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 (2008) 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**.

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

It is a "`zoo`" series containing 25 daily time series from 1971-01-04 to 2008-01-04. The columns correspond to the prices for various currencies (in ISO 4217 format) with respect to CHF as the unit currency.

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, SGD, 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.* (2008) are a basket of the most important floating currencies (USD, JPY, EUR, GBP). 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("2007-12-31"),
+   other = c("USD", "JPY", "EUR", "GBP"), 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,
+   data = window(cny, end = as.Date("2005-10-31")))
> summary(cny_lm)

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

Residuals:
      Min        1Q    Median        3Q       Max
-0.065697 -0.021036  0.001147  0.021440  0.069985

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.004782   0.003688  -1.297    0.199
USD          0.999653   0.008779 113.868   <2e-16 ***
JPY          0.004668   0.010669   0.437    0.663
EUR         -0.014238   0.026516  -0.537    0.593
GBP         -0.007744   0.014568  -0.532    0.597
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02953 on 63 degrees of freedom
Multiple R-squared: 0.9979,       Adjusted R-squared: 0.9978
F-statistic:  7577 on 4 and 63 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))
```

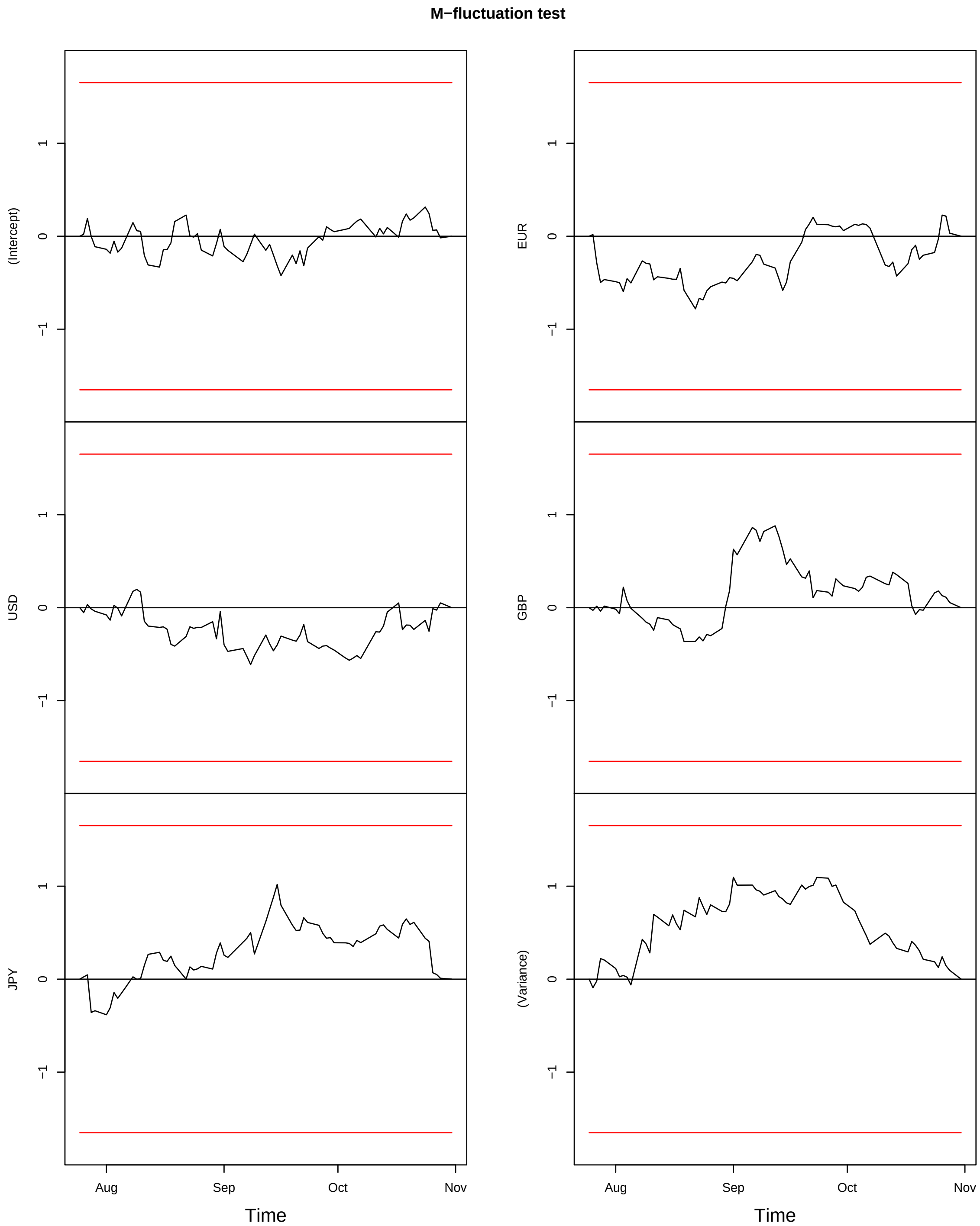

Figure 1: Historical fluctuation process for CNY exchange rate regime.

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

```
> sctest(cny_efp)

        M-fluctuation test

data:  cny_efp
f(efp) = 1.0968, p-value = 0.6965
```

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,
+   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 the variance component of the fluctuation process starts to deviate clearly from its mean. However, none of the coefficients deviates from its zero mean, signalling that there was no significant change in the currency weights. The change occurs in

```
> cny_mon

Monitoring of FX model

Formula: CNY ~ USD + JPY + EUR + GBP
History period: 2005-07-26 to 2005-10-31
Break detected: 2006-03-27
```

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,
+   data = cny, h = 20, breaks = 10)

[1] TRUE
```

We determine the optimal breakpoints for $1, \ldots, 10$ 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

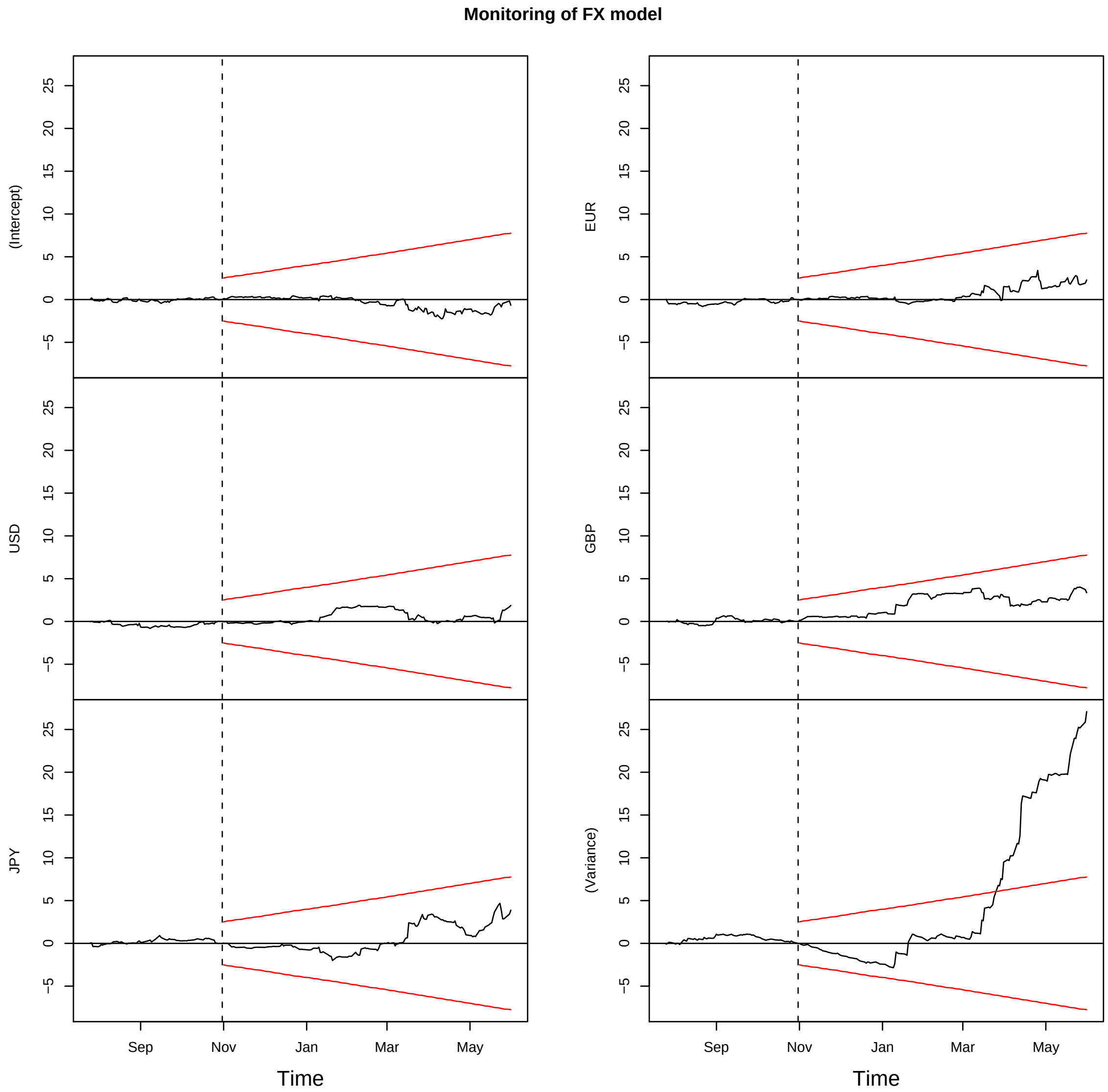

Figure 2: Monitoring fluctuation process for CNY exchange rate regime.

```
> 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., shortly before the boundary crossing in the monitoring procedure, confirming the findings above. The confidence interval for the break can be obtained by

```
> confint(cny_reg, level = 0.9)
```

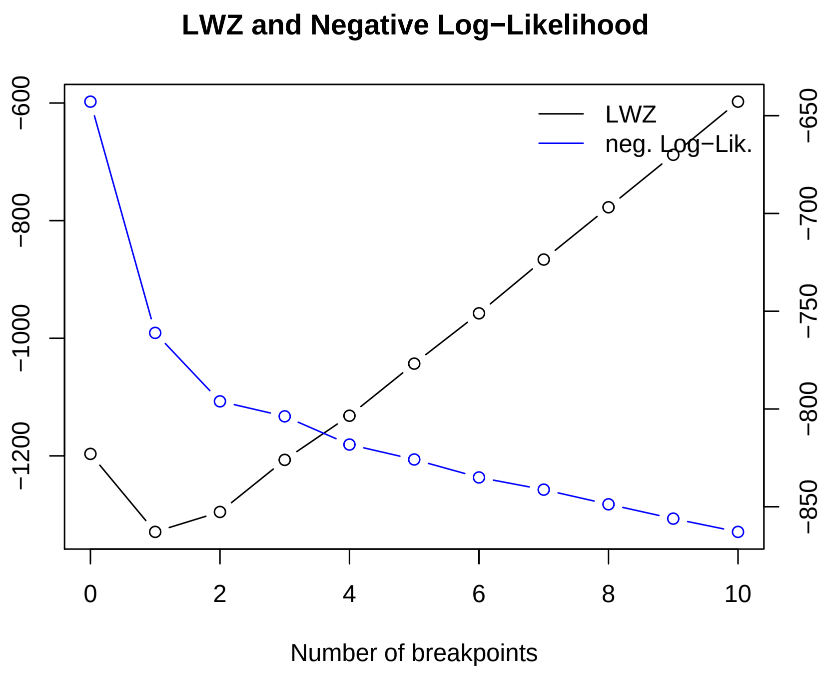

Figure 3: Negative log-likelihood and LWZ information criterion for CNY exchange rate regimes.

```
         Confidence intervals for breakpoints
         of optimal 2-segment partition: 

Call:
confint.fxregimes(object = cny_reg, level = 0.9)

Breakpoints at observation number:
  5 % breakpoints 95 %
1 142         158  159

Corresponding to breakdates:
         5 % breakpoints       95 %
1 2006-02-17  2006-03-14 2006-03-15
```

showing that the end of the low variance period can be determined more precisely than the start of the high variance period. The parameter estimates for both segments can be obtained by

```
> coef(cny_reg)

                        (Intercept)       USD          JPY         EUR
2005-07-26--2006-03-14 -0.005032973 0.9994096  0.005184123 -0.01524398
```

```
2006-03-15--2007-12-31 -0.020139885 0.9765548 -0.014909249  0.03036471
                                GBP   (Variance)
2005-07-26--2006-03-14  0.006838512 0.0007816822
2006-03-15--2007-12-31 -0.008622117 0.0092753281
```

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
-0.106628 -0.015830  0.001518  0.016454  0.090368

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.005033   0.002266  -2.221   0.0278 *
USD          0.999410   0.005421 184.370   <2e-16 ***
JPY          0.005184   0.005230   0.991   0.3231
EUR         -0.015244   0.016588  -0.919   0.3596
GBP          0.006839   0.008257   0.828   0.4088
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.02841 on 153 degrees of freedom
Multiple R-squared: 0.9979,       Adjusted R-squared: 0.9978
F-statistic: 1.788e+04 on 4 and 153 DF,  p-value: < 2.2e-16


$`2006-03-15--2007-12-31`

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

Residuals:
      Min        1Q    Median        3Q       Max
-0.455652 -0.060540  0.008402  0.056677  0.402327

Coefficients:
```

```
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.020140   0.004572  -4.405 1.32e-05 ***
USD          0.976555   0.013236  73.779  < 2e-16 ***
JPY         -0.014909   0.011043  -1.350    0.178
EUR          0.030365   0.029250   1.038    0.300
GBP         -0.008622   0.015585  -0.553    0.580
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 0.09684 on 451 degrees of freedom
Multiple R-squared: 0.9594,       Adjusted R-squared: 0.9591
F-statistic:  2667 on 4 and 451 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 $\sigma = 0.028$ to 0.096 which is still very low, even compared with other pegged exchange rate regimes (see the results India in `vignette("INR", package = "fxregime")`). The intercept is clearly smaller than 0, reflecting a slow appreciation of the CNY and thus 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 (2008). "Testing, Monitoring, and Dating Structural Changes in Maximum Likelihood Models." *Report 70*, Department of Statistics and Mathematics, Wirtschaftsuniversität Wien, Research Report Series. URL http://epub.wu-wien.ac.at/.