

# What is the new Chinese currency regime?

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## Abstract

The revaluation of the renminbi in July 2005 was described by the Chinese central bank as a change in the currency regime, rather than merely a changed level of the exchange rate. The reform was said to involve a shift away from the fixed exchange rate, a gradual movement towards greater flexibility, and a peg to a basket of currencies.

This paper closely examines the post-July Chinese currency regime utilising contemporary ideas in the econometrics of structural change. We find that the yuan has remained pegged to the US dollar, rather than to a basket, and has extremely limited currency flexibility. We find no evidence of structural change in the post-July period, which suggests that there has been no evolution towards greater flexibility. We show a monitoring procedure which will detect future evolution of the currency regime.

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# 1 Introduction

In recent years, there has been an enormous global focus on the Chinese currency regime. Some have argued that a new equilibrium relationship between China and the US has come about, which involves Chinese pegging to the US dollar (USD), undervaluation of the renminbi, and sustained current account surpluses in China. On the other hand, there is also a sense that there are considerable macroeconomic imbalances in the world economy. The adjustment process of the global general equilibrium will involve many elements, one of which is expected to be the Chinese exchange rate.

In July 2005, China announced a small appreciation of the yuan. In addition, reforms of the currency *regime* were announced. It was claimed that there would be greater flexibility in the future, and that there would be a basket peg.

A substantial literature has emphasised the gap between what countries say about their currency regime and what they actually do. In this paper, we examine the *de facto* currency regime that is in place in the post-July period, through a familiar regression model that measures the relationship between daily changes in cross-currency rates. We find that in the early months after the announcement, the renminbi has remained pegged to the USD, with extremely limited currency flexibility. Despite claims to the contrary, there is no evidence of a peg to a basket.

These estimates may mask a gradual evolution of the currency regime, with China gradually moving away from the erstwhile fixed exchange rate towards one with greater flexibility and one with diminished pegging to the US dollar. In order to explore this question, we apply contemporary ideas in the econometrics of structural change, so as to be able to learn about the evolution (if any) of the currency regime. We find no evidence that the Chinese currency *regime* has been evolving in the period after 21 July.

Looking forward, the resolution of global macroeconomic imbalances is likely to involve adjustments in the Chinese currency regime. In order to be able to recognise structural change in the regime when and if it takes place in the future, this paper offers a method for monitoring the currency regime, which will permit detection of changes in the Chinese currency regime soon after this takes place.

The remainder of this paper is organised as follows. We start with Section 2, which reviews the macroeconomic backdrop of the Chinese currency regime question. In Section 3, we pose the specific questions that this paper addresses. Section 4 shows our estimation strategy. Section 5 applies these methods to data for China, and seven other large countries, in order to report on the nature of the currency regime seen in the period after 22 July 2005. We find that China appears to be using a USD peg with extremely limited currency flexibility.

Section 6 goes on to investigate this period with tests of structural change, which would pickup evidence of an evolving Chinese currency regime. No such evidence is found. Section

7 shows a monitoring framework which can be used to obtain realtime evidence about the evolution of the Chinese currency regime in the future. Section 8 touches upon the publicly available computer software which implements the methods of the paper. Section 9 summarises our findings and concludes the paper.

## 2 The evolution of China's currency regime

The Chinese yuan remained fixed at 8.277 renminbi to the US dollar from August 8, 1997 to July 21, 2005. In recent years, China has had a large and growing current account surplus. By 2004, the current account surplus had risen to 4.2 percent of China's GDP. Some analysts have argued that the renminbi was 15 to 40 percent undervalued ([Glaser and Skanderup, 2005](#); [Goldstein, 2003](#)).

The US has experienced the biggest rise in imports from China. In 2004, China exported USD 196.7 billion to the US, and imported USD 35 billion from the US, resulting in a bilateral trade deficit of US at USD 162 billion. The large US China bilateral trade deficit has led to American pressure on China to revalue the yuan. Perceiving Chinese manufactured imports as a threat to US industry, a bill was sponsored by US senators Chuck Schumer and Lindsey Graham, threatening to impose a 27.5 percent import duty on Chinese imports, unless China revalued its currency within 6 months. On April 15, US President George Bush called upon China to float its currency. On May 26, US Treasury Secretary John Snow said he expected China to revalue the renminbi before October 2005. However, a rapid appreciation of the yuan is not necessarily in the best interests of large US corporations who manufacture in China, or in the interests of US consumers who are benefiting from cheap goods and low interest rates. The pressure for greater flexibility of the renminbi from US trade and industry is thus not unanimous ([Uchitelle, 2005](#)).

On July 21, 2005, the People's Bank of China (PBC) made a public announcement on "Reforming the RMB Exchange rate regime". It revalued the yuan by 2 per cent to 8.11 yuan per USD. It said China will "reform the exchange regime by moving into a managed floating exchange rate regime based on market supply and demand with reference to a basket of currencies. RMB will no longer be pegged to the US dollar and the RMB exchange rate will be improved with greater flexibility" ([PBC, 2005e](#)). Given the emphasis and experience of PBC staff in socialist economic policy, their policy process appears to have involved consulting top international experts in open economy macroeconomics and finance. The attempt appears to have been to evolve the Chinese currency *regime*, and not just do a one-off revaluation, so as to move towards a modern framework for open economy macroeconomics, involving an open capital account, and currency futures trading.

Many scholars have argued that the best path for China was not just greater flexibility in the framework of an exchange rate that was pegged to the USD, but a shift to a basket peg ([Williamson, 2005](#)). On 10 August, China announced that there would be a peg to a

basket of currencies, and named the currencies in the basket. The PBC governor said:

“...the basket should be composed of currencies of the countries to which China has a prominent exposure in terms of foreign trade, external debt (interest repayment) and foreign direct investment (dividend). And the weights respectively assigned to these currencies should also be consistent with the proportional importance of these countries in China’s external sector.”

“China’s major trading partners are the United States, the Euro land, Japan, Korea, etc., and naturally, US dollar, euro, Japanese yen and Korean won become major currencies of the basket. In addition, China also trades significantly with Singapore, UK, Malaysia, Russia, Australia, Thailand, and Canada, currencies of these countries are also important in determining China’s RMB exchange rate. Generally speaking, annual bilateral trade volume in excess of US \$10 billion is not negligible in weight assignment, whereas that exceeding US \$5 billion should also be considered as a significant factor in currency weight deliberation.”

The initial global response to the renminbi revaluation was very positive. It was described by some analysts as a ‘watershed event’ (Blustein, 2005). In the days immediately after the revaluation, there was considerable speculation in the international media on whether the 2 percent move was going to be followed by a larger move. Expectations of a rapid currency appreciation are likely to have triggered off capital flows seeking to benefit from an RMB appreciation. Subsequently, the PBC issued a “solemn statement” on July 26, saying that the move did not “warrant further actions in the future” and it had been taken “taking into account the resilience of the domestic enterprise to absorb risks” (PBC, 2005f).

In the period following the announcement of the change in the currency regime, the yuan barely moved. This led to a resurgence of criticism from the US (Blustein, 2005). On October 28, US Treasury Secretary John Snow told China’s leaders that the US wanted to see another revaluation before the visit to China by George W. Bush.

At the time of the revaluation, the Chinese foreign exchange market was underdeveloped, as is expected under a fixed exchange rate regime. As part of the reform of the currency regime, the Chinese central bank has taken a number of steps towards developing a foreign exchange market in China (PBC, 2005c,d).

Keeping in mind the developments in the Chinese foreign exchange markets, the renewed pressure from the US and the PBC’s plan to “adjust the RMB exchange rate band when necessary”, there is a possibility that the Chinese currency regime will evolve further in the future. However, as the PBC governor pointed out, in the future, there will be “no official adjustment of the exchange rate level” (PBC, 2005b).

Questions about the evolution of the Chinese currency regime are presently the subject of a vigorous debate, with several alternative strands of reasoning (Dooley and Setser, 2005). The “Bretton Woods II hypothesis” argues that a new equilibrium relationship has come about, in which Asian countries peg their currencies to the US dollar, and the US runs large current account deficits financed by official capital flows in the form of reserve accumulation from Asian countries. This school of thought argues that the Chinese currency regime will not evolve substantially, apart from token changes designed to stave off protectionism.

In 2003, the prediction about China was made: ““To head off trade partner commercial policy, there may be a token revaluation of up to 3%, over the course of time”” (Dooley *et al.*, 2003).

On the other hand, many scholars have argued that the present situation is not an equilibrium, and that this small Chinese revaluation is the beginning of a more significant evolution of the currency regime (Pocha, 2005). Greater flexibility in China’s exchange rate is viewed as an essential element of a global response to the large macroeconomic imbalances in the world economy (Goldstein, 2003). It is argued that it is in China’s best interest to adopt greater currency flexibility, which will be associated with a bigger currency appreciation (Roubini, 2005; Rogoff, 2005). To the extent that such ideas do play out in the future, there is a need for closely monitoring the evolution of the Chinese currency regime.

### 3 Questions

As is well known in the literature on currency regimes, there is often a difference between the currency regime that a central bank claims is in operation, i.e, the *de jure* currency regime, and the *de facto* currency regime that is actually in operation (Calvo and Reinhart, 2002). Hence, there is a case for examining the empirical evidence to discern the extent to which the *de facto* Chinese currency regime deviates from that claimed by the Chinese central bank. Knowledge about the nature of the currency regime that is actually in operation in China is important for currency traders, global portfolio managers, trade negotiators, and macroeconomists who are analysing global imbalances. The Chinese reform of the currency regime has been watched with unprecedented interest: a google search for China "currency regime" yields 1.9 million hits.

Further, Chinese macro policy may envisage a gradual evolution of the currency regime towards greater flexibility. The pace of evolution may be influenced by the pace at which the Chinese currency derivatives market develops, and it becomes possible for Chinese firms to hedge against currency risk. Alternatively, the pace of evolution could be influenced by trade negotiations. The PBC has said that reform of the “RMB exchange rate regime must proceed in a proactive, controllable and gradual way” (PBC, 2005b). It is therefore important to *monitor* China’s currency regime in the coming months and years.

In this context, this paper seeks to address the following questions:

1. What is the nature of the new Chinese currency regime, in the period after 22 July 2005?
2. How flexible is this regime, when compared with other large countries?
3. Is a basket peg in operation? If so, what are the weights of major currencies?

4. Has structural change been taking place in the period after 22 July? Conversely, has China been gradually modifying the currency regime?
5. How can a monitoring procedure be set up to obtain real-time evidence on the evolution of the Chinese currency regime?

## 4 Methods of *de facto* currency regime classification

In the recent decade, there has been a heightened interest in the distinction between the *de facto* and *de jure* currency regime that is in operation in a country, given the frequent incidence of a gap between the two. Several schemes for automatic algorithms for classifying currency regimes have been proposed (Levy-Yeyati and Sturzenegger, 2003; Reinhart and Rogoff, 2003).

In this paper, we build on a statistical methodology for inferring the *de facto* currency regime, which uses a regression model which measures the relationship between daily log-changes in cross-currency rates involving a numeraire currency,  $k$ . Benassy-Quere and Coeure (2003) point out that while the model was brought to prominence by Frankel and Wei (1994), it has been in use at least since Haldane and Hall (1991). It has been extensively used in the empirical literature, including work on Asian currency regimes, such as Cavoli and Rajan (2005); Shah and Patnaik (Forthcoming); Nguyen (2005).

The log-change in the exchange rate on date  $t$  between currency  $i$  and the numeraire  $k$  is denoted as  $\Delta e_{i/k,t}$ . A typical numeraire currency that is used in this context is the Swiss franc (CHF).<sup>1</sup> The model estimated is:

$$\Delta e_{i/k,t} = a_0 + a_1 \Delta e_{\text{USD}/k,t} + a_2 \Delta e_{\text{EUR}/k,t} + a_3 \Delta e_{\text{JPY}/k,t} + a_4 \Delta e_{\text{GBP}/k,t} + u_t \quad (1)$$

The three cases of interest are :

1. *Fixed rate*: If a currency  $i$  is a fixed rate to the USD, then every movement in the USD/ $k$  rate will be seen in the  $i/k$  rate. This corresponds to  $a_1 = R^2 = 1$  and  $a_2 = a_3 = a_4 = \sigma_u^2 = 0$ .
2. *Pegged to USD*: When  $i$  is pegged to the USD,  $a_1$  is close to 1 but  $\sigma_u^2 > 0$  and  $R^2 < 1$ . Bigger values for  $\sigma_u^2$  and  $1 - R^2$  correspond to greater currency flexibility.
3. *Basket peg*: If a basket peg is in operation involving the Euro, the Yen or the Pound, the corresponding coefficients will be significant. The flexibility of the currency away from the basket peg is seen in the extent to which  $\sigma_u^2 > 0$  and  $R^2 < 1$ .

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<sup>1</sup>Benassy-Quere and Coeure (2003) emphasise the difficulties in finding an appropriate numeraire. For example, the Swiss Franc is an inappropriate numeraire in the period where it was (in turn) pegged to the Deutsche Mark. However, in our period of estimation, the Swiss Franc serves as an ideal numeraire, since Switzerland is relatively unimportant in the current account and capital account of all countries being analysed, and the Swiss Franc is a clean floating exchange rate.

In addition to *characterising* the Chinese currency regime in the period after 22 July, this paper seeks to obtain evidence about the *evolution* of the Chinese currency regime. The strength of the regression-based approach is that evolution of the currency regime corresponds to structural change in the regression. This allows us to bring the powerful tools of testing for structural change, and methods for monitoring an equation for structural change, to bear on the question of the classification and evolution of the *de facto* currency regime.

As an example, consider a currency which starts out as a peg to the USD, and there is a possibility of evolution of the currency regime away from this. Several kinds of evolution of the currency regime are conceivable, each of which have a well identified impact on the parameter vector  $(a, \sigma_u^2)$ :

**All else unchanged, but the pace of appreciation changes** In this case, we would see change in the intercept  $a_0$ .

**USD peg, but greater flexibility** In this case, we would have  $a_1 = 1$  and  $a_2 = a_3 = a_4 = 0$ , but  $\sigma_u^2$  would go up.

**Away from a USD peg towards a basket peg** In this case, some or all of  $a_2, a_3$  and  $a_4$  would become increasingly significant.

**Towards a basket peg, with greater flexibility** Some or all of  $a_2, a_3$  and  $a_4$  would become increasingly significant, and  $\sigma_u^2$  would go up.

Economic questions about the evolution of the Chinese currency regime thus map to statistical questions about the stability of the combined model parameters  $(\hat{a}, \hat{\sigma}^2)$ . Following the approach of the Nyblom-Hansen test (Nyblom, 1989; Hansen, 1992), we use a fluctuation test that assesses whether there are any systematic deviations in the empirical estimating functions  $\hat{\psi}_t = (\psi_a(\Delta e_t, \hat{a}), \psi_{\sigma^2}(\Delta e_t, \hat{a}, \hat{\sigma}^2))$  of the model. If  $\Delta e_t$  denotes the combined vector of log-changes in the exchange rates, then the estimating functions for  $a$  and  $\sigma^2$  are defined via:

$$r(e_t, a) = \Delta e_{i/k,t} - a_0 - a_1 \Delta e_{\text{USD}/k,t} - \dots - a_4 \Delta e_{\text{GBP}/k,t} \quad (2)$$

$$\psi_a(\Delta e_t, a) = r(e_t, a) (1, \Delta e_{\text{USD}/k,t}, \dots, \Delta e_{\text{GBP}/k,t}) \quad (3)$$

$$\psi_{\sigma^2}(\Delta e_t, a, \sigma^2) = r(e_t, a)^2 - \sigma^2. \quad (4)$$

The residual function yields the usual residuals  $r(e_t, \hat{a}) = \hat{u}_t$  and by setting the sum of the estimating functions to zero we obtain the usual OLS estimates (or ML estimates in a normal model) for  $\hat{a}$  and  $\hat{\sigma}^2$ .

To capture instabilities over time, virtually all common parameter instability tests are based on a scaled cumulative sum process (Zeileis, 2005):

$$efp(j) = \hat{J}^{-1/2} T^{-1/2} \sum_{t=1}^{\lfloor Tj \rfloor} \hat{\psi}_t, \quad (5)$$

where  $T$  is the sample size and  $\hat{J}$  is a quadratic spectral kernel HAC estimate. The resulting empirical fluctuation process  $efp(j)$  with  $j \in [0, 1]$  is a 6-dimensional process (corresponding to the 5 coefficients in  $a$  and the  $\sigma^2$ ) capturing deviations from model stability.

To assess overall significance, the following idea is used: If the model parameters are stable,  $efp(\cdot)$  converges to a standard Brownian bridge on  $[0, 1]$ . Hence, if a suitable functional applied to the empirical process exceeds a critical value that is exceeded by the limiting process just with a probability of 5%, there is evidence for a parameter instability. Here, we capture fluctuations in the process by using a double maximum test statistic  $M = \max_j \max |efp(j)|$  (maximum over time  $j \in [0, 1]$  and all 6 components).

This approach is further extended, in Section 7, to design a monitoring procedure for the evolution of the currency regime.

## 5 The Chinese currency regime after 22 July 2005

In order to obtain a cross-country perspective on the currency regime, the 20 largest countries of the world were identified, using GDP on a purchasing power parity basis from the Penn World Tables. If a country had a currency which is one of the four explanatory variables of Equation 1, then it was excluded. This procedure isolated eight countries of interest: China, India, Brazil, Russia, Canada, Mexico, Korea, and Indonesia.

Table 1 shows estimates of Equation 1 for these countries.<sup>2</sup> Daily data for the 0.27 years after 2005-07-26 is used, which has 68 observations. To account for potential heteroskedasticity or autocorrelation in the disturbances<sup>3</sup>, the  $t$  statistics are based on estimated standard deviations computed from a quadratic spectral kernel HAC estimator with prewhitening and automatic bandwidth selection based on an AR(1) approximation as suggested by Andrews (1991) and Andrews and Monahan (1992). Bootstrap inference was used to compute the 95% confidence interval of  $\sigma_u$  based on 1000 bootstrap replicates.

The results show that the new Chinese currency regime has remarkably little flexibility. The coefficient of the USD is 0.9997, with a  $t$  statistic of 144.73, which suggests pegging to the USD. None of the other currencies are statistically significant. This contradicts the

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<sup>2</sup>Daily data for all exchange rates was obtained from the US Federal Reserve website (<http://www.federalreserve.gov/releases/H10/hist>), except for Indonesia and Russia, which were sourced from <http://www.oanda.com/> on the web.

<sup>3</sup>With daily data, estimation of Equation 1 generally encounters little difficulty with autocorrelation or heteroskedasticity. As an example, for China, both the Durbin-Watson and the Breusch-Pagan tests yield non-significant results with  $p$  values of 0.3046 and 0.2843 respectively.

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**Table 1** The currency regime in large countries, 2005-07-26 to 2005-10-31

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This table shows estimates for Equation 1 for countries which do not use one of the four explanatory variables as their currency, out of the largest 20 countries of the world by GDP on a PPP basis. Information from 2005-07-26 to 2005-10-31 – a period of 0.27 years – is used, which has 68 observations of daily data. The values in brackets are HAC-corrected  $t$  statistics. In addition to the point estimate of  $\sigma_u$ , the 95% confidence interval, obtained using bootstrap inference with 1000 bootstrap replications, is shown.

As an example, the coefficient of the USD for China is 0.9997, with a  $t$  statistic of 144.73. None of the other three currencies are significant. The 95% confidence interval for  $\sigma_u$  lies between 0.0255 and 0.0336 percent. The  $R^2$  of the regression is 0.9979.

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Country	USD	JPY	EUR	GBP	$\sigma_u$		$R^2$
					Point	95% Conf.Int.	
China (CNY)	0.9997 (144.73)	0.0047 ( 0.54)	-0.0142 ( -0.52)	-0.0077 ( -0.51)	0.0284	0.0255 - 0.0336	0.9979
India (INR)	0.8116 (10.58)	0.0143 ( 0.20)	0.2276 ( 1.09)	0.0619 ( 0.55)	0.1861	0.1407 - 0.2488	0.8951
Brazil (BRL)	0.6599 ( 2.77)	0.6494 ( 2.65)	1.2029 ( 2.32)	-0.8370 (-2.10)	0.9048	0.7030 - 1.1624	0.3277
Russia (RUB)	0.9783 (15.37)	0.0620 ( 0.88)	-0.0478 (-0.20)	-0.0414 (-0.29)	0.2312	0.1880 - 0.2947	0.8770
Canada (CAD)	0.5218 ( 3.49)	0.0457 ( 0.34)	0.8819 ( 1.88)	0.2083 ( 0.78)	0.4553	0.4034 - 0.5424	0.5184
Mexico (MXN)	0.8368 ( 6.24)	0.2167 ( 2.01)	-0.0508 (-0.16)	-0.1012 (-0.48)	0.4104	0.3671 - 0.4873	0.6544
Korea (KRW)	0.4115 (5.36)	0.3421 (3.88)	0.4941 (1.92)	0.1069 (0.89)	0.2575	0.2287 - 0.3128	0.7430
Indonesia (IDR)	0.4430 ( 1.24)	-0.0099 (-0.04)	0.8819 ( 1.22)	0.6223 ( 1.16)	0.8975	0.6997 - 1.2263	0.2375

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official claim of pegging to a basket. The  $R^2$  of the regression is astonishingly high, at 99.79%.

The  $\sigma_u$ , which is perhaps the best expression of currency flexibility in this context, ranges from values such as 0.8975 for Indonesia and 0.9048 for Brazil, to 0.1861 for India. In China's case, the point estimate is just 0.0284. Even though there are only 68 observations of daily data in the span of 0.27 years after 2005-07-26, the design matrix supports sharp inferences: the 95% confidence interval for  $\sigma_u$  runs from 0.0255 to 0.0336.

This evidence suggests that the new Chinese currency regime is a peg to the USD. When compared with the other large countries of the world, China has extremely limited currency flexibility. The least flexible currencies in this set, other than China, are those of India and Russia, which have a  $\sigma_u$  of 0.1861 and 0.2312 respectively, and an  $R^2$  of 89.51% and 87.7% respectively.

## 6 Is the currency regime evolving after 22 July 2005?

The results of Table 1 suggest that China is using a pegged rate to the USD with a very small  $\sigma_u$ . One possibility that merits consideration is that the Chinese currency regime is not static; that it is gradually evolving towards greater flexibility. For example, on 10 August, China announced that a basket peg would be used. On September 25 PBC widened the band of RMB exchange rate against non-USD currencies from +/- 1.5 percent to +/- 3 percent (PBC, 2005a). If there has been a gradual evolution of the currency regime, this would manifest itself as structural change in the regression in the post-22-July period.

We test for structural change using the  $M$  statistic described in Section 4. With our data, this attains the value of  $M = 1.19$ , which clearly fails to exceed its 5% critical value of 1.65, and corresponds to a  $p$  value of 0.5240.

Figure 1 shows all 6 fluctuation processes, and all remain clearly below the 5% critical value 1.65. None of the processes shows significant peaks. Thus, we cannot reject the null of stable parameters. In other words, the parameter vector  $(a, \sigma^2)$  of Equation 1 has been stable in the period from 2005-07-26 to 2005-10-31, and there is no evidence of an evolving Chinese currency regime in this period.

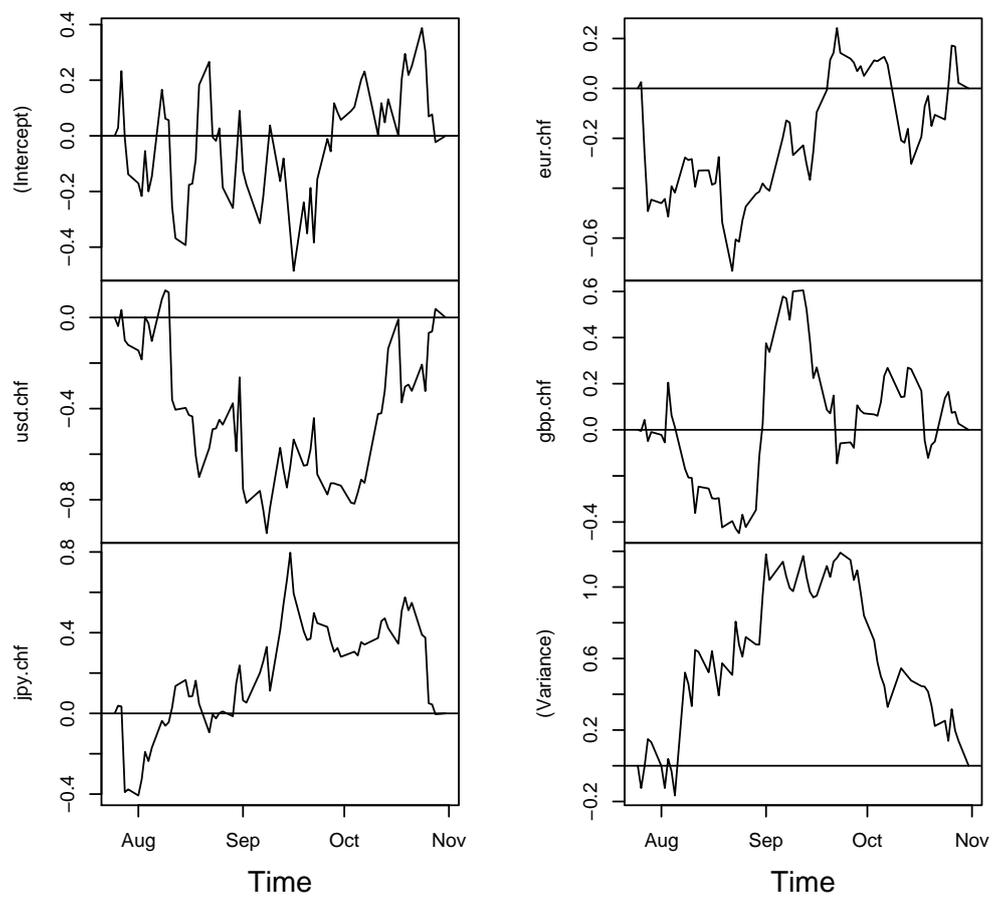
## 7 A monitoring procedure

The results so far suggest that the Chinese currency regime is now a stable pegged rate to the USD, with a  $\sigma_u$  of roughly 0.03% per day.

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**Figure 1** Empirical fluctuation processes for China parameters

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China continues to claim that there will be a basket peg and there will be greater currency flexibility. It could be the case that while, in the early period, the currency was tightly pegged to the USD, China could evolve towards greater flexibility in the future. The PBC says that reform of the “RMB exchange rate regime must be carried forward in a gradual manner to ensure sufficient resilience of all parties involved” (PBC, 2005b). This indicates that there is a need for a method for *monitoring* the Chinese currency regime in realtime, in order to infer changes in the currency regime without requiring announcements from PBC.

The idea for monitoring such a regression model is to fit the model in the so-called history period, and then update the empirical fluctuation process  $efp(j)$  for every incoming observation  $t > T$  (corresponding to  $j > 1$ ). In our case the  $T = 68$  observations from 2005-07-26 to 2005-10-31, over which parameter stability has been verified, form a natural history period.

If the currency regime changes at some point in this monitoring period ( $t > T$ ), there should be a shift in the empirical fluctuation process. Whether or not this shift is significant can again be assessed with the same ideas as in the previous section. For each time point  $j$  a critical value can be computed that is crossed by the limiting process just with a known probability of, e.g., 5%. This type of monitoring procedure was suggested by Chu *et al.* (1996), applied to macroeconomic regression models in Zeileis *et al.* (2005), and adapted to various kinds of regression models by Zeileis (2005).

More formally, the model that should be monitored is estimated once in the history period  $t = 1, \dots, T$  where it is required to be stable. Then the estimating functions  $\psi_a$  and  $\psi_{\sigma^2}$  are evaluated for each incoming observation  $t > T$  using the parameter estimates  $\hat{a}$  and  $\hat{\sigma}^2$  from the history period. Subsequently,  $efp(j)$  is computed, again using the covariance matrix estimate  $\hat{J}$  from the history period. Finally, if  $\max |efp(j)|$  crosses its critical value  $c(j)$  for any  $j > 1$ , we can announce structural change in the monitoring period.

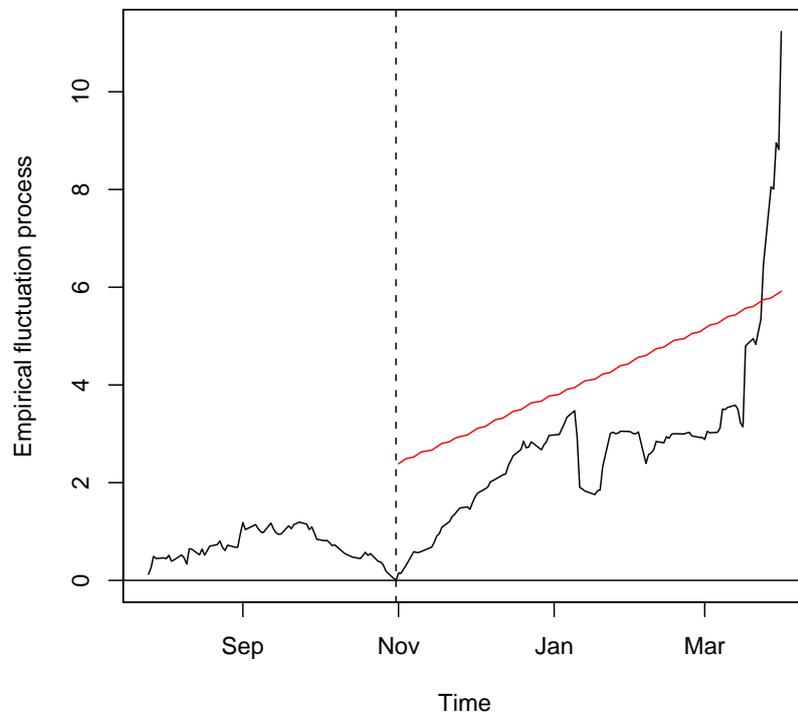
Here, we use the boundary function (or critical value function)  $c(j) = 2.353 \cdot j$  which is interpolated from Table III in Zeileis *et al.* (2005). It controls the asymptotic crossing probability under parameter stability in a monitoring period  $1 < j \leq 3$  to 5%. This means that we can monitor the model for China for about half a year and any boundary crossing during this time would signal a significant departure from the current currency regime at 5% level.

Figure 2 shows the resulting monitoring process  $\max |efp(j)|$ . On the left of the vertical dashed line (corresponding to 2005-10-31) the history period is depicted, on the right the process along with its boundary in the monitoring period can be seen. Up to 2006-03-31, there is only very little fluctuation in the data and the process stays clearly away from its boundary suggesting that there has been no change in the currency regime since 2005-10-31. Of course, the monitoring period contains only very few observations, therefore we have set up a Web page at [http://www.mayin.org/ajayshah/papers/CNY\\_regime/](http://www.mayin.org/ajayshah/papers/CNY_regime/) on which frequent updates of the monitoring process can be found in the next months.

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**Figure 2** Aggregated monitoring process for all parameters in the China model.

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## 8 Implementation

The results of this paper were obtained using the R system for statistical computing, version 2.1.1 (R Development Core Team, 2005) and the packages **boot**, **lmtest**, **sandwich**, **strucchange** and **zoo**. All this software is freely available. To make the results of this paper exactly reproducible, and to enable the use of the suggested methods by other researchers, data and source code for all analyses are available online from [http://www.mayin.org/ajayshah/papers/CNY\\_regime/](http://www.mayin.org/ajayshah/papers/CNY_regime/).

## 9 Conclusion

In this paper, we have obtained useful insights into currency regime classification, and measurement of the *de facto* currency regime, by marrying Equation 1 with contemporary methods for testing and monitoring structural change in an OLS regression. Our results show that:

1. China appears to have shifted from a fixed exchange rate regime to a USD peg with a  $\sigma_u$  of roughly 0.03 and an  $R^2$  of 99.79%.
2. This is a highly limited extent of currency flexibility.
3. There is no evidence of a basket peg in operation, despite the claim to the contrary.
4. There is no evidence of a gradual evolution of the currency regime over the period after 22 July 2005.

The empirical results shown in the paper pertain to the early 0.27 years after 22 July. There is every possibility that China has actually embarked on a far-reaching transformation of its currency regime, moving towards modern elements of open economy macro policy such as an open capital account, a basket peg, or a floating rate. In this case, in the future, the Chinese currency regime will evolve away from that seen in the limited period observed in this paper. The paper has hence offered a methodology, and computer programs, through which the currency regime can be monitored in the future.

Going beyond China, there has been considerable interest in the questions of credibility and transparency of exchange rate regimes. As an example, Frankel *et al.* (2001) show that when a central bank claims to use a basket peg with a band, it is extremely difficult to verify, based on observable data, whether it is indeed doing so. The methods offered in this paper can help in improving the verifiability of pegged exchange rates.

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