

Exchange Rate Regime Analysis for the Chinese Yuan

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Abstract

We investigate the Chinese exchange rate regime after China gave up on a fixed exchange rate to the US dollar in 2005. This reproduces the analysis from Zeileis, Shah, and Patnaik (2007) initiated by Shah, Zeileis, and Patnaik (2005). Please refer to these papers for a more detailed discussion.

1 Analysis

Exchange rate regime analysis is based on a linear regression model for cross-currency returns. A large data set derived from exchange rates available online from the US Federal Reserve at <http://www.federalreserve.gov/releases/h10/Hist/> is provided in the FXRatesCHF data set in `fxregime`. It is a “zoo” series containing 25 daily time series from 1971-01-04 to 2006-11-29. The columns correspond to the prices for various currencies (in ISO 4217 format) with respect to CHF as the unit currency.

```
> library("fxregime")
> data("FXRatesCHF", package = "fxregime")
```

In the following, we investigate the exchange rate regime for the Chinese yuan CNY which was fixed to the US dollar USD in the years leading up to mid-2005. In July 2005, China announced a small appreciation of CNY, and, in addition, a reform of the exchange rate regime. The People’s Bank of China (PBC) announced this reform to involve a shift away from the fixed exchange rate to a basket of currencies with greater flexibility. In August 2005, PBC also announced that USD, JPY, EUR and KRW would be the currencies in this basket. Further currencies announced to be of interest are GBP, MYR, Singapore dollar, RUB, AUD, THB and CAD.

Despite the announcements of the PBC, little evidence could be found for China moving away from a USD peg in the months after July 2005 (Shah *et al.*, 2005). To begin our investigation here, we follow up on our own analysis from autumn 2005: Using daily returns for the first three months after the announcement, we establish a stable exchange regression and monitor it in the subsequent months. The currencies considered by Zeileis *et al.* (2007) are the four first-tier currencies announced (USD, JPY, EUR, KRW) as well two further currencies (GBP, MYR). The returns can be extracted from FXRatesCHF and pre-processed via

```
> cny <- fxreturns("CNY", frequency = "daily",
+ start = as.Date("2005-07-25"), end = as.Date("2007-06-07"),
+ other = c("USD", "JPY", "EUR", "GBP", "KRW", "MYR"), data = FXRatesCHF)
```

In a first step, we fit the exchange regression for these first three months after the announcements of the PBC.

```
> cny_lm <- fxlm(CNY ~ USD + JPY + EUR + GBP + KRW + MYR,  
+ data = window(cny, end = as.Date("2005-10-31")))  
> summary(cny_lm)
```

Call:

```
fxlm(formula = CNY ~ USD + JPY + EUR + GBP + KRW + MYR, data = window(cny,  
end = as.Date("2005-10-31")))
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.070541	-0.019286	0.001469	0.020654	0.071260

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.004962	0.003734	-1.329	0.189
USD	0.968053	0.048815	19.831	<2e-16 ***
JPY	0.001749	0.011806	0.148	0.883
EUR	-0.018795	0.027660	-0.679	0.499
GBP	-0.007530	0.014934	-0.504	0.616
KRW	0.009374	0.014043	0.667	0.507
MYR	0.027308	0.046890	0.582	0.562

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02982 on 61 degrees of freedom

Multiple R-Squared: 0.998, Adjusted R-squared: 0.9978

F-statistic: 4954 on 6 and 61 DF, p-value: < 2.2e-16

Only the USD coefficient differing significantly from 0 (but not significantly from 1), thus signalling a very clear USD peg. The R^2 of the regression is 99.8% due to the extremely low standard deviation of $\sigma = 0.028$. (Note that we use the un-adjusted estimate of σ , rather than the adjusted version reported in the `summary()` above.)

To capture the fluctuation in the parameters during this history period, we compute the associated empirical fluctuation process

```
> cny_efp <- gefp(cny_lm, fit = NULL)
```

that can be visualized (along with the boundaries for the double maximum test) by

```
> plot(cny_efp, aggregate = FALSE, ylim = c(-1.85, 1.85))
```

Figure 1 shows that the fluctuation in the parameters during this history period is very small and non-significant:

M-fluctuation test

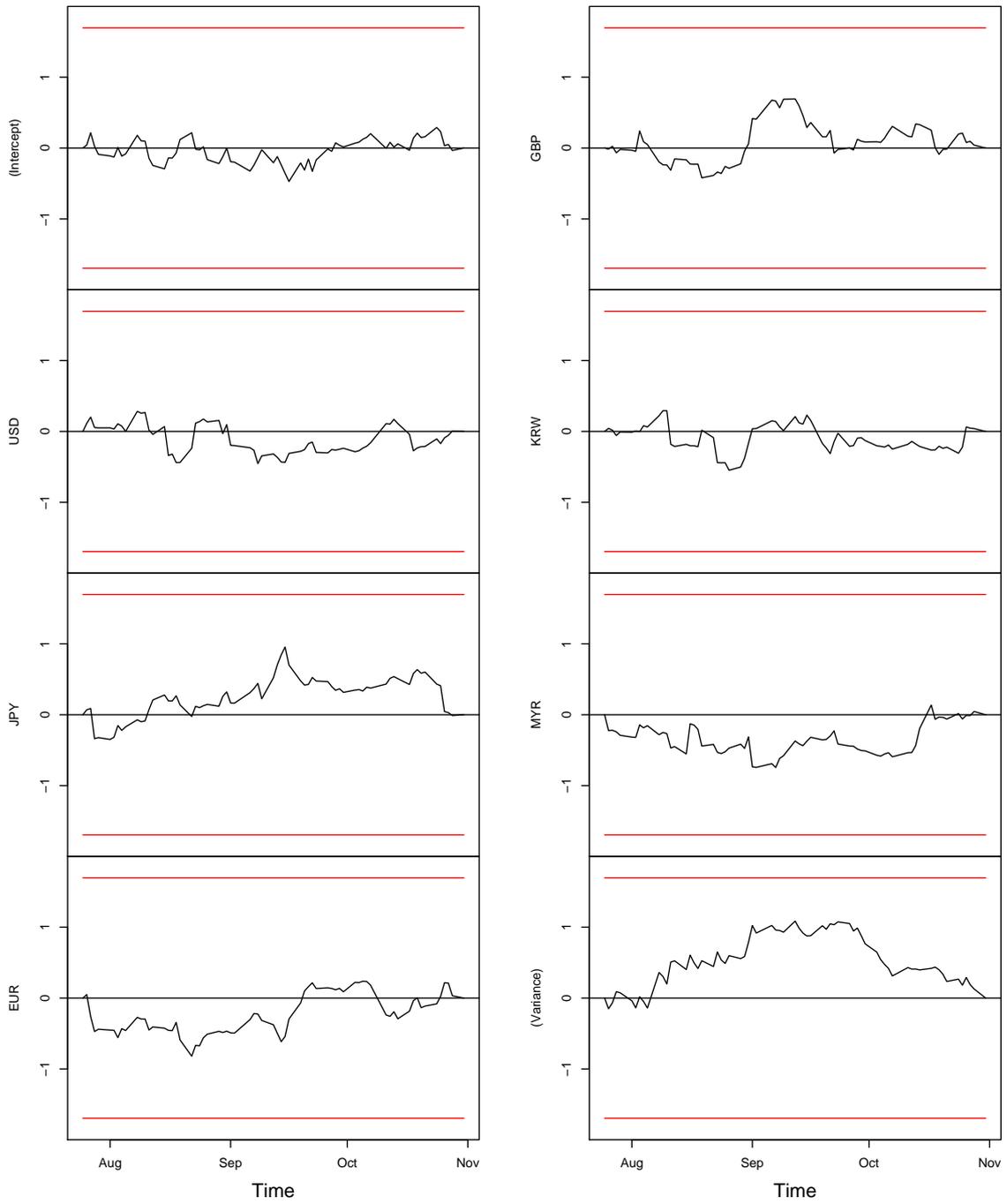


Figure 1: Historical fluctuation process for CNY exchange rate regime.

```
> sctest(cny_efp)
```

```
M-fluctuation test
```

```
data: cny_efp  
f(efp) = 1.0855, p-value = 0.8134
```

The same fluctuation process can be continued in the monitoring period to check whether future observations still conform with the established model. Using a linear boundary, derived at 5% significance level (for monitoring up to $T = 4$), this can be performed via

```
> cny_mon <- fxmonitor(CNY ~ USD + JPY + EUR + GBP + KRW + MYR,  
+ data = window(cny, end = as.Date("2006-05-31")),  
+ start = as.Date("2005-11-01"), end = 4)  
> plot(cny_mon, aggregate = FALSE)
```

yielding the visualization in Figure 2. In the first months, up to spring 2006, there is still moderate fluctuation in all processes signalling no departure from the previously established USD peg. In fact, the only larger deviation during that time period is surprisingly a *decrease* in the variance—corresponding to a somewhat tighter USD peg—which almost leads to a boundary crossing in January 2006. However, the situation relaxes a bit before in the next weeks before in March 2006 several components of the fluctuation process start to deviate clearly from their mean: The largest deviation is in the variance, slightly smaller deviations can be seen for the USD and MYR coefficients. Note that the USD coefficient, corresponding to its weight in the currency basket, decreases while the MYR coefficient increases. The earliest crossing is for the MYR coefficient (that starts to deviate a bit earlier than the other two parameters) in

```
> cny_mon
```

```
Monitoring of FX model
```

```
Formula: CNY ~ USD + JPY + EUR + GBP + KRW + MYR  
History period: 2005-07-26 to 2005-10-31  
Break detected: 2006-03-15
```

To capture the changes in the China's exchange rate regime more formally, we fit a segmented exchange rate regression based on the full extended data set:

```
> cny_reg <- fxregimes(CNY ~ USD + JPY + EUR + GBP + KRW + MYR,  
+ data = cny, h = 20, breaks = 10)
```

```
[1] TRUE
```

We determine the optimal breakpoints for $1, \dots, 10$ breaks with a minimal segment size of 20 observations and compute the associated segmented negative log-likelihood (NLL) and LWZ criterion. Both can be visualized via

Monitoring of FX model

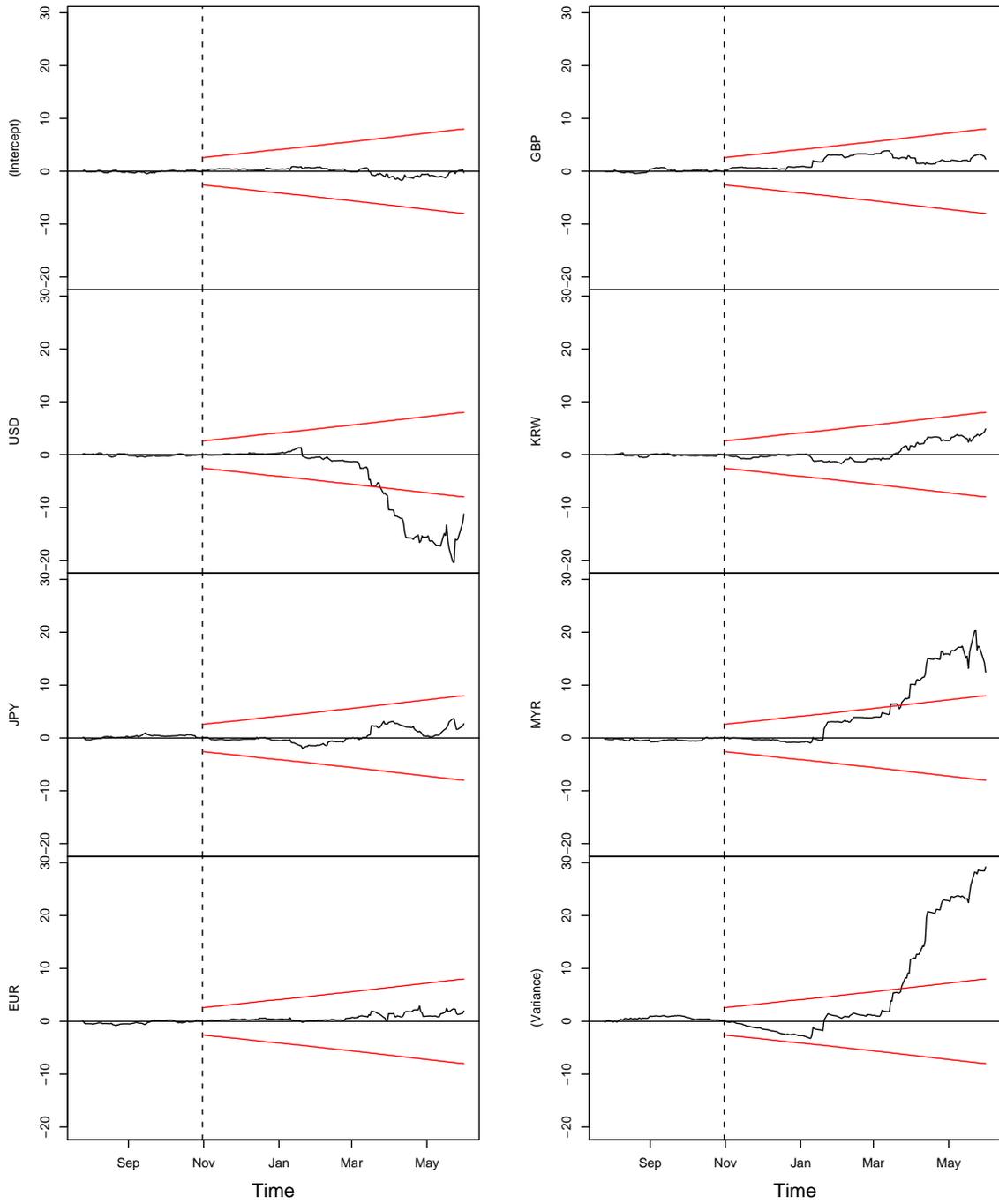


Figure 2: Monitoring fluctuation process for CNY exchange rate regime.

LWZ and Negative Log-Likelihood

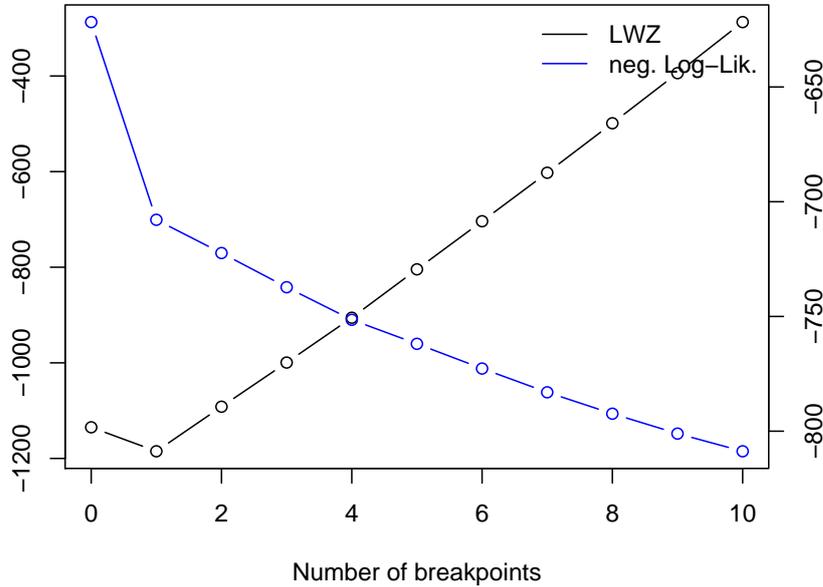


Figure 3: Negative log-likelihood and LWZ information criterion for CNY exchange rate regimes.

```
> plot(cny_reg)
```

NLL decreases with every additional break but with a marked decrease only for going from 0 to 1 break. This is also reflected in the LWZ criterion that assumes its minimum for 1 break so that we choose a 1-break (or 2-segment) model. The estimated breakpoint is 2006-03-14, i.e., just one day before the boundary crossing in the monitoring procedure, confirming the findings above. The associated parameter estimates can be obtained by

```
> coef(cny_reg)
```

	(Intercept)	USD	JPY	EUR
2005-07-26--2006-03-14	-0.004208872	0.9234474	0.002790719	-0.01180439
2006-03-15--2007-06-07	-0.015126860	0.9209976	-0.003657390	-0.02257305
	GBP	KRW	MYR	(Variance)
2005-07-26--2006-03-14	0.005397075	0.005963361	0.07192414	0.0007324711
2006-03-15--2007-06-07	-0.019503983	0.042278375	0.04218371	0.0057598695

A complete summary can be computed by first re-fitting the model on both sub-samples (returning a list of “fxlm” objects) and then applying the usual `summary()`:

```
> cny_rf <- refit(cny_reg)
> lapply(cny_rf, summary)
```

\$'2005-07-26--2006-03-14'

Call:

```
fxlm(formula = object$formula, data = window(object$data, start = sbp[i],
      end = ebp[i]))
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.088126	-0.014090	0.000792	0.018333	0.088558

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.004209	0.002228	-1.889	0.06078 .
USD	0.923447	0.025189	36.660	< 2e-16 ***
JPY	0.002791	0.005385	0.518	0.60503
EUR	-0.011804	0.016248	-0.727	0.46865
GBP	0.005397	0.008059	0.670	0.50409
KRW	0.005963	0.005818	1.025	0.30698
MYR	0.071924	0.024477	2.938	0.00382 **

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02768 on 151 degrees of freedom

Multiple R-Squared: 0.998, Adjusted R-squared: 0.9979

F-statistic: 1.256e+04 on 6 and 151 DF, p-value: < 2.2e-16

\$'2006-03-15--2007-06-07'

Call:

```
fxlm(formula = object$formula, data = window(object$data, start = sbp[i],
      end = ebp[i]))
```

Residuals:

	Min	1Q	Median	3Q	Max
	-0.232286	-0.039623	0.008056	0.045409	0.299457

Coefficients:

	Estimate	Std. Error	t value	Pr(> t)
(Intercept)	-0.015127	0.004412	-3.428	0.000691 ***
USD	0.920998	0.020095	45.831	< 2e-16 ***
JPY	-0.003657	0.012141	-0.301	0.763426
EUR	-0.022573	0.029875	-0.756	0.450483
GBP	-0.019504	0.016679	-1.169	0.243171
KRW	0.042278	0.015233	2.776	0.005852 **
MYR	0.042184	0.020865	2.022	0.044074 *

Signif. codes: 0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.07676 on 305 degrees of freedom
Multiple R-Squared: 0.976, Adjusted R-squared: 0.9756
F-statistic: 2071 on 6 and 305 DF, p-value: < 2.2e-16

These results allow for several conclusions about the Chinese exchange rate regime after spring 2006: CNY is still closely linked to USD. The exchange rate regime got much more flexible increasing from $\sigma = 0.027$ to 0.076 which is still very low, even compared with other pegged exchange rate regimes (see results below for India). The intercept is significantly smaller than 0, reflecting a slow appreciation of the CNY. There is some small but significant weight on KRW and MYR, however no weight at all in the other currencies JPY, EUR and GBP. Unfortunately, there is a small deviation from a plain USD peg also in the first period before spring 2006. The reason is that the change in the MYR coefficient occurs slightly earlier than for the USD coefficient and the variance σ^2 . Nevertheless, the change is captured well enough for practical purposes (albeit not completely perfect) in a 2-segment model signalling a modest liberation of the rigid USD peg in spring 2006.

2 Summary

For the Chinese yuan, a 2-segment model is found for the time after July 2005 when China gave up on a fixed exchange rate to the USD. While being still closely linked to USD in both periods, there has been a small step in the direction of the claims of the Chinese central bank: flexibility slightly increased while the weight of the USD in the currency basket slightly decreased.

References

- Shah A, Zeileis A, Patnaik I (2005). "What is the New Chinese Currency Regime?" *Report 23*, Department of Statistics and Mathematics, Wirtschaftsuniversität Wien, Research Report Series. URL <http://epub.wu-wien.ac.at/>.
- Zeileis A, Shah A, Patnaik I (2007). "Exchange Rate Regime Analysis Using Structural Change Methods." *Report 56*, Department of Statistics and Mathematics, Wirtschaftsuniversität Wien, Research Report Series. URL <http://epub.wu-wien.ac.at/>.