Exchange Rate Policy in China after the Financial Crisis: Estimation of the Time-Varying Exchange Rate Basket

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February 2014

Abstract

We analyze the recent period of a relatively flexible exchange rate regime of the renminbi after June 2010. We estimate a time varying structure of a hypothetical currency basket using the Kalman filter. The currency weights of selected currencies are modeled as stochastic processes (random walks). We show that the exchange rate policy continues to focus on the US dollar also recently. However, we observe a declining weight attached to the USD. In turn, the euro possibly played some role before summer 2011, yet its weight approached zero and became negligible after the deepening of the debt crisis.

Keywords: Exchange rate regime, Kalman filter, financial crisis.

JEL Classifications: E58, F33, C32.

1 Introduction

China, which introduced unprecedented reforms in 1980s, today boasts an extensive modern industrial economy with booming urban regions. Nearly a quarter of the population now lives in cities with income per capita that resembles that of certain OECD countries. In particular, in China's richest 25 metropolitan areas GDP per capita is on average equivalent, in PPP terms, to Portugal's value (OECD, 2013). During the last decade the country's high trade growth has been supported by expanding exports (Bussière et al., 2008) and large foreign direct investment (FDI) flows (Eichengreen & Tong, 2005).

Not surprisingly, growth in the world's most populous country has changed the distribution of economic activities across the world. According to the International Monetary Fund (IMF), the share of Chinese GDP in the world economy, valued at purchasing-power-adjusted prices, nearly doubled from 7.5% as of 2001 to 14.3% in 2011 (see Figure 2a). This remarkable economic development is accompanied by financial sector reforms and growing competition among domestic companies. Despite a global slowdown, China's economy has continued to expand rapidly in recent years. The economy grew at an average rate of more than 9% per year between 2008 and 2011. The World Bank expects China to become a high-income economy and the world's largest economy as well before 2030 (World Bank, 2013).

In contrast to the majority of central banks in advanced economies, the People's Bank of China (PBC) does not use only the standard instruments of monetary policy. The use of multiple instruments should support the PBC monetary policy, which pursues multiple objectives –– price stability, economic growth and exchange rate stability (Sun, 2013). Correspondingly, China unified its exchange rates in 1994 and established full current account convertibility in 1996. Since then, the stable exchange rate has been used to anchor inflation expectations as well as to smooth real economic growth (see e.g. McKinnon and Schnabel, 2012; Nair and Sinnakkannu, 2010).

After more than a decade of pegging the renminbi (RMB) to the US dollar (USD)

at an exchange rate of RMB 8.28 per 1 USD, the PBC announced a revaluation of its currency and a reform of the exchange rate regime on 21 July, 2005. The main part of the exchange rate reform was, according to the announcement of the PBC, the introduction of a peg to a basket of currencies with secret weights and with narrow fluctuation bands of $\pm$ 0.3% on daily changes against the USD and $\pm$ 1.5% on daily changes against the Japanese yen (JPY) and the euro (EUR). After the outbreak of the US sub-prime crisis in August 2008, the PBC again pegged the RMB to the USD.

Prior to the exchange rate reform in 2005, the US administration demanded a significant appreciation of the RMB against the USD of roughly around 20%. Moreover, various models of equilibrium exchange rates implied an undervaluation of the RMB against the USD between 15% and 35% (Goldstein, 2004; Frankel, 2004; Nair & Sinnakkannu, 2010). Actually, the RMB appreciated against the USD by around 20% in nominal terms between July 2005 and July 2008. Thus, the size of nominal appreciation corresponded largely to the devaluation demands voiced by US economic policy makers as well as by academic research, while the distribution of this adjustment over a period of three years allowed for a smooth adjustment of Chinese exporters.

This first period of a managed floating exchange rate regime from 2005 to 2008 is analyzed in several papers (Frankel, 2006; Funke & Gronwald, 2008; Fidrmuc, 2010; Tian & Chen, 2013). The empirical evidence supported the international markets' rather skeptical view, as they believed that the old policy would be continued under the new regime. However, empirical research also provided several arguments in favour of a managed floating regime. In addition to the implication for the trade between China and the USA, the discussion points out that the RMB peg to the USD results in a stabilization of the RMB against a much broader set of currencies. This has important implications for inter-regional trade in Asia and for the dollar-based financial and commodity markets beyond Asia. Following McKinnon & Schnabl (2012) this broader effect of a "dollar-peg" is based on the facts that trade in East

Asia is invoiced in USD and that the USD remains the dominant means of settling international payments.

Moreover, deviations between *de facto* and *de jure* exchange rate regimes are in general widespread across countries (Reinhart & Rogoff, 2002, 2004). In particular, pursuing a more rigid exchange rate policy than announced corresponds to the so-called fear-of-floating phenomenon (Calvo & Reinhart, 2002). In this vein, McKinnon (2006), McKinnon & Schnabl (2008), and McKinnon & Schnabl (2009) discuss various arguments for maintaining some degree of exchange rate stability in China, which include for example carry trades.

The PBC announced a return to the managed floating exchange rate policy on 19 June, 2010. Moreover, the PBC widened the floating bands of the RMB against the USD in the inter-bank spot foreign exchange market from 0.5 percent to 1 percent on 16 April, 2012. This signaled a move towards a more market-determined exchange rate regime which has been accompanied by non-growing foreign exchange reserves (OECD, 2013) and more moderate expectations by the market compared to the first period of managed floating. Most recently, the difference between the spot rate and the non-deliverable forwards is rather negligible, whereas it achieved considerable values during the first period of managed floating of 2005 to 2008 (see Figure 2b). This finding is supported by the fact that foreign exchange reserves[1] are also stable, which indicates that there are no net interventions in the foreign exchange market. The stability of these indicators implies, that the exchange rate could be closer to its equilibrium level than between 2005 and 2008.

Compared to the first period of a managed floating exchange rate regime from July 2005 to August 2008, the second period which started in June 2010 has received much less academic attention so far. IMF (2012) classifies China's exchange rate arrangement as a crawl-like arrangement where a monetary aggregate is targeted which basically serves as an exchange rate anchor to the USD. Wang & Xie (2013)

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[1] This reflects the hypothesis laid out by Calvo & Reinhart (2002), who argue that the variance of reserves should be zero in a pure float.

find that the secret currency basket is arranged with the USD as the most important currency followed in decreasing order by the EUR, the JPY, and the Korean won (KRW).

We use the methodology proposed by Fidrmuc (2010) and estimate the importance of selected international currencies for the RMB exchange rate. We show that the second and most recent period of exchange rate reforms shows many similarities to the first but also many differences.

First, the recent exchange rate of the RMB exhibits lesser regularities than during the period from 2005 to 2008. Second, we confirm the dominance of the USD also during this second period of managed floating. We observe a declining weight attached to the USD over the whole period. We observe slight evidence that the EUR was used as exchange rate target in the beginning of the second period of managed floating, but its weight approached zero after the deepening of the debt crisis in the European Monetary Union. However, the increasing weight of the USD during the mid of 2012 can be possibly attributed to the development of the EUR.

Hence, this study contributes to the discussion regarding China's managed floating exchange rate regime and sheds some light on the most recent composition of the secret basket of currencies used by the PBC. It contributes to our understanding of how far China's exchange rate policy has changed in the aftermath of the latest policy announcements and the financial crisis.

The remainder of the paper is structured as follows. The next section emphasizes the Chinese exchange rate policy. Section 3 describes empirical methods for the estimation of time-varying exchange rate baskets. Section 4 describes the data and identifies relevant sub-periods for our estimations. Section 5 reports the results using a (rolling) ordinary least squares regression. Section 6 reports the results using time-varying coefficients based on the Kalman filter. The last section concludes the paper and offers some policy recommendation.

2 Chinese Exchange Rate Policy

Corresponding to the rising importance of the Chinese economy and its increasing trade integration with other economies, China's economic developments and policy measures are of great and increasing consequence not only for itself but also for its trading partners. Exchange rate regimes and the levels of the exchange rates belong to one of the most controversial issues in the world economy today. The analysis of China's exchange rate regime takes an important and ongoing place in the political discussion and was particularly hotly debated during the last presidential elections in the USA. Korhonen & Ritola (2009), for example, found 29 academic papers dealing with the misalignment (over-valuation) of the exchange rate of the RMB.

Given China's position in the global supply chain, Thorbecke & Smith (2010) argue that it is naive to believe that a RMB appreciation as a stand alone measure could overcome global imbalances. The question whether an appreciation of the RMB against the USD can also correct trade imbalances between the two countries is theoretically addressed by McKinnon & Schnabl (2009), McKinnon & Schnabl (2012), and Qiao (2007) as well as empirically by Zhang & Sato (2012). Theoretically, in a world of globalized finance, a reduction of China's trade balance due to an appreciating RMB is doubtful. McKinnon & Schnabl (2009, 2012) argue that an appreciating RMB would turn China into a higher cost country, thereby forcing globally oriented firms to invest elsewhere. As a result, China's saving-investment balance and trade surplus could increase rather than decrease. Qiao (2007) finds that a currency depreciation in an open economy does not necessarily improve its trade balance. Applying the theoretical considerations of Qiao (2007) to China, by taking into account characteristics of creditor countries, these findings hold in particular. Empirically, the dynamic effect of the bilateral exchange rate of China and the US on China's trade balance is very limited (Zhang & Sato, 2012). Despite the RMB appreciation in nominal terms against the USD between 2005 and 2008 the bilateral trade balance between the rwo countries increased.

Nair & Sinnakkannu (2010) find that between July 2005 and June 2009 a period

of an appreciating RMB against the USD has not altered China's international trade competitiveness. On the other hand, Thorbecke & Smith (2010) find that a 10% unilateral appreciation of the RMB against the currencies of those countries buying Chinese final exports would diminish manufacturing exports by almost 12%. With respect to growth, Rodrik (2008) reports estimates which imply that a 10% real appreciation would reduce growth in China by 0.86 percentage points (Rodrik, 2010).

3   Estimation of the Implicit Currency Basket

Although the structure of the possible currency basket is kept secret, the implicit weights can be estimated on the base of actual exchange rate developments of the RMB against the list of potential target currencies.[2] Originally this approach was proposed by Frankel & Wei (2007, 2008) and then followed in the literature. As long as the exchange rates are generally believed to follow a random walk (Meese & Rogoff, 1983), a simple estimation of the relationship between the currencies would likely be subject to the spurious regression problem. This is especially important for rolling or sub-sample (e.g. for each month) regressions with a relatively low number of observations. Therefore, the estimation of the exchange rate basket of the RMB is stated in first differences,

$$\Delta e_{rmb/cur,t} = \beta_1 + \beta_2 \Delta e_{usd/cur,t} + \beta_3 \Delta e_{eur/cur,t} + \beta_4 \Delta e_{jpy/cur,t} + \epsilon_t \qquad (1)$$

where Δe is the first difference of the natural logarithm of the bilateral exchange rates of the RMB and selected currencies against a base currency which is denoted by *cur* and β_1 is a constant to allow for the likelihood of a trend appreciation.

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[2] During the first period of flexible exchange rates in China, *de jure* exchange rate policy was designed as a peg to a secret basket of selected international currencies which are supposed to remain more or less the same also during the current period (PBC, 2010). According to the PBC, the secret basket for the Chinese exchange rate policy may include the US dollar (USD), the Japanese yen (JPY), and the euro (EUR). Other currencies, namely those of Australia (AUD), Canada (CAD), Great Britain (GBP), Malaysia (MYR), Russia (RUB), Singapore (SQD), South Korea (KRW), and Thailand (THB), were also announced to play some role, however this has not been confirmed by previous research (Fidrmuc, 2010).

In general, the previous analyses concluded that only the USD, and to a much lesser extent the EUR, had significant informative value for the development of the exchange rate of the RMB.

Although equation (1) should be appropriate for the estimation of the currency basket, it is also subject to possible drawbacks, which were ignored in the previous literature. First, the relationship has to be estimated over some time period, while the weights may be subject to frequent or even continuous changes. Therefore, the majority of studies estimate rolling regressions usually using a comparatively short window. However, this often results in a relatively low number of observations despite the use of daily data. Moreover, the structural changes are then artificially smoothed and they cannot be clearly attributed to a specific date. This can then result in higher and correlated errors from the regression. Funke & Gronwald (2008) show that the ARCH test rejects the null of no autoregressive conditional heteroskedastivity of the error term in the OLS regression of equation (1). In addition, the estimation of equation (1) is based on differenced data, while actual exchange rate policy is likely to consider the level of the exchange rate. This is especially important, since the exchange rate of the RMB is announced to move within a narrow fluctuation interval. For less important currencies, fluctuation bands of 1.0% may be sufficient to make the estimates fuzzy.

We address both points of criticism. First, we reflect the possibility that coefficients are changing gradually by an alternative methodology of estimation. Following Harvey (1989) and Ogawa & Sakane (2006), the estimated structure of the currency basket with time varying weights is estimated by the Kalman filter. Second, we use data in levels to see whether non-differenced time series are more informative regarding the changes of an implicit exchange rate policy. In this specification, we do not take logs of exchange rates, therefore they are denoted by E. The estimation

equation can be stated as

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\begin{aligned}
E_{rmb/cur,t} &= \alpha + \omega_{usd/cur,t} E_{usd/cur,t} + \omega_{eur/cur,t} E_{eur/cur,t} \\
&\quad + \omega_{jpy/cur,t} E_{jpy/cur,t} + \epsilon_t
\end{aligned} \tag{2}
$$

where α is the intercept and the remaining parameters are estimated as time varying parameter processes which follow a random walk

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\omega_{i,t} = \omega_{i,t-1} + \eta_{i,t} \tag{3}
$$

$$
\text{where } i = usd/cur, eur/cur, jpy/cur.
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As the analysis of the first period of flexible exchange rate showed that only the main currencies were actually used for the determination of the exchange rate, we include solely the USD, the EUR and the JPY in our analysis.

4   Data Description

We have daily exchange rate data between January 1996 and June 2013 of selected currencies, namely USD, JPY, and EUR. Given the PBC's communication, earlier literature and our preliminary analysis on the remaining currencies show that additional currencies are not informative for the development of the exchange rate of the RMB. In the empirical part, we concentrate on the second period of managed floating characterized by relatively variable (appreciating) exchange rates between June 2010 and June 2013. The data are according to Bloomberg. Exchange rate data relate to trading days of the New York Stock Exchange but result from 24/7 over-the-counter quotes from market contributors. Hence, given the simultaneity of our data, different time zones related to different geographical locations of stock exchanges have not to be taken into consideration.

We select the Australian dollar as a reference currency following the argument of Calvo & Reinhart (2002), as it is considered to be a typical free floating currency of a relatively small country. We are aware that the Australian dollar is included

in the list of the target currencies published by the PBC. Given that the previous analyses did not find any significant *de facto* weight for this currency, we believe that the possible bias is negligible. Nonetheless, to illustrate that our results are not selective to the choice of a reference currency, we also use daily exchange rate data of the Swedish krona (SEK) as base currency. We do not consider the Swiss franc (CHF), which was recommended by Funke & Gronwald (2008), because the Swiss Central Bank has tried to avoid excessive appreciation of the CHF against the EUR and has even set appreciation limits recently, which could bias the results for the euro.

Relevant sub-periods are drawn from the development of the RMB against the USD. Figure 2c shows that there are two periods where the change in the exchange rate of the RMB against the USD is obviously different from zero. Table 2 confirms that the change in the exchange rate of the RMB against the USD from July 2005 to June 2008 and from June 2010 to June 2013 is statistically significantly different from zero. Changes of the RMB against the JPY and the EUR over time as well as during the sub-periods are not significantly different from zero.

For reliable statistical inference in the following empirical analysis it is necessary to check whether the time series under consideration are stationary or not. Given our methodology, all time series under consideration ought to be integrated of order one, I(1). Applying both augmented Dickey-Fuller and Phillips-Perron tests with various specifications, we have robust evidence that all time series are non-stationary in levels but stationary in first differences of the natural logarithm.

5   OLS Estimation in First Differences

Following Frankel & Wei (2007, 2008), we start our analysis with the OLS estimation stated in equation (1). We use 2010 as base year to index the time series and transform our time series by taking the first differences of the natural logarithms. We compare the results for the whole period available which is from January 1996 to June 2013 with several subperiods (see Table 3). Subperiods are determined by relevant policy decions and thus reflect the dollar-peg until 2005, the first period of

managed floating, the re-peg against the dollar between 2008 and 2010, the complete second period of managed floating, and the second period of managed floating with an extended trading band. At first glance, the OLS performs very well for all periods, as can be seen from high test *t-statistics* and R^2. However, the residual statistics reveal more problems over the whole sample and in almost all subperiods. The residuals show significant serial correlation in all specifications (see Durbin-Watson statistic) and the null hypothesis of no autoregressive conditional heteroskedasticity can be rejected for all specifications. The relatively good residuals for the most recent subperiod is an exception rather than a rule.

Table 3 shows that the coefficient of the USD fluctuates around 1 in all periods. Thus, its role remains comparably high and is, in particular, surprisingly high in the period of interest, namely the second period of managed floating from June 2010 to June 2013. The coefficient was particularly high during the peg period against the USD during the financial crisis from July 2008 to June 2010, but it becomes even higher than 1 in the most recent period of extended fluctuation bands. Surprisingly, the JPY is significant at a 10%-level in the whole sample yet it has no significance in any particular subperiod. The EUR is significant at a 10%-level (but negative) during the period when the RMB was pegged against USD until July 2005. The intercept term is positive and highly significant during the periods of managed floating (except the most recent period, however). This might reflect a general appreciation trend which is not captured by the individual currencies.

However, the results for the second period of managed floating are rather surprising. Even though the visual inspection of the bilateral exchange rate between China and the US (see Figure 2c) reveals that there was a return to the *de facto* regime of managed floating, this is not clearly confirmed in the corresponding regression. The coefficient of the USD is higher compared to the initial period of a *de facto* exchange rate peg from January 1996 to July 2005. Hence, the standard methodology based on differenced data fails to reveal policy changes accurately, because it puts too much weight on relatively negligible fluctuations of the exchange rate around

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the new implicit target.

Next we estimate a rolling OLS regression with a window size of 100 trading days (see Figure A1). First-order serially correlated residuals are less problematic than before, nonetheless autoregressive conditional heteroskedasticity remains an issue plus we face an extremely reduced number of observations. In general, the rolling OLS regression confirms the comparably high role of the USD, yet it fails to precisely describe the changes made in Chinese exchange rate policy. A high weigth of the USD and short periods in which the JPY as well as the EUR temporarily gained some weight are the most obvious findings. Both the EUR as well as the JPY move with some minor exceptions in narrow confidence intervalls and do not move in one clear dierction away from their weight of zero over the whole sample period. The JPY seems to have played a stronger role when the first period of managed floating was initiated. The euro had some weight at the very end of the first period of managed floating. However, Frankel (2009) for example presents contrary findings to ours regarding the EUR in which the EUR has played some role in the second half of 2008. Hence, the use of small windows to allow for some time variation fails to reveal policy changes accurately as well.

The robustness analysis, using the SEK as base currency, reveals almost equal findings. The OLS estimation shows quite similar coefficients as well as significance for the USD and the constant. The JPY and the EUR are both statistcally insignificant across all periods with one exception; which is the JPY during the period of the first USD peg. The period of the first peg against the USD as well as the whole sample period are not unrestrictedly comparable to the OLS estimations using the AUD as base currency since data availability differs.

Also the rolling regression using the SEK as base currency shows results similar to the baseline rolling regression. A common characteristic of both rolling regressions is that for all three major currencies confidence intervalls significantly increased in the second quarter of 2007 which might be attributed to an initial shock due to the onset of the sub-prime crisis.

6 Time-Varying Approach in Levels

So far, the estimation of the implicit currency basket has provided rather mixed results. On the one hand, we can see that the exchange rate policy was oriented mainly towards the USD, also during the relatively flexible periods between July 2005 and July 2008 as well as between June 2010 and June 2013. On the other hand, we get surprising results since the USD most recently shows a higher coefficient than it has shown during the period of a *de facto* exchange rate peg between January 1996 and July 2005.

We address this issue by estimating the implicit currency weights by the Kalman filter in levels using the methodology proposed by Fidrmuc (2010). We focus on the period of interest, which is the most recent regime of managed floating from 19 June, 2010 until today. During this period the development (appreciation) of the RMB against the USD was much more gradual compared to our two other employed major currencies (see Figure 2d). The Kalman filter is appropriate for the estimation of the relationship between integrated variables. Therefore, we estimate equation (2) with time varying coefficients using the Kalman filter (see Table 1 and Figure 1). We start with a simple specification for the USD as the single explanatory currency of the RMB's exchange rate. The results for the USD are highly robust. The development pattern of estimated coefficients corresponds closely to the announced policy changes. The coefficient of the USD starts to fluctuate in June 2010, departing from a value of 1 implied by the peg prior to the policy change. This specification shows that the weight of the USD stabilized again starting around mid 2011, increased in summer 2012 and dropped after summer 2012 which may correspond to the presidential election in the US that were taking place at that time. However, the trend of appreciation continued at the end of 2012.

Next we include the euro into equation (2). The estimated parameter for the USD remains robust, but the confidence bands expand if the euro is included. It is interesting to note that this specification shows a stabilization of the weight of the USD, but its increase in the summer of 2012 is less pronounced. This may

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indicate that RMB appreciation against the USD was caused by the development of EUR and possibly other currencies as well. Moreover, we can see that the estimated implicit weights for the EUR decrease over the sample period and the weight is not significantly different from zero. The deepening of the sovereign debt crisis in the EMU and increasing uncertainties regarding the future of the common currency are mirrored in declining coefficients for the euro, which converges to zero at the time when the sovereign debt crisis peaked in the summer of 2011. From these two specifications we find weak evidence that with the declining role of the EUR, the USD regained some weight and vice versa that the EUR might have played some role due to the presidential elections in the US. Next we add the JPY to our analysis. Adding the JPY to the USD, the results do not alter previous findings or add any relevant insights to our analysis, respectively. Combining all three major currencies, the estimated implicit weights of the USD and the EUR hardly change but the yen again does not play any role.

Figure 1: Time-varying weights estimated in levels, June 2010 to June 2013
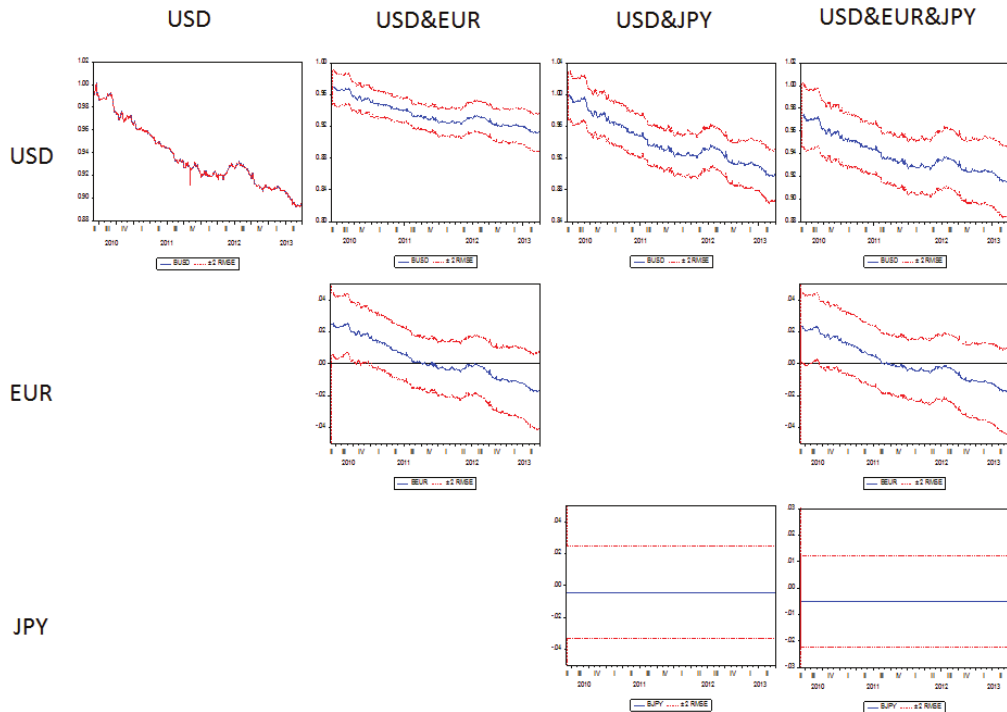
The various information criteria favor the specification with the USD and the EUR. Notably, the confidence intervals of the USD coefficient expand if we include other international currencies. Despite this, the path of a declining but still dominant weight of the USD remains nearly unchanged, while the EUR might have played some role before the deepening of the currency bloc's debt crisis. There is no weight attached to the coefficient of the JPY.

Table 1: Time-varying weights (final states estimates) estimated in Levels

	USD	USD&EUR	USD&JPY	USD&EUR&JPY
USD	0.894***	0.913***	0.898***	0.916***
	(625.698)	(74.373)	(54.008)	(56.996)
EUR		-0.017		-0.017
		(-1.413)		(-1.255)
JPY			-0.004	-0.005
			(-0.295)	(-0.597)
Constant	1.273	1.104	1.306	1.359
	(1.552)	(1.431)	(0.588)	(1.369)
LL	333.052	427.110	195.005	404.996
AIC	-0.826	-1.058	-0.479	-1.000
SIC	-0.814	-1.040	-0.461	-0.977
No of obs.	802	802	802	802

*,**,*** denote significance at the 10, 5, and 1% level, respectively.
Note: Z-statistics are in parentheses.

To check whether our results are selective to the choice of the reference currency, we run a robustness analysis with the Swedish krona (SEK) as reference currency (see Table B2 and Figure B3). The analysis reveals an almost similar pattern for the USD and EUR, therefore confirming our results. Again, the JPY does not play any role. The estimation including all three major currencies does not converge. The main difference between the baseline analysis and the robustness analysis is that the EUR is statistically significant and takes on a negative sign. This finding might be attributed to the relationship between the EUR and the SEK.

7 Conclusion and Policy Recommendation

Economic policy announcements often differ from perceived *de facto* policy. There are numerous examples among developed and developing countries or emerging

economies. The Chinese exchange rate policy belongs to the cases which attract significant attention in economic research and policy. The political discussion is mainly driven by the US due to its trade deficit, but also because of the rising importance of global imbalances in the aftermath of the financial crisis. Since June 2010, the exchange rate of the RMB has been declared to follow a managed floating regime after being re-pegged to the USD with the onset of the US sub-prime crisis. This reform was met internationally with a high degree of skepticism due to the experience of a rather insufficient exchange rate liberalization between 2005 and 2008. We analyze this second regime of managed floating after the financial crisis. Indeed, we confirm again the dominant role of the USD also during the recent period, however we observe a declining weight attached to the USD over the whole period and, in particular, most recently. A short window of increasing weight attached to the USD can possibly be attributed to the declining role of the EUR at that time. In turn, the EUR might have played some role at the beginning of the recent period of managed floating or before the peak of the European debt crisis, respectively, and possibly also during the presidential election in the US in 2012. The JPY does not play any significant role in any specifications.

Although a stabilizing role to the world economy, in particular to East Asian economies, can be attributed to the PBC's exchange rate policy (McKinnon & Schnabl, 2012), further reforms are expected. It is a reasonable assumption that a pick-up in Chinese consumption could correct imbalances in the Chinese trade surplus. Noteworthy that an undervalued currency has the disadvantage of imposing a domestic tax on consumption.

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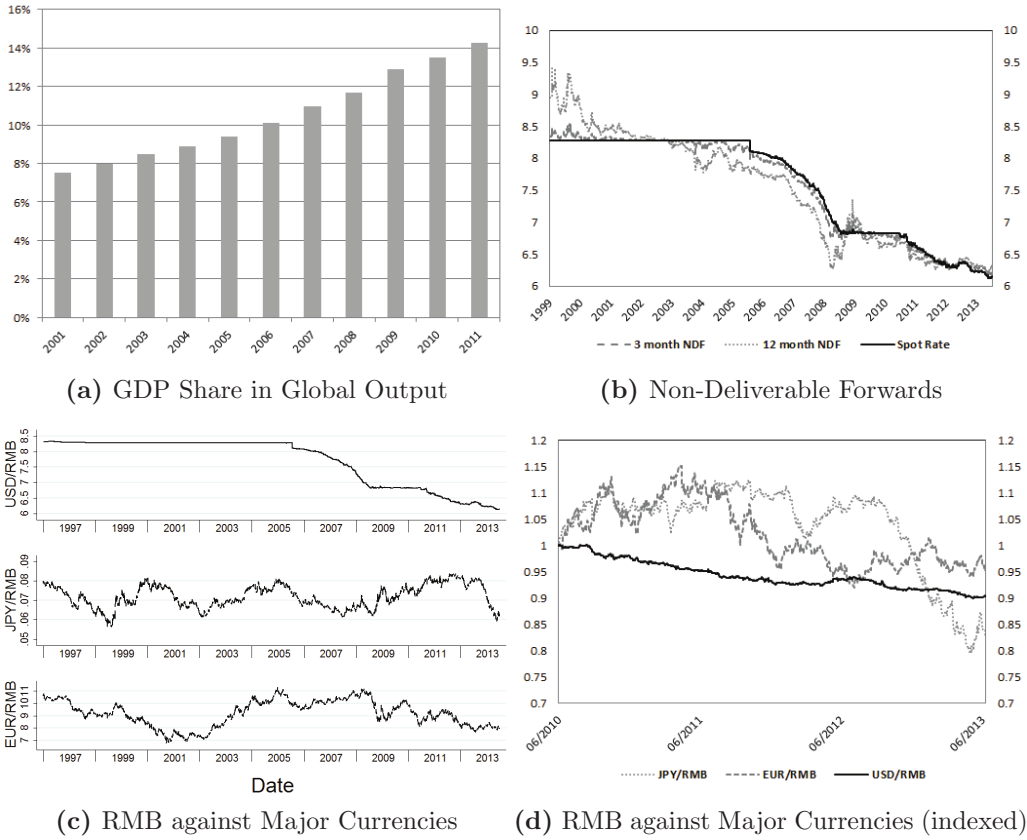
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Figure 2: Stylized Facts on the Chinese Economy and RMB

(a) GDP Share in Global Output

(b) Non-Deliverable Forwards

(c) RMB against Major Currencies

(d) RMB against Major Currencies (indexed)

Note:

(a) Domestic Product based on Purchasing-Power-Parity (PPP) Share of World Total from 2001 until 2011

(b) Prices of Non-Deliverable Forwards (NDFs) and Spot Price from 1999 until June 2013

(c) Exchange Rate of the Renminbi against the US Dollar, the Japanese Yen, and the Euro, from January 1996 to June 2013

(d) Value of the RMB in terms of other major currencies: second period of managed floating; Per RMB (June 21, 2010 = 1)

Sources: IMF, Bloomberg.

Table 2: Descriptive statistics of the RMB, January 1996 to June 2013

		01/96-06/13 (Total Sample)	01/96-07/05 (USD Peg)	07/05-06/08 (Floating)	07/08-06/10 (USD Peg)	06/10-06/13 (Floating)
Δ log (USD/RMB)	Mean	-0.007	-0.001	-0.023	-0.001	-0.013
	t-statistic	-5.889	-1.382	-6.647	-0.191	-2.838
	p-value	0.000	0.167	0.000	0.849	0.005
	Std. Dev.	0.076	0.022	0.096	0.087	0.134
	Skewness	-1.428	-39.576	-1.801	1.407	-0.304
	Kurtosis	32.905	1830.365	19.234	30.078	7.264
	Min	-1.021	-1.011	-1.021	-0.571	-0.769
	Max	0.894	0.075	0.316	0.894	0.624
Δ log (JPY/RMB)	Mean	-0.006	-0.004	-0.017	0.030	-0.025
	t-statistic	-0.547	-0.252	-0.883	0.737	-1.140
	p-value	0.584	0.801	0.378	0.462	0.255
	Std. Dev.	0.695	0.696	0.591	0.921	0.610
	Skewness	0.390	0.738	0.358	-0.013	-0.575
	Kurtosis	8.531	9.324	4.444	6.731	6.663
	Min	-5.516	-3.335	-2.535	-5.516	-3.407
	Max	6.946	6.946	2.692	3.495	2.809
Δ log (EUR/RMB)	Mean	-0.006	-0.002	0.009	-0.048	-0.007
	t-statistic	-0.649	-0.177	0.510	-1.283	-0.316
	p-value	0.517	0.859	0.610	0.200	0.752
	Std. Dev.	0.657	0.656	0.518	0.842	0.645
	Skewness	0.291	0.456	0.215	0.281	-0.138
	Kurtosis	6.937	8.309	9.206	4.063	3.854
	Min	-3.340	-3.225	-3.340	-2.365	-2.424
	Max	6.551	6.551	3.936	3.504	2.309

Note: The first differences of the natural logarithm of the bilateral exchange rate against the RMB are multiplied by 100.

Table 3: Currency weights estimated by OLS in first differences

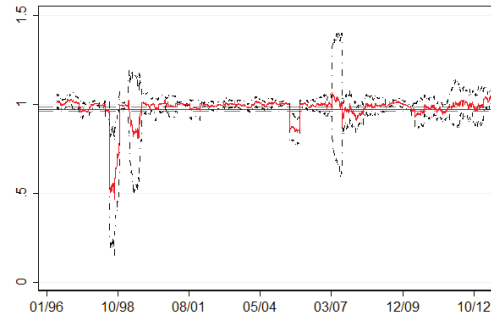|	01/96-06/13 (Tot. Sample)	01/96-07/05 (USD Peg)	07/05-07/08 (Floating)	07/08-06/10 (USD Peg)	06/10-06/13 (Floating)	04/12-06/13 (Floating[a])
USD	0.972***	0.966***	0.964***	0.991***	0.986***	1.009***
	(114.17)	(72.70)	(45.81)	(143.49)	(99.270)	(73.540)
EUR	-0.004	-0.010*	-0.015	0.011	0.007	-0.005
	(-0.87)	(-1.65)	(-0.51)	(1.50)	(0.75)	(-0.27)
JPY	0.014*	0.016	0.033	-0.003	-0.006	-0.008
	(1.90)	(1.51)	(1.20)	(-0.40)	(-0.82)	(-0.93)
Constant	0.000***	0.000	0.000***	0.000	0.000***	0.000
	(2.37)	(0.05)	(3.11)	(-0.05)	(2.70)	(1.23)
No. of obs.	4563	2491	792	489	791	315
Adj. R	0.949	0.918	0.900	0.995	0.961	0.960
DW	2.851	2.976	2.659	2.500	2.395	2.167
Arch[4]	1767.346	1074.751	308.565	89.594	223.244	24.604
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Arch[10]	1778.874	1083.736	344.842	95.398	223.428	27.644
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.002]

The base year is 2010. All variables are in logs and first differences. a - Extended floating band.

Note: t-statistics and p-values are reported in parentheses and brackets, respectively.
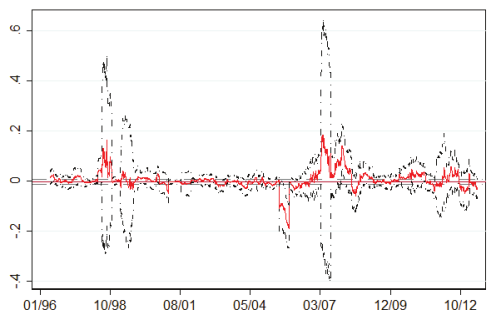
* (**) [***] stands for significance at the 10% (5%) [1%] level.
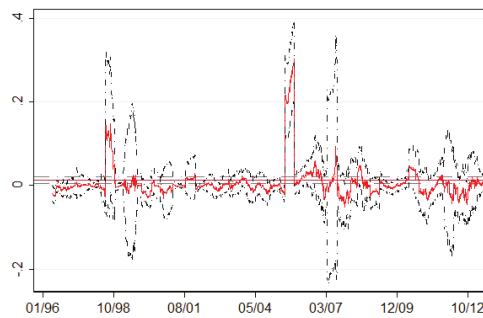
Appendix A Rolling Regressions

Figure A1: Currency weights estimated by a rolling OLS

(a) USD

(b) EUR

(c) JPY

Note:

(a) Coefficient on the USD (95% CI) vs full-sample etsimate

(b) Coefficient on the EUR (95% CI) vs full-sample etsimate

(c) Coefficient on the JPY (95% CI) vs full-sample etsimate

Source: Bloomberg.

Appendix B   Robustness Analysis - Alternative Reference Currency (SEK)

**Table B1:** Currency weights estimated by OLS in first differences, SEK as base currency

	01/04-06/13 (Tot. Sample)	01/04-07/05 (USD Peg)	07/05-07/08 (Floating)	07/08-06/10 (USD Peg)	06/10-06/2013 (Floating)	04/12-06/13 (Floating[a])
USD	0.985***	0.993***	0.962***	0.997***	0.991***	1.005***
	(167.85)	(161.57)	(63.40)	(141.78)	(105.24)	(56.64)
EUR	-0.002	0.005	0.006	-0.004	-0.007	0.007
	(-0.26)	(0.31)	(0.19)	(-0.42)	(-0.53)	(0.32)
JPY	0.007	0.011**	0.027	0.000	-0.005	-0.011
	(1.11)	(2.13)	(1.16)	(0.06)	(-0.69)	(-1.05)
Constant	0.000***	0.000	0.000***	0.000	0.000***	0.000
	(3.89)	(0.09)	(3.10)	(0.21)	(2.57)	(0.85)
No. of obs.	2473	402	768	513	790	315
Adj. R	0.967	0.995	0.881	0.993	0.969	0.944
DW	2.645	2.819	2.649	2.500	2.486	2.649
Arch[4]	795.152	28.330	300.702	71.626	204.920	144.673
	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]	[0.000]
Arch[10]	818.205	31.212	337.182	73.162	210.090	149.623
	[0.000]	[0.001]	[0.000]	[0.000]	[0.000]	[0.000]

The base year is 2010. All variables are in logs and first differences. a - Extended floating band.
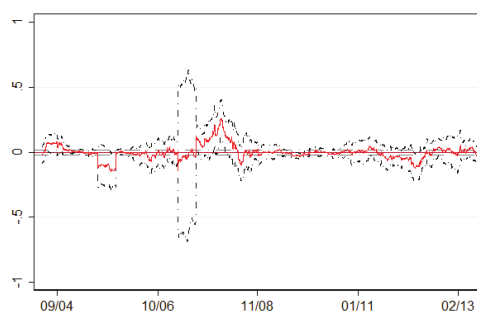Note: t-statistics and p-values are reported in parentheses and brackets, respectively.
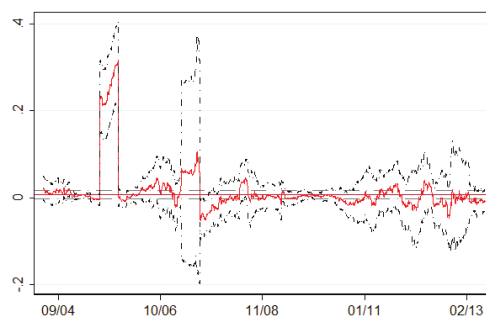* (**) [***] stands for significance at the 10% (5%) [1%] level.

Figure B2: Currency weights estimated by a rolling OLS: SEK as base currency
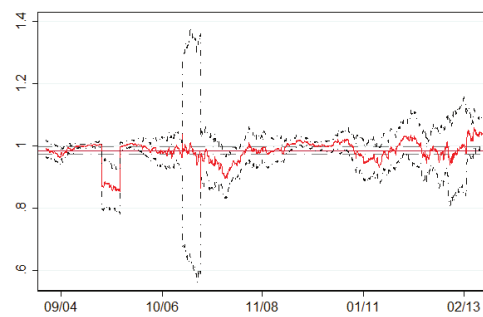
(a) USD

(b) EUR

(c) JPY

Note:

(a) Coefficient on the USD (95% CI) vs full-sample etsimate

(b) Coefficient on the EUR (95% CI) vs full-sample etsimate

(c) Coefficient on the JPY (95% CI) vs full-sample etsimate

Sources: Bloomberg.

Table B2: Time-Varying weights (final states estimates) estimated in levels: SEK as base currency

	USD	USD&EUR	USD&JPY
USD	0.891***	0.922***	0.882***
	(661.118)	(69.151)	(86.612)
EUR		-0.036***	
		-2.721	
JPY			-0.008
			(-0.861)
Constant	1.704***	2.238***	3.547
	(2.661)	(1.988)	4.697
LL	398.204	388.343	377.054
AIC	-0.988	-0.961	-0.933
SIC	-0.976	-0.943	-0.915
No of obs.	802	802	802

*,**,*** denote significance at the 10, 5, and 1% level, respectively.

Note: Z-statistics are in parentheses.

Figure B3: Time-Varying weights (final states estimates) estimated in levels, June 2010 to June 2013, SEK as base currency