Regression Analysis: Case Study 2

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Contents

1 Linear Regression Models for Exchange Rate Regimes

1.1 Exchange Rate Data

The Federal Reserve Economic Database (FRED) provides historical daily exchange rates of all major currencies in the world.

An R script ("fm_casestudy_fx_1.r") collects these data and stores them in the R workspace "fm_casestudy_fx_1.RData".

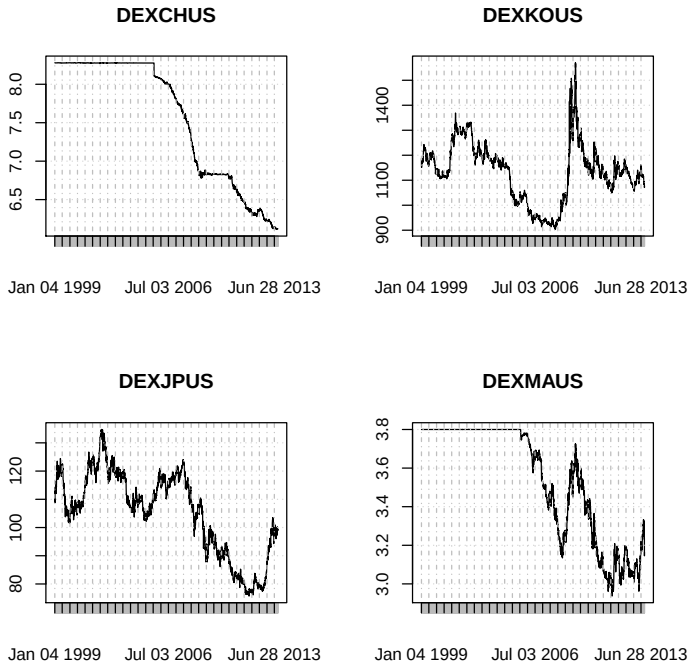
The following commands re-load the data and provide details explaining the data.

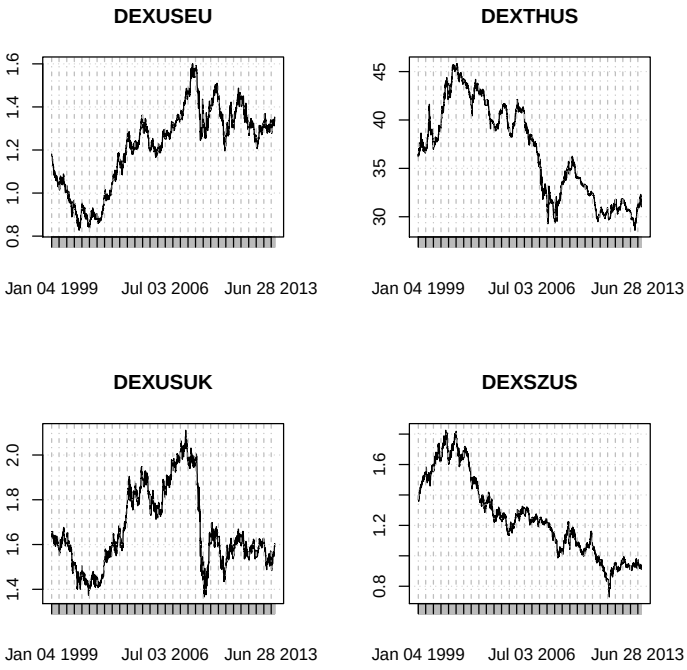
```
> # 0.1 Install/load libraries
> source(file="fm_casestudy_0_InstallOrLoadLibraries.r")
> # 0.2 Load R workspace created by script fm_casestudy_fx_1.r
> load(file="fm_casestudy_fx_1.Rdata")
> # 1.0 Extract time series matrix of exchange rates for symbols given by list.symbol0 ----
>
> list.symbol0<-c("DEXCHUS", "DEXJPUS", "DEXKOUS", "DEXMAUS",
+                 "DEXUSEU", "DEXUSUK", "DEXTHUS", "DEXSZUS")
> fxrates000<-fred.fxrates.00[,list.symbol0]
> dim(fxrates000)

[1] 3704    8

> head(fxrates000)

           DEXCHUS DEXJPUS DEXKOUS DEXMAUS DEXUSEU DEXUSUK DEXTHUS DEXSZUS
1999-01-04  8.2793  112.15  1187.5     3.8  1.1812  1.6581   36.20  1.3666
1999-01-05  8.2795  111.15  1166.0     3.8  1.1760  1.6566   36.18  1.3694
1999-01-06  8.2795  112.78  1160.0     3.8  1.1636  1.6547   36.50  1.3852
1999-01-07  8.2798  111.69  1151.0     3.8  1.1672  1.6495   36.30  1.3863
1999-01-08  8.2796  111.52  1174.0     3.8  1.1554  1.6405   36.45  1.3970
1999-01-11  8.2797  108.83  1175.0     3.8  1.1534  1.6375   36.28  1.3963

> tail(fxrates000)

           DEXCHUS DEXJPUS DEXKOUS DEXMAUS DEXUSEU DEXUSUK DEXTHUS DEXSZUS
2013-09-13  6.1186   99.38 1085.88  3.2880  1.3276  1.5861   31.81  0.9319
2013-09-16  6.1198   98.98 1081.34  3.2880  1.3350  1.5927   31.66  0.9258
2013-09-17  6.1213   99.16 1082.15  3.2455  1.3357  1.5901   31.68  0.9266
2013-09-18  6.1210   99.04 1081.40  3.2320  1.3351  1.5965   31.65  0.9260
2013-09-19  6.1210   99.33 1070.88  3.1455  1.3527  1.6043   31.03  0.9112
2013-09-20  6.1210   99.38 1076.02  3.1640  1.3522  1.6021   31.04  0.9104

>
> # Print symbol/description/units of these rates from data frame  fred.fxrates.doc
```

```
> options(width=120)
> print(fred.fxrates.doc[match(list.symbol0, fred.fxrates.doc$symbol),
+                        c("symbol0", "fx.desc", "fx.units")])
```

```
   symbol0                                    fx.desc                       fx.units
3  DEXCHUS       China / U.S. Foreign Exchange Rate      Chinese Yuan to  1 U.S. $
7  DEXJPUS       Japan / U.S. Foreign Exchange Rate      Japanese Yen to  1 U.S. $
8  DEXKOUS South Korea / U.S. Foreign Exchange Rate  South Korean Won to  1 U.S. $
9  DEXMAUS    Malaysia / U.S. Foreign Exchange Rate Malaysian Ringgit to  1 U.S. $
20 DEXUSEU        U.S. / Euro Foreign Exchange Rate              U.S. $ to  1 Euro
22 DEXUSUK        U.S. / U.K. Foreign Exchange Rate     U.S. $ to  1 British Pound
18 DEXTHUS    Thailand / U.S. Foreign Exchange Rate         Thai Baht to  1 U.S. $
16 DEXSZUS Switzerland / U.S. Foreign Exchange Rate      Swiss Francs to  1 U.S. $
```

```
> # Plot exchange rate time series in 2x2 panels
> par(mfcol=c(2,2))
> for (j0 in c(1:ncol(fxrates000))){
+   plot(fxrates000[,j0],
+        main=dimnames(fxrates000)[[2]][j0])
+ }
```





The time series matrix $fxrates000$ has data directly from the FRED website.

1.2 Exchange Rate Regimes for the Chinese Yuan

The Chinese Yuan was pegged to the US Dollar prior to July 2005. Then, China announced that the exchange rate would be set with reference to a basket of other currencies, allowing for a movement of up to 0.3% movement within any given day. The actual currencies and their basket weights are unannounced by China.

From an empirical standpoint, there are several important questions

- For any given period, what is the implicit reference basket for the Chinese currency?
- Has the reference basket changed over time?
- Has the Chinese currency depreciated with respect to the dollar?

  If so, how much and when?

Frankel and Wei (1994) detail methodology for evaluating the implicit exchange rate regime of a currency. The approach regesses changes in the target currency on changes in the values of possible currencies in the reference basket.

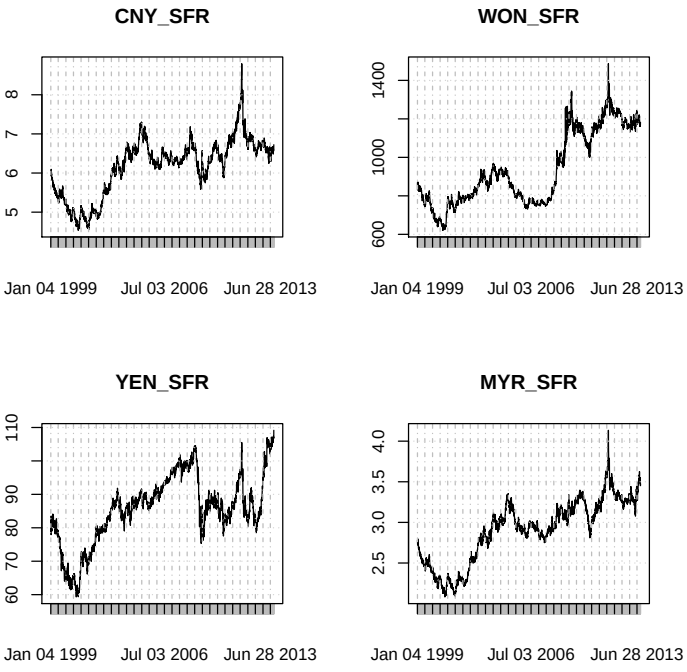
To apply this methodology we re-express the dollar-based exchange rates using another currency, the Swiss Franc. This allows currency moves of the

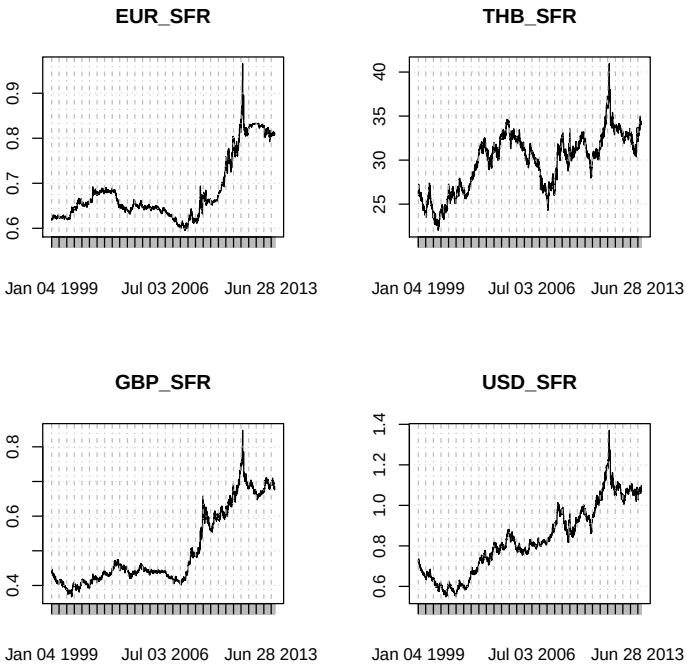
dollar to be be used to explain moves in the Yuan. The choice of Swiss Franc is consistent with evaluations with respect to a stable, developed-market currency.

1.3 Converting from USD Base to Swiss Franc Base

The following R commands convert the dollar-based rates in $fxrates000$ to Swiss-Franc-based rates in $fxrates000.0$

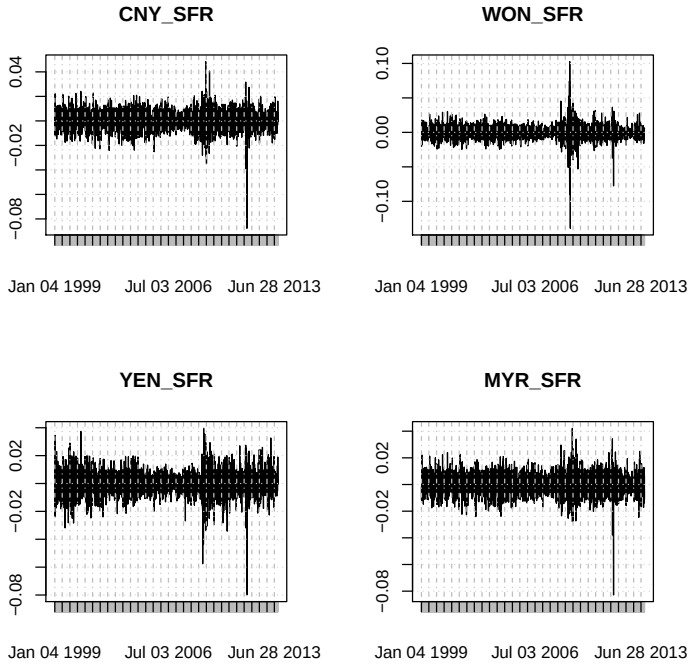
```
> # 2.0 Convert currencies to base rate of DEXSZUS, Swiss Franc
> fxrates000.0<-fxrates000
> # For exchange rates with 1 U.S. $ in base, divide by DEXSZUS
> for (jcol0 in c(1,2,3,4,7)){
+   coredata(fxrates000.0)[,jcol0]<- coredata(fxrates000.0[,jcol0])/
+     coredata(fxrates000[,8])
+
+ }
> # For exchange rates with 1 U.S. $ in numerator, divide inverse by DEXSZUS
> for (jcol0 in c(5,6)){
+   coredata(fxrates000.0)[,jcol0]<- coredata(1./fxrates000.0[,jcol0])/
+     coredata(fxrates000.0[,8])
+ }
> # For USD, divide $1 by the DEXSZUS rate
> dimnames(fxrates000.0)[[2]]

[1] "DEXCHUS" "DEXJPUS" "DEXKOUS" "DEXMAUS" "DEXUSEU" "DEXUSUK" "DEXTHUS" "DEXSZUS"

> coredata(fxrates000.0)[,8]<- 1/coredata(fxrates000)[,8]
> # Rename series in terms of the SWIFT currency codes
> #     as determined by the International Organization for Standardization.
>
> list.symbol0.swiftcode<-c("CNY","YEN","WON","MYR","EUR","GBP","THB","USD")
> dimnames(fxrates000.0)[[2]]<-paste(list.symbol0.swiftcode,"_SFR",sep="")
> head(fxrates000.0)

            CNY_SFR  YEN_SFR  WON_SFR  MYR_SFR   EUR_SFR   GBP_SFR  THB_SFR   USD_SFR
1999-01-04 6.058320 82.06498 868.9448 2.780623 0.6194912 0.4413142 26.48910 0.7317430
1999-01-05 6.046079 81.16693 851.4678 2.774938 0.6209582 0.4408106 26.42033 0.7302468
1999-01-06 5.977115 81.41785 837.4242 2.743286 0.6204172 0.4362830 26.34999 0.7219174
1999-01-07 5.972589 80.56698 830.2676 2.741109 0.6180128 0.4373111 26.18481 0.7213446
1999-01-08 5.926700 79.82820 840.3722 2.720115 0.6195427 0.4363423 26.09162 0.7158196
1999-01-11 5.929743 77.94170 841.5097 2.721478 0.6209281 0.4373609 25.98295 0.7161785

> #  Plot exchange rate time series in 2x4 panel
> par(mfcol=c(2,2))
> for (j0 in c(1:ncol(fxrates000.0))){
+   plot(fxrates000.0[,j0],
+        main=dimnames(fxrates000.0)[[2]][j0])
+ }
```


CNY_SFR
5
6
7
8
Jan 04 1999
Jul 03 2006
Jun 28 2013
WON_SFR
600
1000
1400
Jan 04 1999
Jul 03 2006
Jun 28 2013
YEN_SFR
60
70
80
90
110
Jan 04 1999
Jul 03 2006
Jun 28 2013
MYR_SFR
2.5
3.0
3.5
4.0
Jan 04 1999
Jul 03 2006
Jun 28 2013



1.4 Linear Regression Models of Currency Returns

```
> # 3.0 Compute daily price changes on the log scale
> #     Due to missing data, fill in missing values with previous non-NA
> #     To check for presence of missing values, execute
> #         apply(is.na(fxrates000.0),2,sum)
> #     If necessary apply
> #   fxrates000.0<-na.locf(fxrates000.0)
> fxrates000.0.logret<-diff(log(fxrates000.0))
> dimnames(fxrates000.0.logret)[[2]]

[1] "CNY_SFR" "YEN_SFR" "WON_SFR" "MYR_SFR" "EUR_SFR" "GBP_SFR" "THB_SFR" "USD_SFR"

> par(mfcol=c(2,2))
> for (j0 in c(1:ncol(fxrates000.0.logret))){
+   plot(fxrates000.0.logret[,j0],
+        main=dimnames(fxrates000.0.logret)[[2]][j0])
+ }
```



First, we fit the regression model for the period prior to July 2005 when the Chinese currency was pegged to the US dollar.

```
> lmfit.period1<-lm( CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR,
+          data=window(fxrates000.0.logret,
+                      start=as.Date("2001-01-01"), end=as.Date("2005-06-30")) )
> summary.lm(lmfit.period1)

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR,
    data = window(fxrates000.0.logret, start = as.Date("2001-01-01"),
        end = as.Date("2005-06-30")))

Residuals:
       Min         1Q     Median         3Q        Max
-1.086e-03 -1.136e-05  1.500e-07  1.103e-05  1.137e-03

Coefficients:
             Estimate Std. Error  t value Pr(>|t|)
(Intercept) -1.170e-07  2.486e-06   -0.047    0.962
USD_SFR      1.000e+00  5.440e-04 1838.910   <2e-16
YEN_SFR     -3.226e-04  4.712e-04   -0.685    0.494
EUR_SFR     -5.396e-04  1.210e-03   -0.446    0.656
```

```
GBP_SFR     -2.183e-05  7.075e-04   -0.031    0.975

Residual standard error: 8.354e-05 on 1126 degrees of freedom
Multiple R-squared: 0.9999,        Adjusted R-squared: 0.9999
F-statistic: 1.894e+06 on 4 and 1126 DF,  p-value: < 2.2e-16
```

The regression fit identifies the pegging of the Yuan (CNR_SFR) to the US Dollar (USD_SFR). The $R - Squared$ is nearly 1.0

Second, we fit the regression model for the first six months following the announcement of the change in currency policy.

```
> lmfit.period2<-lm( CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
+                      WON_SFR + MYR_SFR + THB_SFR,
+                    data=window(fxrates000.0.logret,
+                        start=as.Date("2005-07-01"), end=as.Date("2005-12-31")) )
> summary.lm(lmfit.period2)

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = window(fxrates000.0.logret,
    start = as.Date("2005-07-01"), end = as.Date("2005-12-31")))

Residuals:
       Min         1Q     Median         3Q        Max
-0.0132690 -0.0004520  0.0000850  0.0005842  0.0032820

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0001198  0.0001382  -0.867    0.387
USD_SFR      0.1948616  0.1528495   1.275    0.205
YEN_SFR     -0.0082667  0.0381872  -0.216    0.829
EUR_SFR      0.0697740  0.0937341   0.744    0.458
GBP_SFR     -0.0255185  0.0455883  -0.560    0.577
WON_SFR      0.1785894  0.0362880   4.921 2.84e-06
MYR_SFR      0.7526919  0.1471344   5.116 1.24e-06
THB_SFR     -0.0693646  0.0609775  -1.138    0.258

Residual standard error: 0.001522 on 117 degrees of freedom
Multiple R-squared: 0.9491,        Adjusted R-squared: 0.946
F-statistic: 311.4 on 7 and 117 DF,  p-value: < 2.2e-16
```

During this six-month period, there is evidence of the Yuan departing from a US Dollar peg. The exchange rates with the statsitically significant regression parameters are for the Korean Won (WON_SFR) and the Malaysian Ringgit (MYR_SFR).

To examine for futher changes in the implicit reference basket, we fit the same model for the annual periods from 2006 through 2012 and for the first 6 months of 2013.

```
> for (year0 in as.character(c(2006:2013))){
+   # year0<-"2012"
+   lmfit.year0<-lm( CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
+                      WON_SFR + MYR_SFR + THB_SFR,
+                    data=fxrates000.0.logret[year0])
+
+   cat("\n\n--------------------------------\n");cat(year0);cat(":\n")
+   print(summary.lm(lmfit.year0))
+   rate.appreciation.usd<-round( exp(252*log(1+ lmfit.year0$coefficients[1])) -1,digits=3)
+   cat("\n"); cat(year0); cat("\t Annualized appreciation rate to implied reference basket:
+ }

--------------------------------
2006:

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])

Residuals:
       Min         1Q     Median         3Q        Max
-2.413e-03 -2.625e-04  5.131e-05  3.899e-04  2.504e-03

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.173e-04  4.228e-05  -2.773 0.005979
USD_SFR      9.222e-01  1.859e-02  49.614  < 2e-16
YEN_SFR     -5.226e-03  1.121e-02  -0.466 0.641520
EUR_SFR     -1.841e-02  2.927e-02  -0.629 0.529985
GBP_SFR     -1.693e-02  1.695e-02  -0.999 0.318732
WON_SFR      2.906e-02  1.201e-02   2.420 0.016245
MYR_SFR      6.909e-02  1.904e-02   3.628 0.000348
THB_SFR     -8.371e-03  1.100e-02  -0.761 0.447360

Residual standard error: 0.0006512 on 243 degrees of freedom
Multiple R-squared: 0.9866,        Adjusted R-squared: 0.9862
F-statistic:  2553 on 7 and 243 DF,  p-value: < 2.2e-16


2006         Annualized appreciation rate to implied reference basket: -0.029


--------------------------------
2007:

Call:
```

```
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])

Residuals:
       Min         1Q     Median         3Q        Max
-0.0043388 -0.0006900  0.0001165  0.0006523  0.0035492

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -2.477e-04  7.111e-05  -3.484 0.000585
USD_SFR      9.201e-01  3.655e-02  25.172  < 2e-16
YEN_SFR     -1.847e-02  1.774e-02  -1.041 0.298850
EUR_SFR      1.629e-02  4.971e-02   0.328 0.743357
GBP_SFR      4.861e-03  2.268e-02   0.214 0.830452
WON_SFR      2.148e-02  2.709e-02   0.793 0.428514
MYR_SFR      1.227e-02  2.907e-02   0.422 0.673389
THB_SFR      1.411e-03  8.770e-03   0.161 0.872287

Residual standard error: 0.001109 on 246 degrees of freedom
Multiple R-squared: 0.9332,        Adjusted R-squared: 0.9313
F-statistic: 491.2 on 7 and 246 DF,  p-value: < 2.2e-16


2007         Annualized appreciation rate to implied reference basket: -0.061


--------------------------------
2008:

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])

Residuals:
       Min         1Q     Median         3Q        Max
-0.0103217 -0.0008105  0.0000162  0.0007503  0.0098093

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept) -0.0002996  0.0001222  -2.452  0.01492
USD_SFR      0.9124811  0.0369556  24.691  < 2e-16
YEN_SFR     -0.0010178  0.0173259  -0.059  0.95320
EUR_SFR      0.0415111  0.0342314   1.213  0.22643
GBP_SFR      0.0163507  0.0193508   0.845  0.39896
WON_SFR     -0.0192298  0.0073131  -2.629  0.00909
MYR_SFR      0.0739607  0.0307166   2.408  0.01679
```

```
THB_SFR      0.0114822  0.0208899   0.550  0.58306

Residual standard error: 0.001906 on 244 degrees of freedom
Multiple R-squared: 0.9621,        Adjusted R-squared: 0.9611
F-statistic: 885.8 on 7 and 244 DF,  p-value: < 2.2e-16


2008         Annualized appreciation rate to implied reference basket: -0.073


--------------------------------
2009:

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])

Residuals:
       Min         1Q     Median         3Q        Max
-1.994e-03 -1.400e-04  1.770e-06  1.305e-04  1.221e-03

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  7.771e-06  2.176e-05   0.357 0.721273
USD_SFR      9.405e-01  9.676e-03  97.201  < 2e-16
YEN_SFR      5.974e-03  2.960e-03   2.018 0.044641
EUR_SFR     -1.549e-02  6.958e-03  -2.227 0.026879
GBP_SFR      4.148e-03  3.014e-03   1.376 0.170055
WON_SFR     -1.672e-03  2.669e-03  -0.626 0.531606
MYR_SFR      2.530e-02  6.950e-03   3.640 0.000333
THB_SFR      3.102e-02  1.239e-02   2.504 0.012946

Residual standard error: 0.0003438 on 244 degrees of freedom
Multiple R-squared: 0.9984,        Adjusted R-squared: 0.9983
F-statistic: 2.165e+04 on 7 and 244 DF,  p-value: < 2.2e-16


2009         Annualized appreciation rate to implied reference basket: 0.002


--------------------------------
2010:

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])
```

```
Residuals:
       Min         1Q     Median         3Q        Max
-0.0051398 -0.0002402  0.0000951  0.0003745  0.0036134

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -9.527e-05  6.374e-05  -1.495   0.1363
USD_SFR      9.116e-01  3.078e-02  29.613   <2e-16
YEN_SFR      1.170e-03  1.048e-02   0.112   0.9112
EUR_SFR      2.072e-02  1.441e-02   1.439   0.1516
GBP_SFR     -3.160e-02  1.248e-02  -2.532   0.0120
WON_SFR      2.656e-03  1.066e-02   0.249   0.8035
MYR_SFR      2.359e-02  1.801e-02   1.310   0.1915
THB_SFR      6.507e-02  3.372e-02   1.930   0.0548

Residual standard error: 0.0009746 on 242 degrees of freedom
Multiple R-squared: 0.9805,        Adjusted R-squared: 0.9799
F-statistic:  1739 on 7 and 242 DF,  p-value: < 2.2e-16


2010         Annualized appreciation rate to implied reference basket: -0.024


--------------------------------
2011:

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])

Residuals:
       Min         1Q     Median         3Q        Max
-0.0048725 -0.0005380  0.0000138  0.0005746  0.0061446

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.968e-04  8.079e-05  -2.436   0.0156
USD_SFR      8.702e-01  2.834e-02  30.705  < 2e-16
YEN_SFR      7.857e-03  1.519e-02   0.517   0.6054
EUR_SFR     -3.959e-04  1.670e-02  -0.024   0.9811
GBP_SFR      4.297e-02  2.092e-02   2.054   0.0410
WON_SFR     -2.590e-02  1.696e-02  -1.527   0.1281
MYR_SFR      9.535e-02  2.351e-02   4.056 6.73e-05
THB_SFR      1.743e-02  3.329e-02   0.523   0.6011
```

```
Residual standard error: 0.001275 on 243 degrees of freedom
Multiple R-squared: 0.9837,        Adjusted R-squared: 0.9832
F-statistic:  2097 on 7 and 243 DF,  p-value: < 2.2e-16


2011         Annualized appreciation rate to implied reference basket: -0.048


--------------------------------
2012:

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])

Residuals:
       Min         1Q     Median         3Q        Max
-0.0042900 -0.0003965  0.0000060  0.0004424  0.0044475

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.951e-05  6.105e-05  -0.320   0.7495
USD_SFR      9.064e-01  2.669e-02  33.957  < 2e-16
YEN_SFR     -5.759e-03  1.323e-02  -0.435   0.6637
EUR_SFR     -1.320e-01  5.985e-02  -2.205   0.0284
GBP_SFR     -8.758e-03  2.132e-02  -0.411   0.6816
WON_SFR      1.777e-03  2.282e-02   0.078   0.9380
MYR_SFR      1.103e-01  2.216e-02   4.979 1.21e-06
THB_SFR      1.895e-03  2.880e-02   0.066   0.9476

Residual standard error: 0.0009568 on 243 degrees of freedom
Multiple R-squared: 0.9711,        Adjusted R-squared: 0.9702
F-statistic:  1165 on 7 and 243 DF,  p-value: < 2.2e-16


2012         Annualized appreciation rate to implied reference basket: -0.005


--------------------------------
2013:

Call:
lm(formula = CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
    WON_SFR + MYR_SFR + THB_SFR, data = fxrates000.0.logret[year0])

Residuals:
```

```
       Min         1Q     Median         3Q        Max
-1.914e-03 -3.606e-04  2.782e-05  3.593e-04  2.042e-03

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept) -1.040e-04  4.941e-05  -2.106  0.03666
USD_SFR      9.679e-01  1.596e-02  60.655  < 2e-16
YEN_SFR      9.051e-03  7.594e-03   1.192  0.23492
EUR_SFR      1.581e-02  2.138e-02   0.740  0.46056
GBP_SFR     -3.526e-03  1.366e-02  -0.258  0.79658
WON_SFR      3.770e-02  1.316e-02   2.864  0.00469
MYR_SFR      4.628e-05  1.313e-02   0.004  0.99719
THB_SFR     -1.033e-03  1.460e-02  -0.071  0.94364

Residual standard error: 0.0006637 on 175 degrees of freedom
Multiple R-squared: 0.9891,        Adjusted R-squared: 0.9886
F-statistic:  2263 on 7 and 175 DF,  p-value: < 2.2e-16


2013         Annualized appreciation rate to implied reference basket: -0.026
```

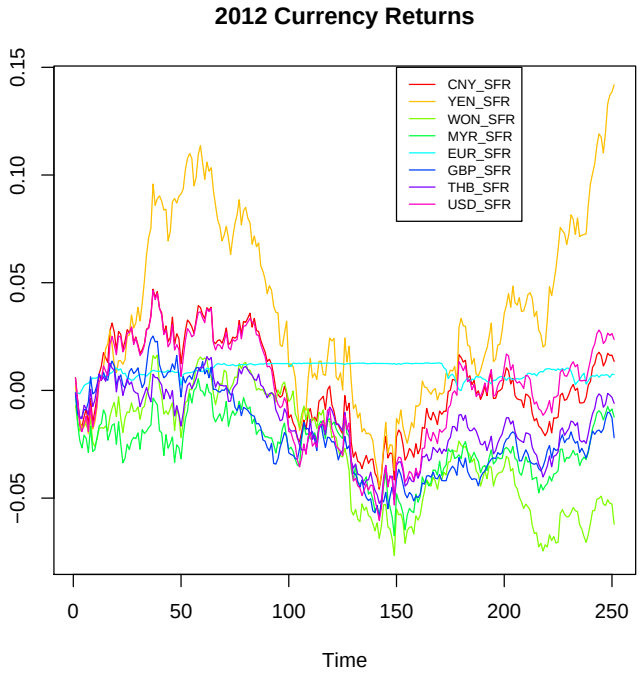
From these annual results we note:

- These fitted regression models demonstrate that the statistical evidence for the underlying reference basket of currencies changes from year to year.
- Note how the different exhange rates are significant predictors of the daily change in the Yuan exchange rate for different years.
- The computations include a measure of the annualized trend in the Yuan exchange rate relative to the other currencies. Notice that this rate is negative, to varying degrees over the seven-plus years.

We illustrate some additional features of exchange rate regime modelling using the reference basket implied by the data for 2012.

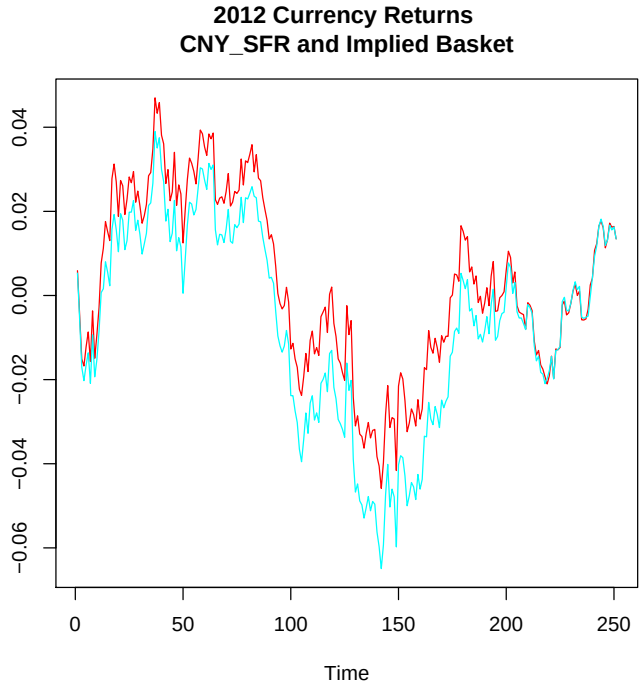
First, we plot the currency returns for the Yuan and all currencies included in the analysis.

```
> year0<-"2012"
> par(mfcol=c(1,1))
>   ts.plot(cumsum(fxrates000.0.logret["2012"]), col=rainbow(NCOL(fxrates000.0.logret)),
+           main="2012 Currency Returns")
>   legend(x=150,y=.15, legend=dimnames(fxrates000.0.logret)[[2]], lty=rep(1,times=ncol(fxra
+        col=rainbow(NCOL(fxrates000.0.logret)), cex=0.70)
```



Then, we plot the currency return of the Yuan and that of the implied reference basket specified by the regression:

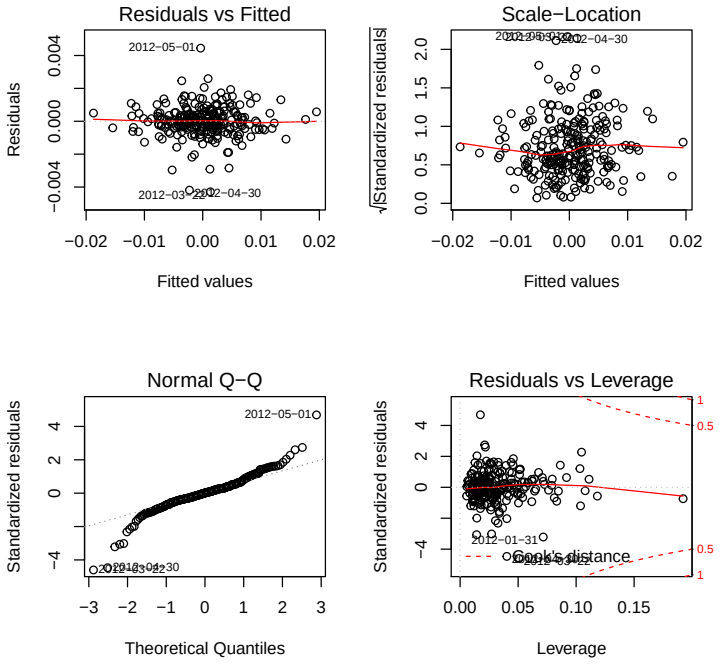
```
> lmfit.year0<-lm( CNY_SFR ~ USD_SFR + YEN_SFR + EUR_SFR + GBP_SFR +
+                    WON_SFR + MYR_SFR + THB_SFR,
+                  data=fxrates000.0.logret[year0])
> y0.actual<-fxrates000.0.logret["2012"][,"CNY_SFR"]
> y0.fit<-y0.actual - lmfit.year0$residuals
> ts.plot(cumsum(cbind(y0.actual, y0.fit)),
+         col=rainbow(NCOL(fxrates000.0.logret))[c(1,5)],
+         main="2012 Currency Returns \nCNY_SFR and Implied Basket")
```



Note how closely the reference basket tracks the Yuan. This is to be expected given the high $R-$squared of the regression.

Finally, we apply the R function $influence.measures()$

```
> layout(matrix(c(1,2,3,4),2,2)) # optional 4 graphs/page
> plot(lmfit.year0)
```



These diagnostics indicate:

- The residuals appear well-behaved as they relate to the size of the fitted values. The residual variance does not increase with the magnitude of the fitted values.
- The residuals exhibit heavier tails than those of a normal distribution. However for those residuals within two standard deviations of their mean, their distribution is close to that of a normal distribution.

References

Frankel J.A., and S Wei (1994) Yen Bloc or Dollar Bloc? Exchange Rate Policies of the East Asian Economies, Chaptr in *Macroeconomic Linkage: Savings, Exchange Rates, and Capital Flows, NBER-EASE Volume 3*, Takatoshi Ito and Anne Krueger, editors. University of Chicago Press, Chapter URL: http://www.nber.org/chapters/c8537.pdf

Frankel J.A., and S Wei (2007) Assessing China's Exchange Rate Regime, NATIONAL BUREAU OF ECONOMIC RESEARCH: Working Paper 13100, http://www.nber.org/papers/w13100 , Cambridge.

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