

USD Exchange Rate Modelling

Wei-Chih Chuang

Stat, NCU

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Motivations

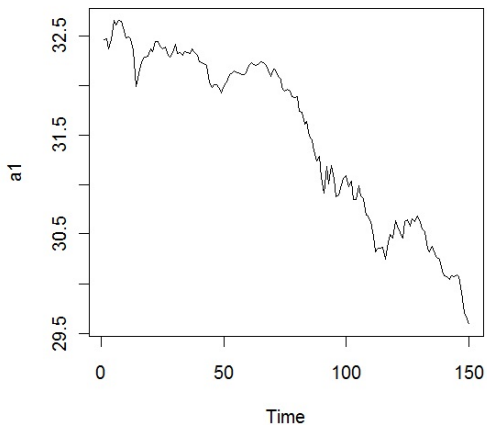
Recently, the exchange rate has large volatility between NTD and USD. By historical news, we can see it usually fluctuate between NT\$29 and NT\$31, there might be few reasons : the relationship between North & South Korea ,the intervention by Soros ,or even the implementation of ECFA etc. So I'd like to model the data and even predict for couple days.

Data

Date	Short	Cash
20100601	short	32.462
20100602	short	32.472
20100603	short	32.372
⋮	⋮	⋮
20101228	short	29.672
20101229	short	29.592

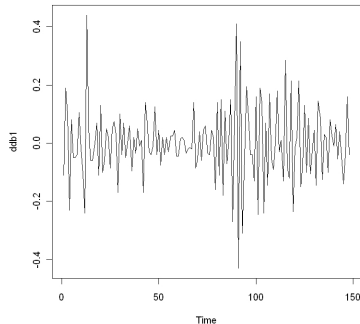
Data source : Taiwan Bank
(<http://rate.bot.com.tw/Pages/Static/UIP003.zh-TW.htm>)

Time series plot



The Proposed Model

According to the time series plot, it is obviously not stationary and there is a decreasing trend, so I tried to differenece the data twice.



The Proposed Model I

Although the mean term might be stable, but the variance are quite weird. We can see that the variance at interval 50 to 65 is quite different to others, it is not satisfied the assumption of stationary data.

To fit this data, I used the following models :

- ARCH(1) model

$$y_t = \sigma_t \omega_t, \sigma_t^2 = 0.0059515 + 0.305249 y_{t-1}^2$$

The Proposed Model I

Diagnostic Tests:

Jarque Bera Test

H_0 : The skewness and kurtosis of residuals are normal.

data: Residuals

X-squared = 12.6428, df = 2, p-value = 0.001797

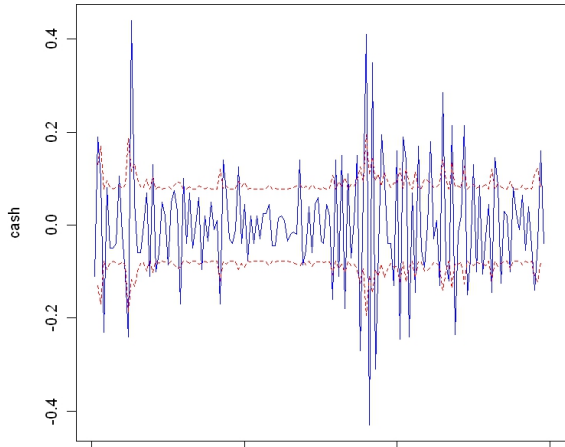
Box-Ljung test

H_0 : The correlation of residuals are 0.

data: Squared.Residuals

X-squared = 1.3101, df = 1, p-value = 0.2524

The Proposed Model I



The Proposed Model II

In addition to GARCH model, I also tried another method to fit this data, which is called Self-Exciting Threshold Autoregressive model or SETAR (TAR). This model was introduced by Chan(1983) and discussed extensively in Tong(1990), it is actually a particular case of the more general TAR model.

The Proposed Model II

SETAR Model

$$X_{t+s} = \begin{cases} \phi_1 + \phi_{10}X_t + \phi_{11}X_{t-d} + \dots + \phi_{1L}X_{t-(L-1)d} + \epsilon_{t+s} & Z_t \leq \text{th} \\ \phi_2 + \phi_{20}X_t + \phi_{21}X_{t-d} + \dots + \phi_{2H}X_{t-(H-1)d} + \epsilon_{t+s} & Z_t > \text{th} \end{cases}$$

where $Z_t = x_{t-\delta d}$ with threshold delay δ .

The Proposed Model II

- Unit-Root Test (Phillips-Perron Unit Root Test)

H_0 : Nonstationary v.s H_1 : Stationary

p-value = 0.7218

⇒ Nonstationary.

The Proposed Model II

1 1-Threshold Model

$$x_{t+1,L} = -2.415660 + 1.078913x_t, \text{ if } x_t < 31.01$$

$$x_{t+1,H} = -2.319857 + 1.071567x_t, \text{ if } x_t > 31.01$$

2 2-Threshold Model

$$x_{t+1,L} = -6.209066 + 1.205356x_t, \text{ if } x_t < 30.46$$

$$x_{t+1,M} = -9.412818 + 1.305947x_t, \text{ if } 30.46 < x_t < 31.01$$

$$x_{t+1,H} = -2.319857 + 1.071567x_t, \text{ if } x_t > 31.01$$

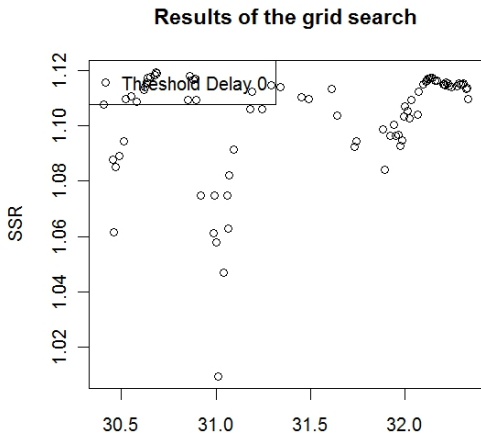
The Proposed Model II

1-Threshold

```
> print(y1)
Results of the grid search for 1 threshold
      Conditional on m= 1
      thDelay   th   SSR
1         0 31.012 1.009404
2         0 31.042 1.046853
3         0 31.002 1.057997
4         0 30.987 1.061225
5         0 30.462 1.061637
6         0 31.067 1.062965
7         0 31.062 1.074690
8         0 30.992 1.074751
9         0 30.922 1.074886
10        0 31.072 1.082167
> |
```

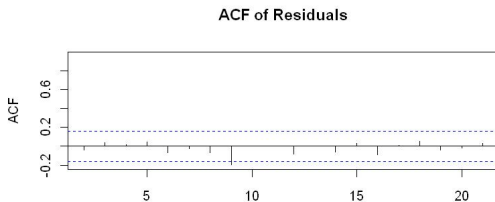
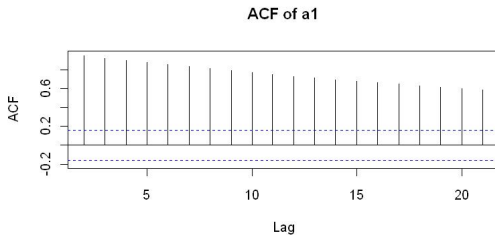
The Proposed Model II

1-Threshold grid

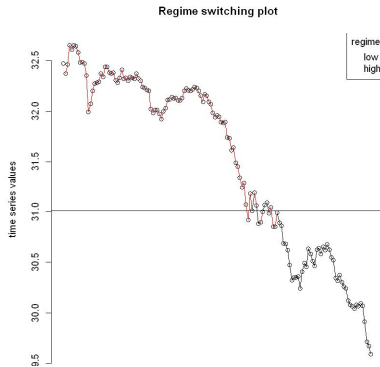


The Proposed Model II

1-Threshold ACF



The Proposed Model II



The Proposed Model II

2-Threshold

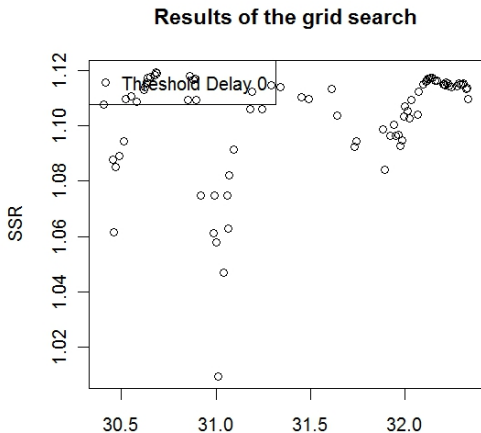
```
> print(y2)
Results of the grid search for 1 threshold
      Conditional on m= 1
  thDelay   th   SSR
1         0 31.012 1.009404
2         0 31.042 1.046853
3         0 31.002 1.057997
4         0 30.987 1.061225
5         0 30.462 1.061637

Results of the grid search for 2 thresholds
      Conditional on thDelay = 0 and m = 1
      th1   th2   SSR
1 30.462 31.012 0.9237535

Overall best results:
  thDelay   th1   th2   SSR
0.0000000 30.4620000 31.0120000 0.9237535
With lags:
  -ML: 1
  -MM: 1
  -MH: 1
> |
```

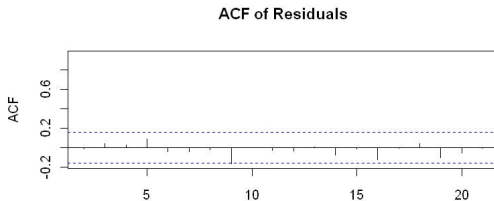
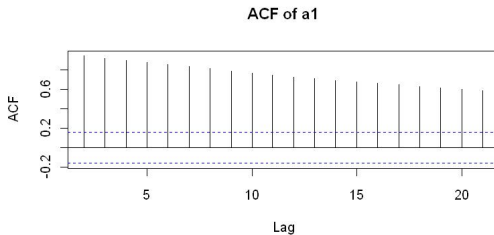
The Proposed Model II

1-Threshold grid

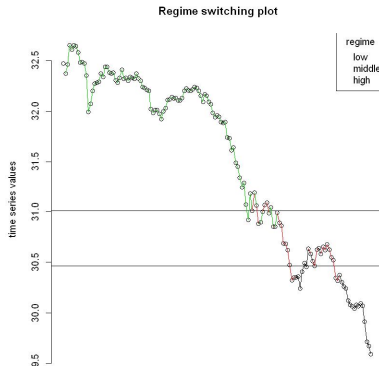


The Proposed Model II

1-Threshold ACF

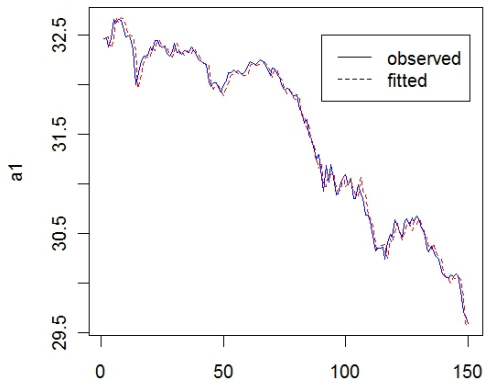


The Proposed Model II



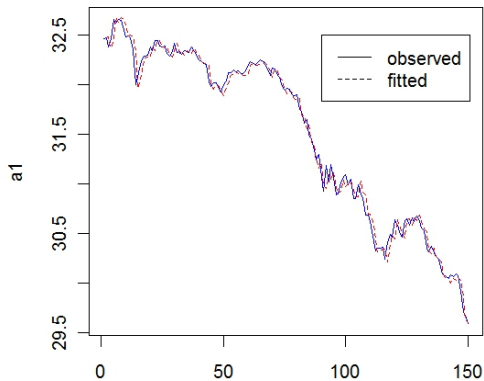
The Proposed Model II

1-Threshold Fitted



The Proposed Model II

2-Threshold Fitted



The Proposed Model II

Date	Real	1-Threshold	2-Threshold
20101231	29.322	29.5115	29.2327
20110103	29.307	29.4247	28.7636
20110104	NA	29.3310	28.1509
20110105	NA	29.2300	27.3508
20110106	NA	29.1210	26.3059

Future Works

- Improving the ARCH model and try to do forecasting.
- Find out how to estimate the threshold value in SETAR model.
- Try to fit data by MS-AR model.

References

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