* is the annualised standard deviation of daily percentage change of the exchange rate of a currency against the SDR over the past five years. *TRADE* denotes the share of international trade in the total world trade.[5] The lagged dependent variable is included to capture the persistence effect, whereby the impact of shocks to the other explanatory variables accumulates in the equilibrium value of the dependent variable. To capture possible specific characteristics or conditions of each reserve currency, a cross section fixed effect model is used in the panel regression. It is expected that $\beta_1, \beta_3, \beta_5, \beta_6$ have positive signs and β_2, β_4 have negative signs. The data are of quarterly frequency covering the period of 1999 Q1 to 2006 Q3.

As noted above, there might be a "tipping phenomenon" in changes in the currency shares of reserve holdings. To capture this non-linear relationship, the model is also estimated using the logistic transformation of the reserve share (*LSHARE*) as the dependent variable. Equations (2) and (3) are the final estimates obtained after dropping the insignificant variables from the preliminary estimates.

[5] In calculating the share of the euro area's trade in the world total, the intra-euro area trade is taken out in both the numerator and denominator, so that the definition of trade share is consistent with that for the other four currencies.

$$\hat{SHARE} = \underset{(0.82)}{-0.001} + \underset{(0.01)}{0.080}\,GDP + \underset{(0.00)}{0.044}\,MARKET\_CAP + \underset{(0.00)}{0.910}\,SHARE(-1) \quad (2)$$

$$\hat{LSHARE} = \underset{(0.01)}{-0.365} + \underset{(0.03)}{0.935}\,GDP + \underset{(0.00)}{0.912}\,LSHARE(-1) \quad (3)$$

The numbers in the parentheses are p-values of t-statistics for the estimated coefficients, and the equations are estimated over the mean of the fixed effects.

In the linear model, only the coefficients of the GDP share, share of market capitalisation, and the lagged reserve share are statistically significant. In the nonlinear model, only the GDP share and the lagged dependent variable turn out to be significant.[6]

The two models suggest that the size of the economy as measured by the share of GDP in the world total is more important than other fundamental variables in determining the currency shares of reserve holdings. In particular, the trade share variable is not significant, consistent with the results in Chinn and Frankel (2005). A possible explanation is that the GDP and trade shares are correlated and the former better captures the size effect.

The lagged dependent variable is significant and its estimated coefficient has a value of 0.9. This supports the hypothesis that the currency shares of reserve holdings tend to be highly persistent and a shock arising from say a change in the GDP share only gradually leads to a change in the reserve share. Specifically, our linear model estimates suggest that a rise in the GDP share by 1 percentage point would lead to an increase in the reserve currency share by 0.9 percentage point in the long run. But, it takes about 7 years for half of the impact to complete.

The share of stock market capitalisation is significant in the linear model but insignificant in the non-linear model. This probably reflects the difficulties in finding a good and comprehensive measure of the size of the financial market.[7] To take our linear model estimates literally, an increase by 1 percentage point in the share of stock market capitalisation would raise the reserve currency share by 0.5 percentage point in the long run, and it takes about 7 years for half of the effect to complete.

Neither inflation differential nor exchange rate volatility is statistically significant, probably reflecting the short sample period. In the long run, the stability in the value of a currency should be a significant factor affecting the international demand for the currency. In Chinn and Frankel (2005), inflation differential and exchange rate volatility are statistically significant in some of their regression models.[8]

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[6] The use of the market exchange rate in calculating both the dependable variable and some explanatory variables such as GDP and market capitalisation shares may raise concern about endogeneity. However, it is not necessarily so since exchange rates do not enter the equation directly on the right hand side, see Chinn and Frankel (2005).

[7] In Chinn and Frankel (2005), the foreign exchange turnover is used as the indicator of the financial market development. It turns out that only in one of the seven regressions it is statistically significant. In our case, quarterly data on foreign exchange turnover are not available.

[8] Chinn and Frankel (2005) tried the long run depreciation trend of the exchange rate against SDR and found it is insignificant.

3.3 Counterfactual exercise for the renminbi

Currently there are restrictions for renminbi capital account transactions, especially portfolio investment, although liberalisation measures have been taken through schemes of Qualified Domestic Institution Investors (QDII) and Qualified Foreign Institution Investors (QFII). If the renminbi were to be become fully convertible, some economies might choose to hold part of their foreign reserves in renminbi assets, especially those having close trade and investment ties with Mainland China. To gauge the potential significance of the renminbi as a reserve currency, we conduct a counterfactual simulation using the estimated models presented above.

Applying the current levels of China's share of GDP (at the market exchange rate) in the world total and that of the stock market capitalisation in the total of the six markets, which is 6.8% for GDP and 10.5% for stock market capitalisation, the renminbi's share in the world reserves would be about 10% according to the linear model, and 3% based on the nonlinear model. The relatively low estimate from the non-linear model partly reflects the "tipping phenomenon" whereby the reserve currency share increases slowly when it is at a low level.

For comparison purposes, we calculated the potential reserve share of the renminbi using the estimated models in Chinn and Frankel (2005). Specifically, we employed two models presented in Table 1 and 2 in the appendix of that paper:

$$\begin{aligned} \hat{SHARE} &= \underset{(0.02)}{0.098}\,GDP - \underset{(0.17)}{0.071}\,INFDIFF \\ &- \underset{(0.16)}{0.028}\,EXVOL + \underset{(0.00)}{0.956}\,SHARE(-1) \end{aligned} \qquad (4)$$

$$\begin{aligned} \hat{LSHARE} &= \underset{(0.00)}{-0.506} + \underset{(0.00)}{2.285}\,GDP \\ &- \underset{(0.09)}{1.565}\,INFDIFF - \underset{(0.34)}{0.445}\,EXVOL \\ &+ \underset{(0.00)}{0.879}\,LSHARE(-1) \end{aligned} \qquad (5),$$

where *INFDIFF* denotes inflation differential and *EXVOL* denotes exchange rate volatility. In the calculation for the share of renminbi, the differential of China's average inflation over the past ten years from that of G-7 countries is used for *INFDIFF*, and the annualised standard deviation of the log first difference of the renminbi-SDR exchange rate over the past ten years is used for *EXVOL*. Equation (5) is the non-linear version of equation (4), using the logistic transformation of the reserve currency share as the dependable variable. Chinn and Frankel (2005) use foreign exchange turnover to measure the size and development of the financial market and it turns out to be significant in only one of the models. Considering that the foreign exchange turnover in the case of the renminbi is limited by the restrictions on the capital account transactions, we choose the two models in which the foreign exchange turnover is not included.

Applying China's data, the renminbi's share in the world reserve holdings would be 12.7% according to the linear model and 4.4% based on the nonlinear model. Again, the non-linear model gives a lower estimate. Overall, our estimates are broadly in line with those derived from the models of Chinn and Frankel (2005). They suggest that the renminbi's potential as a

reserve currency would be comparable to the case of the Japanese yen and British pound should the renminbi become fully convertible today.[9]

4. Rising role of the renminbi in the region

The empirical work of the previous section suggests that the renminbi has great potential to become an international currency. Indeed it has been suggested that the impact of the renminbi on regional currencies has been rising, more notably after China's exchange rate reform in July 2005. It may be the result of government policies and/or market forces. Asian economies have often pursued an export-driven strategy for economic growth. It has been suggested that Asian currencies may be moving away from a dollar bloc to tracking a broad-basket effective exchange rate in order to maintain competitiveness of their exports (Kawai, 2002 and Ho, et al., 2005). If this is the case, the renminbi may have started to feature in the currency baskets that Asian economies track because of the competitive relationship between Mainland China and these economies in export markets. Branson and Healy (2005) show that the structure of the Mainland's exports, both in terms of market and commodity distributions, is similar to that of a number of Asian economies. Asian economies therefore have the incentive to keep a close watch on renminbi movements in managing their currencies in order not to lose competitiveness against Mainland exports.

Apart from government policies, market forces may also give rise to the renminbi's influence. The importance of the Mainland economy may lead the market to believe that the Asian currencies should follow the renminbi movements. In addition, some Asian currencies such as the Singapore dollar have been used as proxies for renminbi trading in the global foreign exchange markets (Yam, 2007). In view of the Mainland's large trade surpluses, there have been wide expectations of renminbi appreciation in recent years. However, as the renminbi is unconvertible and the access to renminbi trading is restricted, it is difficult for international investors to position themselves to directly benefit from renminbi appreciation. Under the circumstances, there are reports of the practice in the currency market of using Asian currencies as proxies to take a position for renminbi appreciation, on expectations that these currencies will follow suit if the renminbi appreciates.

4.1 Framework for testing the renminbi impact

One way of formally testing the impact is to use the framework introduced by Frankel and Wei (1994):

$$\Delta e_{Asiancurrency/SwissFranc} = \alpha_0 + \alpha_1 \Delta e_{Usd/SwissFranc} + \alpha_2 \Delta e_{Yen/SwissFranc} + \alpha_3 \Delta e_{Eur/SwissFranc} + \alpha_4 \Delta e_{Rmb/SwissFranc} \quad (6)$$

In equation (6), e_j and 'e_i's are, respectively, exchange rates of an Asian currency under study and those which might influence it, including the US dollar, Japanese

[9] Li and Liu (2007) use a similar approach and estimate an empirical model of reserve currency share using annual data from 1967 to 2004. Their simulation suggests that the renminbi would be the third major reserve currency behind the US dollar and euro in 20 years, assuming China's rapid economic growth continues.

yen, euro and renminbi. The exchange rates are measured against a common currency, the Swiss franc in this case as typical in the literature. A significant α_i would suggest that currency i has an impact on the Asian currency, and α_i is interpreted as the importance or weight of currency i in the currency basket. The sum of the 'α_i's should be close to one if all the relevant currencies are included in the basket the currency j is targeting. The approach has been widely used in estimating weights in a currency basket and for classifying de facto exchange rate regimes, including a number of applications on Asian currencies. For example, Eichengreen (2006) and Frankel (2007) apply it in an attempt to unveil the composition of the currency basket in the new renminbi exchange rate regime. McKinnon and Schnabl's (2004) application is to demonstrate the evolving role of the US dollar in influencing Asian currencies after the 1997-8 financial crisis.

In our estimation, the exchange rates are taken logs and transformed into first differences. Daily data for nine Asian currencies between 1 January 1999 and 12 February 2009, obtained from Bloomberg and CEIC, are used. The sample is split into two periods: before and after the renminbi exchange rate reform in July 2005, to investigate whether the role of the renminbi has changed over time.

One issue to deal with in the estimation arises from the high correlation between the renminbi and US dollar, even after the de jure de-linking of the two. Peng et al. (2006) show that significance was still attached to the stability of the RMB/USD exchange rate for their sample period of between end-July 2005 and 2006 Q2. Eichengreen (2006) and Frankel (2007) also reveal that although declining, the weight of the US dollar remained very high in 2006 in the currency basket the renminbi has been tracking. To circumvent the multi-collinearity problem, we run an auxiliary regression of the changes in the renminbi on those of the US dollar, and the residual from this regression is taken to be renminbi movements independent of the US dollar. We use this residual to represent the renminbi exchange rate in estimating equation (6).[10] In this modified framework, α_4 can still indicate how much the renminbi exchange rate influences movements of an Asian currency, but it can no longer be interpreted as the weight in a currency basket. As will be seen later in our estimation results, the 'α_i's do not sum up to one as in the original framework of Frankel and Wei (1994).

4.2 Estimation results

Tables 3 and 4 report the estimation results for two sample periods – before and after the exchange rate reform. The overall results point to a clear rise in the importance of the renminbi in influencing other currencies after the regime shift. The US dollar continues to have a dominant effect on Asian currencies, and the Japanese yen is also a component in currency baskets some Asian currencies track. We now discuss the details of the estimation results for the two periods.

[10] We have also estimated auxiliary regressions which include all G3 currencies as regressors. However, the coefficients on the euro and yen are not significant.

Table 3: Asian currencies regimes before the renminbi exchange rate reform

(1/1/1999 -- 20/7/2005)

	Constant α_0	*Dollar* α_1	*Yen* α_2	*Euro* α_3	*Rmb* α_4	*Adjusted* R^2
Hong Kong dollar	0.000	0.994 ***	0.005 ***	0.004 **	0.002	0.998
	(0.340)	(536.921)	(3.227)	(2.156)	(0.015)	
Indian rupee	0.001	0.987 ***	0.022 ***	0.032 *	0.459	0.951
	(0.354)	(130.578)	(3.330)	(1.858)	(0.371)	
Indonesian rupiah	0.011	0.879 ***	0.188 ***	0.083	-13.295	0.314
	(0.444)	(16.920)	(3.579)	(0.674)	(-1.438)	
Korean won	-0.008	0.851 ***	0.177 ***	0.014	-1.397	0.706
	(-0.785)	(39.795)	(9.022)	(0.330)	(-0.373)	
Malaysian ringgit	0.000	1.001 ***	0.000	-0.001	-0.075	1.000
	(0.017)	(2151.299)	(-0.641)	(-1.558)	(-0.950)	
Philippine peso	0.021 *	0.920 ***	0.080 ***	0.032	-3.512	0.672
	(1.820)	(50.471)	(2.892)	(0.773)	(-0.986)	
Singapore dollar	0.001	0.723 ***	0.201 ***	0.048	1.373	0.877
	(0.252)	(60.609)	(19.024)	(1.623)	(0.806)	
New Taiwan dollar	0.000	0.934 ***	0.040 ***	-0.007	-0.226	0.890
	(-0.047)	(82.627)	(3.255)	(-0.291)	(-0.111)	
Thai baht	0.009	0.786 ***	0.178 ***	0.045	0.960	0.774
	(1.048)	(45.052)	(11.569)	(1.209)	(0.319)	

Note: t-values are in ( ). *, ** and *** indicate that coefficients are significant at the 10%, 5% and 1% levels respectively.
Sources: Bloomberg and authors' estimates.

Before the exchange rate regime reform: The estimation over the period shows that among the nine currencies, the Hong Kong dollar and Malaysian ringgit were strict dollar peggers. The weight of the coefficient on the US dollar is almost one in the equation for the two currencies, and so is the adjusted R^2. Apart from these two officially pegged to the US dollar, other Asian currencies were also heavily influenced by the US dollar. In the equation for the Indian rupee and Indonesian rupiah, the US dollar also has a coefficient close to one. The coefficient for the US dollar, α_1, is around 0.9 for the Korean Won, Philippine peso and New Taiwan dollar. The US dollar's influence on the Singapore dollar and Thai baht was slightly smaller, with a weight of around 0.7-0.8.

The Japanese yen's influence was noticeably smaller, but present in a number of cases. It did not impact on the Malaysian ringgit. In the equation for the Hong Kong dollar, α_2 is somehow statistically significant, but its magnitude is too small to exert any material impact. α_2 is significant in the other seven equations, and around 0.2 for the Indonesian rupiah, Singapore dollar and Thai baht – higher than for other Asian currencies. The euro virtually had no impact on Asian currencies.

The renminbi did not show any impact during this period with its coefficient, α_4, being statistically insignificant in all the equations.

Goodness of fit is generally reasonable for most of the equations. Apart from the two US dollar peggers with adjusted R^2 close to 1, the adjusted R^2 for other equations is mostly between 0.71-0.95. However, the equation for Indonesian rupiah has relatively low explanatory power with its adjusted R^2 being 0.31.

Table 4: Asian currencies regimes after the renminbi exchange rate reform

(22/7/2005 -- 12/02/2009)

	Constant $?_0$	*Dollar* $?_1$	*Yen* $?_2$	*Euro* $?_3$	*Rmb* $?_4$	*Adjusted* R^2
Hong Kong Dollar	0.001	0.994 ***	0.002 **	-0.003	-0.000	0.996
	(0.525)	(314.244)	(0.501)	-(0.430)	(0.020)	
India rupee	0.010	0.835 ***	0.028	0.184 ***	0.330 ***	0.673
	(0.911)	(26.673)	(0.958)	(2.664)	(2.587)	
Indonesian rupiah	-0.018	0.831 ***	0.061	0.137	0.314 **	0.485
	(1.119)	(17.903)	(1.512)	(1.422)	(2.001)	
Korean won	0.008	0.838 ***	0.068 *	0.105	0.696 ***	0.594
	(0.616)	(23.387)	(1.798)	(1.358)	(4.566)	
Malaysian ringgit	-0.016 *	0.856 ***	0.026	0.116 **	0.542 ***	0.767
	(1.782)	(39.468)	(1.230)	(2.358)	(4.755)	
Philippine peso	-0.031 **	0.836 ***	-0.009	0.076	0.355 **	0.594
	(2.479)	(26.279)	(0.260)	(1.116)	(2.294)	
Singapore dollar	-0.007	0.669 ***	0.052 ***	0.412 ***	0.270 ***	0.803
	(1.068)	(37.519)	(2.687)	(10.488)	(3.134)	
New Taiwan dollar	0.004	0.899 ***	0.036 *	0.032	0.490 ***	0.818
	(0.487)	(43.354)	(1.736)	(0.798)	(6.189)	
Thai baht	-0.014	0.783 ***	0.075 *	-0.027	0.382 *	0.446
	(0.850)	(20.038)	(1.676)	(0.309)	(1.765)	

Note: t-values are in ( ). *, ** and *** indicate that coefficients are significant at the 10%, 5% and 1% levels respectively.
Sources: Bloomberg and authors' estimates.

After the renminbi exchange rate reform: The Hong Kong dollar is the only currency whose regime has remained unchanged from before the reform period. The coefficient on the US dollar, α_1, is close to 1, and the adjusted R^2 is virtually 1. This suggests that the Hong Kong dollar has maintained a strict peg to the US dollar. The other three currencies have no impact on the Hong Kong dollar.

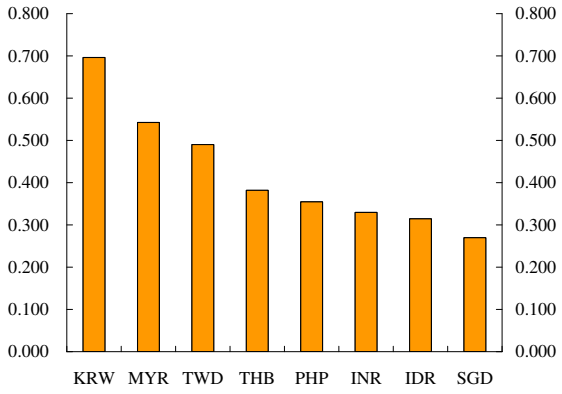
For most of the other currencies, the US dollar has continued to dominate in its impact, but its coefficient, α_1, has generally declined compared with the period before July 2005. Notably,

α_1 drops from close to 1 to 0.86 in Malaysia's case. Shortly after Mainland China announced the changes in the exchange rate regime, Malaysia also officially abandoned the dollar peg, which is captured by the decline in the US dollar weight in the estimated equation for the Malaysian ringgit.

Also markedly, the impact of the Japanese yen has diminished substantially. It only appears to carry a significant weight in Singapore's currency basket, and may have some marginal impact on the Korean won, New Taiwan dollar and Thai baht. The euro has continued to play no part in influencing movements of all Asian currencies except one – the Singapore dollar.

The distinctive change comes from the impact of the renminbi which appears to have started to play a role in regional currency movements. With the sole exception of the Hong Kong dollar, the coefficient for the renminbi, α_4, has become statistically significant in other equations, at the 5% significance level in most cases. Among the currencies, the renminbi's impact is the highest for the Korean won and Malaysia ringgit. A 1% change in the renminbi exchange rate independent of US dollar movements will lead to a corresponding 0.7% and 0.5% change in the won and ringgit respectively (Chart 7).

Chart 7: Impacts of the renminbi on regional exchange rates



Source: Authors' calculations

5. Some policy considerations

It is perhaps not unreasonable to say that the renminbi has potential to play a role in international trade and investment transactions, owing to the large size of the Chinese economy, and it has indeed started to have influence over regional currencies. The limited convertibility of the renminbi and partial opening of China's financial market are restrictive factors for the international role of the renminbi. The liberalisation of the restrictions on currency convertibility should of course obey the overall development and reform strategy, not necessarily for the purpose of promoting the international use of the renminbi, but a higher degree of currency convertibility may lead to an increased use of the renminbi in international transactions, which brings both benefits and risks.

Thus, the international role of the renminbi and the associated concerns would be part of the consideration by the authorities in determining the pace and form of attaining the capital account convertibility of the renminbi. As summarised in Table 5, the main benefits of an

international role include increased business for domestic financial institutions, reduced transaction costs and avoiding of exchange rate risks for residents in conducting international trade and investment activities, and the ability of domestic institutions to issue foreign debt in the domestic currency at the prevailing interest rates. The risks are mainly associated with the external demand for renminbi assets, which may vary significantly over time, complicating the domestic monetary policy formulation and implementation (Hai 2007).

Table 5: Benefits and Risks of the International Use of Renminbi

Benefits	**Risks**
(1) Seignorage: foreign holdings of renminbi are essentially low interest loans to China, and allow China to borrow in the international market in its own currency.	(1) Fluctuations in the international demand for the currency would complicate domestic monetary policy making by increasing exchange rate volatility under a flexible exchange rate regime and variations in the demand for money under a pegged exchange rate arrangement.
(2) Increase of business for domestic financial institutions: the international demand for renminbi assets would bring business for domestic financial institutions, which are the main sources of renminbi liquidity.	(2) Increase in the average demand of the currency. This in general will put appreciation pressure on the exchange rate, which is especially the case in an environment of strong expectations of renminbi appreciation.
(3) Avoiding exchange rate risk: the use of its own currency in international trade and finance allows domestic residents to avoid exchange rate risk.	(3) Burden of responsibility: internationalisation of renminbi would increase China's responsibility and obligations to maintain financial stability in the region, which would limit the freedom of using monetary policies for domestic objectives.
(4) Convenience and prestige: an international currency will bring convenience and prestige for domestic residents.	

Source: Authors' compilation

It is beyond the scope of this paper to provide a comprehensive analysis of the policy considerations in relation to the process of potential internationalisation of the renminbi. Drawing on the international experiences, three issues are considered here, namely the implications of an international role of the renminbi for domestic monetary policy, the relationship between currency internationalisation and domestic financial market development, and the importance of promoting regional integration and cooperation in trade and finance.

Domestic monetary policy

The implication for domestic monetary policy is often cited as the main reason for caution in promoting or facilitating an international role of the renminbi. There are two concerns. One is related to the volatility of the international demand for the renminbi which complicates the central bank's task in assessing monetary conditions and pursuing domestic

monetary stability objectives. Furthermore, considering the general market expectation of renminbi appreciation, an increase in the access of international investors to renminbi assets could lead to a trend of increasing demand for the currency, exacerbating the appreciation pressure on the currency. However, there is potentially an offsetting force. As renminbi becomes increasingly convertible, domestic investors may move part of their assets out of China for diversification purposes.

In this respect, it is interesting to look at the experiences of Japan and Germany. Before the mid-1970s, the Japanese monetary authorities attempted to discourage the international use of the yen out of concern that extensive foreign holdings of their currency would reduce their degree of control over money supply and increase the variability of the exchange rate (Tavlas and Ozeki 1992). Similarly, between the late 1960s and early 1980s, the Bundesbank attempted to limit the international use of the deutsche mark for fear that substantial swings in capital flows could interfere with domestic stabilisation (Tavlas 1991; Thimann 2007). The measures that the Bundesbank took were to control the capital inflows, such as restrictions over the issue of Deutsche mark obligations in the external bond market and international money market. Indeed, it is argued that the non-internationalisation policies pursued by the German and Japanese authorities partly explain the persistence of the dominant US dollar position despite the increased importance of Japan and Germany in the world economy (Eichengreen 2005).

In China's case, the limited variation in the renminbi's exchange rate against the US dollar and the early stage of the development of the financial market are probably the main factors that explain the concern on the potential destabilising effect of the external demand for the renminbi on domestic monetary conditions. However, the increasing exchange rate flexibility and the progress of interest rate deregulation and financial sector development and reform should help increase the domestic economy's resilience to external shocks over time.

Financial market development

This leads to the issue of the relationship between financial market development and an international role of the renminbi. In general, a large and developed financial market increases the capacity of the domestic economy in buffering against shocks arising from the varying external demand for the domestic currency. Thus, limitations in the domestic market are often taken as a risk factor in capital account opening and international use of the domestic currency. On the other hand, an increasing use of the domestic currency for conducting international trade and investment activities would increase the depth and breadth of the financial market by drawing more market participants and increasing linkages with the international market. In considering the balance of pros and cons of an international currency, one should not only focus on the risk to the domestic financial market and understate the potential benefits.

Also, as the size of the financial market increases, the influence of the financial sector on policy making would rise, with pressures for liberalisation measures to improve efficiency, including opening to the international market. After all, it is the financial sector that would benefit most from an international role of the domestic currency.

The experiences of Germany and Japan are again enlightening in this respect. In Japan, the large government budget deficits contributed to a rapid growth of the primary and secondary

bond markets in the 1970s, which led to pressures from the financial community for improvement in the efficiency in the financial market. Beginning in the late 1970s, financial liberalisation measures were implemented, leading to development of new instruments and deregulated interest rates. In May 1984, a new phase began with the release of a report by the Yen-Dollar Committee and an accompanying report by the Ministry of Finance entitled "Current Status and Future Prospects for the liberalisation of Financial and Capital Markets and the Internalisation of the Yen". These two documents noted the importance of financial liberalisation and internationalisation of the yen to the Japanese economy, and proposed reform measures to liberalise the international transaction of yen. The process of Deutsche mark internationalisation was similar. By the mid-1980s, the Bundesbank's position had changed substantially, partly because German financial markets had developed markedly and were better insulated from external disturbances. It acknowledged the difficulty of inhibiting the operation of market forces underlying the demand for assets denominated in the Deutsche mark. Consequently, most restrictions on the issuance of foreign Deutsche mark bonds were lifted.

China's financial market has been growing rapidly in recent years, accompanied by significant progress of the financial sector reform including the listing of the major commercial banks. The stock market capitalisation, albeit affected by market volatility, almost doubled within between 2004 and 2008. In 2007, the A-share market was among the largest IPO fund raising centres in the world before the financial crisis led to a sharp contraction in IPO activities in 2008 across the globe. The share redesignation reform has been largely completed, removing the previous concern on the overhang of the state holdings of non-tradable shares and improving corporate governance by better aligning the interests of majority and minority share holders. Helped by strong economic growth and abundant liquidity, the bond market has also seen strong growth, particularly in short-term commercial papers. By the end of 2008, the total outstanding amount of bonds reached 50% of GDP. The authorities have released this year new and much liberalised regulations on the issuing of corporate bonds, paving the way for rapid growth of the corporate bond market.

In the process of financial market development and liberalisation, China has a unique advantage when compared with other economies. Under the "one country, two systems" arrangement, China has Hong Kong, a developed and highly open international financial centre. Hong Kong is in an ideal position to develop a renminbi market outside the Mainland, which provides a testing ground for the international use of the renminbi. This can be achieved by expanding the scope of the renminbi business in Hong Kong in terms of participants, products and services. There is also an increasing recognition of the need to strengthen market linkages between Hong Kong and the Mainland. Recent initiatives include expanded scope for the qualified domestic institutional investors (QDII) scheme and the announced pilot scheme of allowing Mainland investors to invest directly in Hong Kong listed securities. There are discussions of arrangements under which Hong Kong listed instruments can be traded on the Mainland market and even talks of listing and trading renminbi denominated shares in the Hong Kong Stock Exchange. Preparation is under way for launching a pilot scheme for trade between Hong Kong and selected Mainland regions to be settled in the renminbi. All these will foster the integration of the two markets over time, and a larger and more liquid financial market of China would provide a solid base for the renminbi to play an international role. Already, combing the Hong Kong and Mainland stock markets, the total capitalisation exceeds that of Japan and is the largest in Asia.

Regional integration and cooperation

Finally, it is important to promote financial integration and cooperation in the region, as an international role of the renminbi starts with the use of the currency for conducting trade and investment activities in the Asian region (Yu and Gao 2007), Wu 2007). If the emergence of the euro can be considered as an extension of the internationalisation of the Deutsche mark, the mark internationalisation is clearly more successful than the Japanese yen. This is in no small part owing to the cooperative arrangement within Europe. The stable value of the mark and the relatively large size of the economy had led to the use of the mark as the currency peg in the EMS before the euro was launched. In contrast, the yen experienced large swings in its exchange rate against the US dollar in the past decades while most of the Asian currencies maintained some form of a link to the US dollar, leading to stabilising effects on the Asian economies and hurting the regional use of the yen.

China has extensive trade and investment with the regional economies (Table 6). Financial integration and cooperation on arrangements that may prevent large swings in the exchange rates among the Asian currencies are beneficial to all economies in the region. The exchange rates of most Asian currencies have become more flexible against the US dollar. Indeed, following the renminbi exchange rate reform in July 2005, there are signs that the renminbi has had an increasing influence on the exchange rates of the other Asian currencies (Shu et al 2007). As the renminbi's exchange rate becomes more flexible and China's economic links with the region grow further over time, there would be increasing need to strengthen the regional cooperation in trade and financial issues.

Table 6: Trade Linkages in the Asian Region
(in percent, as of 2007)

	China	Japan	South Korea	ASEAN	Hong Kong	Group Total
Mainland China		10.9	7.4	9.3	9.1	36.6
Japan	18.0		6.2	13.2	3.1	40.4
South Korea	19.9	11.3		9.9	2.9	44.0
ASEAN	10.6	10.8	4.3		4.3	30.0
Hong Kong SAR	47.5	7.3	3.1	9.5		67.5

Sources: IMF Direction of Trade Statistics, authors' calculations.

Note: The recording economies are in the first column. For example, the numbers in the first row are the shares of trade with other Asian economies in China's total trade as recorded by China.

6. Concluding remarks

This paper assesses the potential significance of the renminbi as an international currency by drawing on the experiences of the other major currencies. Built on the study of Chinn and Frankel (2005), we first estimate an empirical relationship between currency shares of reserve holdings and main determinants such as the economic size of the issuing country using data on five major reserve currencies. The empirical result shows that the size of the economy including market development and persistence and network- externality effects are the key determinants for a currency's share in the world reserves in our sample. Using the empirical

relationship, a simulation is conducted to gauge the potential share of the renminbi in the total world reserves if it were to become fully convertible today. According to the linear model, the renminbi's share in the total world reserves would be 10%. According to the non-linear model, the renminbi's share would be 3%. These results suggest that at present the renminbi's potential as a reserve currency would be comparable to that of the Japanese yen and British pound. Also we showed, using a modified framework of Frankel and Wei (1994) that the renminbi has started to play a role in affecting regional currency movements.

Whether the renminbi realises its potential as an international currency that is in line with the size of the Chinese economy will be a market choice. Government policies in financial liberalisation and currency convertibility could facilitate or inhibit the process. In this respect, the authorities need to weigh the benefits and risks associated with an international role of the renminbi in policy formulation and implementation. As the size of the economy and financial market increases and the monetary policy framework including exchange rate flexibility becomes more firmly established, the benefits should increasingly dominate costs. Overall, the international role of the renminbi and the associated benefits and costs should be part of policy considerations on the pace and form of attaining capital account convertibility for the currency.

Hong Kong, being an international financial centre, can play a significant role in the development and opening up of the Mainland financial market. Indeed, the renminbi business in Hong Kong provides a useful testing ground for the expanded use of the renminbi in the region. In the long run, an integrated and much larger financial market that includes both the Mainland and Hong Kong markets would help to promote the international role of the renminbi.

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Appendix:

Chart A1: Reserve currency share vs. exchange rate volatility

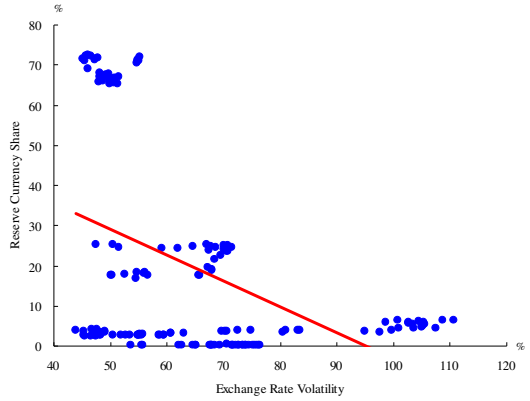


Chart A2: Logistic transformation of reserve currency share vs. exchange rate volatility

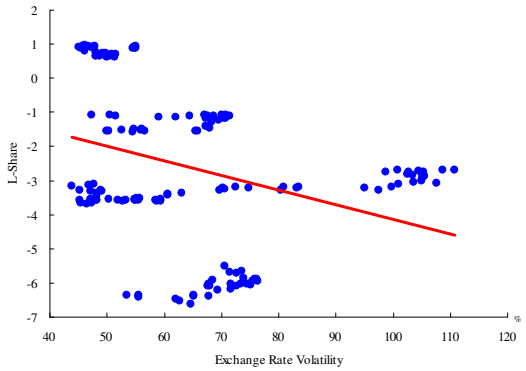


Chart A3: Reserve currency share vs. inflation differential

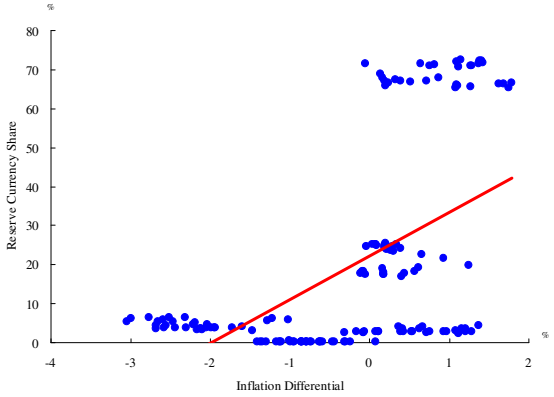


Chart A4: Logistic transformation of reserve currency share vs. inflation differential

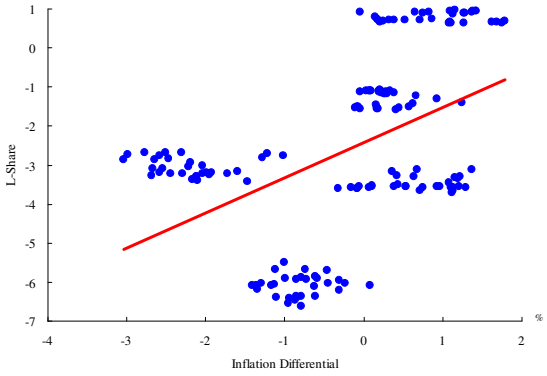


Chart A5: Reserve currency share vs. trade share

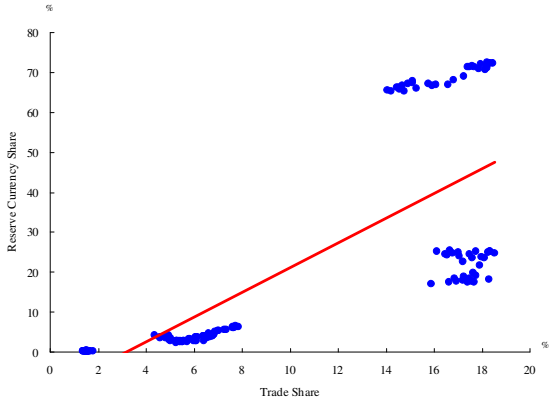
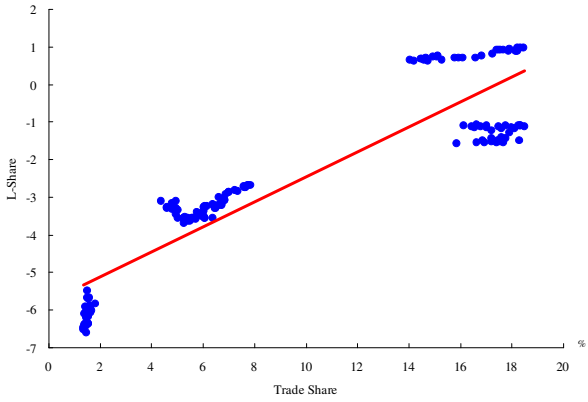


Chart A6: Logistic transformation of reserve currency share vs. trade share



Source: Authors' calculations for Chart A1-6.