

Singapore' Exchange Rate Regime: A Garch Approach

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Singapore is often cited for having successful exchange rate regimes. In fact it has been successful in maintaining low and stable rates of inflation and stability in its exchange rate. The basket, band and crawl features of the exchange rate system have served as an effective anchor of price stability, keeping inflation low and stable over the past 30 years. In addition, Singapore has complemented monetary policy with micron and macro-prudential measures to ensure overall price and financial stability in the economy. This study will demonstrate, through an econometric model in time series, if and how the Singapore *exchange rate policy* has changed in relation to the weight that four currency have within it. Specifically, utilizing Frankel's and Wei (2007) econometric model, we use a Garch approach because for most exchange rate time series, Garch model provide a sufficiently good fit.

1. Introduction

Monetary policy in Singapore has been characterized, since 1980, by price stability as a basis for sustainable economic growth. In this situation, therefore, thus falls the exchange rate regime that it present tree main features: a) the Singapore dollar is managed against a basket of currencies of major trading partners (in bases to weights) and depending on the extent of dependence with a particular country. So, the composition of the basket is revised every so often to take into account changes in Singapore's trade patterns; b) Monetary Authority of Singapore operates in a managed float regime for the his currency. The trade-weighted exchange rate is permissible to fluctuate within an hidden policy band, to a certain extent than kept to a fixed value. The band provides flexibility for the system to put up short-term fluctuations in the foreign exchange markets as well as some buffer in view of the

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country's equilibrium exchange rate, which cannot be known exactly. For this reason, Monetary Authority of Singapore' intervention operations generally works with anti-cyclical policies. Now, if the exchange rate moves outside the band, Monetary Authority will usually step in, through a buying or selling foreign exchange so as to guide the exchange rate back within the band; c) the exchange rate policy band is periodically reviewed to ensure that it remains consistent with the basic fundamentals of the macro-economic policy.

The decision to adopt an exchange rate regime type managed float is in accordance with many emerging markets (Calvo and Reinhart, 2002). This is due to eventually find mainly because these countries, such as Singapore, especially in the 70s and 80s, had a low international credibility. In addition, if we recall *trilemma*, a monetary policy open can only achieve two of the following three objectives: perfect capital mobility, fixed exchange rate regime and monetary policy autonomy. So, as Singapore is a world financial center, it has preferred the mobility of capital or to the detriment of the system of fixed exchange rates or the autonomy of monetary policy. In particular, the Monetary Authority of Singapore chose to use the exchange rate contrasting to the more conservative benchmark policy interest rate as its policy operating tool. But, managing the exchange rate has a high cost associated with the possible epileptic speculative. In this context, with the exception of the Asian financial crisis (1997), the Monetary Authority has successfully deterred speculators to attack the currency over the last three decades even though the major economists argue that it was a managed flexibility of the exchange rate system and its management have helped to Singapore during the Asian crisis. Yip (2005) underlined that Singapore's taking of market driven depreciations in the wake of and amid the deepening of the Asian financial crisis deterred currency speculators from engineering over-depreciation in the domestic currency. Therefore, the Asian financial crisis raised consciousness that exchange rates type *peg* and its attendant indemnity effect exacerbated boom-bust cycles linked with capital flows, thus contributing to the crisis.

In circumstance, the analysis of Singapore' the exchange rate regime seems very particular. The strength of the Singapore model is, in reality, very flexibility. In fact, a fixed exchange rate regime would imply that over a long run, the inflation rate of the economy in question has to

converge to that prevailing in the economies that it trades with. In the adjustment process, since the exchange rate cannot be changed, the entire burden of adjustment must then fall on the goods and the labor markets. While Singapore has more flexibility than most other countries, therefore, a fixed exchange rate regime is not a good idea especially when there are large shocks emanating from the rest of the world. In addition, instead, fully flexible exchange rates on the other hand will introduce volatility into the system, especially in a developing economy.

So, we can say that the Singapore' exchange rate regime that IMF defines "*Managed floating with no pre-determined path for the exchange rate*", present a sort of *Exchange rate anchor*, but with high volatility that may even influence macroeconomic performance. This last statement is very important. In fact, although the objective of this paper is to estimate the currencies in which the dollar Singaporean engages more, the awareness of the volatility cannot be considered as a system subject to the volatility present limitations shared by the literature. In particular, there are two strands of macroeconomic theory, the first strand examines how the domestic economy responds to foreign and domestic real and monetary shocks under different exchange rate regimes, the second strand focuses on the issue of how exchange rate volatility under flexible exchange rate regimes affects international trade. Overall, the shock of the exchange rate regime on volatility will depend on the type of shocks beating the domestic economy, with the general principle being that flexible exchange rates provide better lagging against foreign sourced real shocks, and fixed exchange rates insulating against domestic sourced LM type shocks. Concerning to this point, it is also true that fixed exchange rates are thought to transport more credible monetary policy and lower inflation. To the extent that lower inflation reduces inflation variability then a fixed exchange rate regime will be preferable. For second question, there is also a very large literature examining the question of how the exchange rate regime affects international trade. The all-purpose argument is that exchange rates will be more variable under flexible than fixed exchange rates, and this volatility will be harmful to trade. Trade will be worse affected the more risk averse are firms, the fewer are the opportunities to hedge against exchange rate fluctuations, and the greater is the fraction of revenues and expenditures denominated in foreign currency.

In this regard, we can say that just by virtue of the above affirmed that Singapore clearly has strong defenses against what it deems excessive exchange rate volatility triggered by destabilizing capital flows. These include its strong fundamentals, the adoption of a CB system, and the non adherence to a fixed currency peg when the economic situation changes.

At present the economy and monetary choices that go to influence even those of the exchange, appear to be stabilized. Financial market development is thereby facilitated, and at the same time the risk of heightened currency speculation during turbulent periods is reduced, along with the associated macroeconomic instability.

2. Estimating Exchange Rate Regime

In the past few years, at the end of checking various exchange regimes, many studies have been conducted using different techniques of estimation, notably, those that concern countries that use the anchor for currency regime peg (the Central European Bank, for example, uses models based on Brownian motion geometry). Among these studies Frankel and Wei (1994) proposed an original technical regressive.

Taking a logarithmic equation of the type:

$$(1) \ln \text{homecurrency}_{t+1} - \ln \text{homecurrency}_t = a + \sum w(j) \ln x(j,t,s) - \ln x(j,t)$$

If the national value (home) dependent variable of the model is linked to a series of values x_1, x_2, \dots, x_n for the corresponding weight w_1, w_2, \dots, w_n it would be possible to estimate through a general OLS, the weight of each value of the considered basket peg.

Nevertheless, the impossibility of defining the effective value of each currency, especially in the absence of a rigid basket peg induces the model of consideration of a chart of numbers in presence of which it will present itself regressively:

$$(2) \Delta \ln y_{\text{home}/k} = \alpha + \beta_1 \Delta \ln e_{\text{USD}/k} + \beta_2 \Delta \ln e_{\text{JPY}/k} + \beta_3 \Delta \ln e_{\text{Euro}/k} + \mu_t$$

Returning to the method of ordinary minimal quadratic equations, it is possible to estimate the weight of each single value (measured by

coefficients) that multiply the logarithmic variations of the corresponding exchange rates using a numeraire k respecting two simple criteria of analysis: error standard next to zero and R-squared near to one.

Although, as noted J. Frankel (2009) the weight-inference technique is well-specified if the true regime is a stretched basket peg it may be less well specified if the true regime allows flexibility. For any currency it is probable that in practice the basket peg is not perfect. For this reason is also used a new estimation:

$$\Delta \ln \text{RMB}_t = c + \sum w(j) \Delta \ln X(j)_t + \delta \{ \Delta \text{emp}_t \} + u_t$$

Where Δemp_t denotes the percentage change in exchange market pressure, that is, the increase in international demand for the RMB, which may show up either in the price of the RMB or the quantity of the RMB depending on the policies of the *Country (x)* monetary authorities (floating vs. fixed). So, $\Delta \text{emp}_t \equiv \Delta \ln \text{Currency}_t + \Delta \text{Res}_t / \text{MB}_t$.

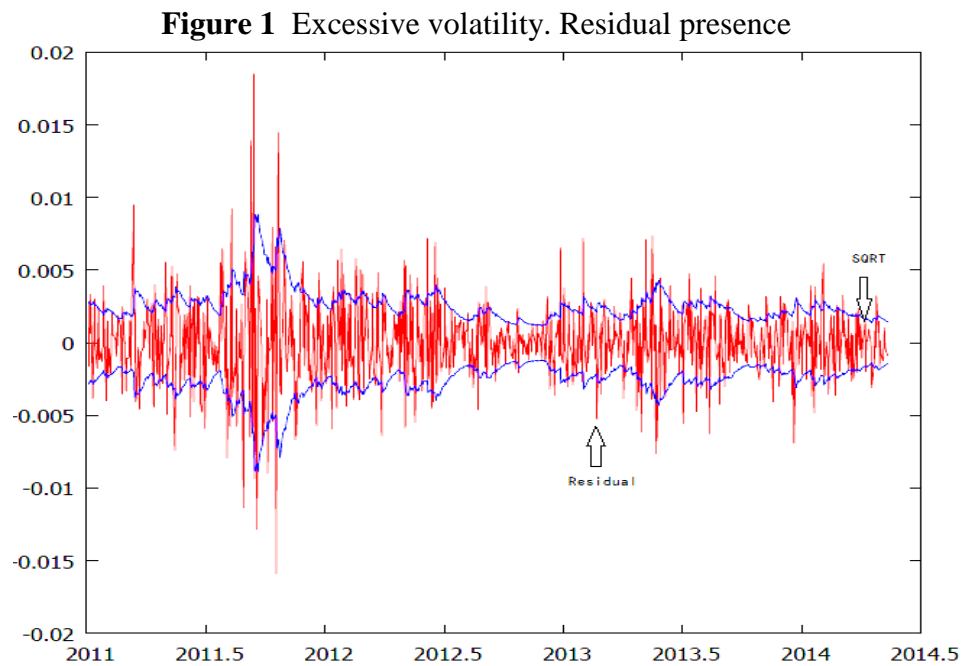
In addition it is possible to analyze the system of exchange based on the type of econometric technique used. It's likely to estimate with generally OLS and so analyzing the value of R^2 and coefficient pendency. Another way, for example Mele (2010), estimate Frankel's regression with a regressive technique in a time series employing a Kalman's filter, in other world using a time series approach. It is still possible to analyze a regime change with time series econometric techniques in more advanced. A case would be estimate a GARCH model for a time series approach. In particular, if an autoregressive moving average model is assumed for the error variance, the model is a generalized autoregressive conditional heteroskedasticity model.

That is, if we look at the analysis that the exchange rate should be seen to represent a form leptokurtic, you will need to specify an equation that assumes a representative in residuals of the type GARCH process.

In fact it is not always possible to be able to minimize the excessive volatility through the use of logarithms or logarithmic first differences. Analysis of the time series on a graph, in fact, could highlight the many excesses of fluctuations, even if stabilized. In this situation, an analysis of ARMA type OLS or become distorted, especially in the residuals: the

regression line does not actually pass between all observations, even in the face of a very high value of R-squared.

We might find, for example, in a situation such as the graph below:



Source: our econometric processing with Gretl. Ver. 1.8.4 software

In a situation like the one shown above, which takes into account the exchange rate of a currency Asian (basket-peg) with daily data, we will face an econometric process:

$$\mathcal{E}_t [I_{t-1} \sim N(0, h_t)]$$

$$h_t = \sigma^2 + \sum_{i=1}^p \alpha_i \mathcal{E}_{i-1}^2 + \sum_{i=1}^q \beta_i h_{i-1}$$

The variance in daily data depends on past news about volatility (\mathcal{E}^2) and past forecast variance (h_t). The inclusion of lagged conditional variances might capture some sort of adaptive learning mechanism. For most financial time series, Garch model provide a sufficiently good fit. This is also true for the others variable. Sufficient condition for well-defined variance and covariance only require $\alpha > 0$; $\beta > 0$; $\alpha + \beta < 1$.

3. On Singapore' exchange rate regime

Frankel' model to estimate has been enriched by various economists that have expanded this approach. The implementations of the model involved the estimation of the numeraire consideration (not always the Swiss franc but also SDR), the use of time series models and the use of Brown' general equilibrium, or using the percentage change in exchange market pressure as $\Delta emp_t \equiv \Delta \ln Currency_t + \Delta Res_t / MB_t$.

Now, using Frankel–Wei method, we consider the following:

$$I_t^{fw} = \Delta_e + \Delta_r$$

where Δ_e is defined as the local currency per some independent numeraire here we use the Special Drawing Right (SDR) and Δ_r is as defined earlier. So, Frankel–Wei method as follows:

$$(3) \Delta_e = \beta_0 + \beta_1 US_t + \beta_2 Yen_t + \beta_3 Euro_t + \beta_n Currency_t + \phi I_t^{fw} + \mu_t$$

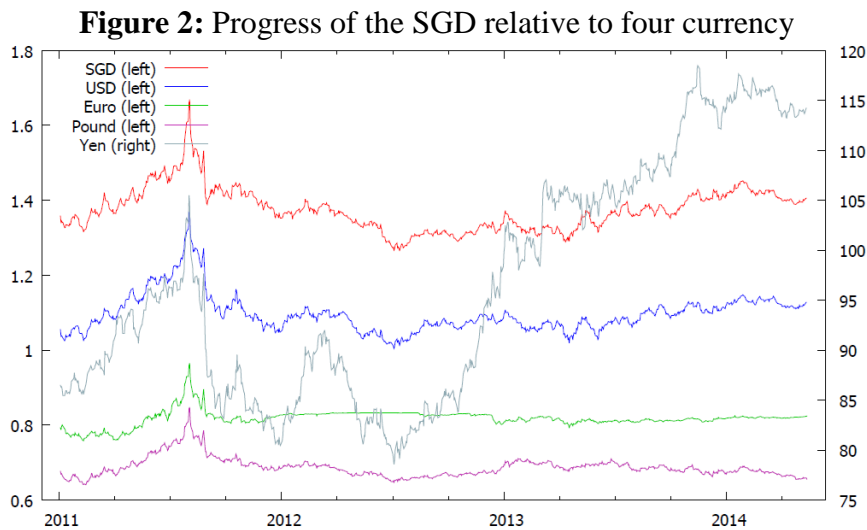
The β coefficients in equation are often interpreted as implicit currency weights. The various currencies used estimating, as for example US dollar, euro and yen (all per the SDR) are chosen as they represent world currencies deemed to exert sufficient influence on the local currency such that it is worthy of consideration in our estimates. While it is tempting to interpret these coefficients as potential basket weights, it is probably more prudent for them to be interpreted as “degrees of influence”.

The reason for this is that it is very difficult to say whether a high and significant coefficient value implies a basket currency or just reflects market-driven correlations. Under equation (3) with ϕ which tends to 1, the exchange rate per local currency becomes more flexible as I_t^{fw} converges to the dependent variable and the β coefficients should be close to zero and/or statistically insignificant. If ϕ tends to 0, the exchange rate becomes more fixed as the situation where reserve movements overshadow exchange rate movements is reflective of a sustained exchange rate intervention and the extent of fixity to various major currencies is captured by the β coefficients.

We use daily data for the period 2011 January 1 to 2014 June 30 or some sub-periods there of depending on data availability. The our equation well be:

$$(4) \Delta \text{SGD}_t = \beta_0 + \beta_1 \text{US}_t + \beta_2 \text{Yen}_t + \beta_3 \text{Euro}_t + \beta_n \text{Pound}_t + \phi I_t^{\text{fw}} + \mu_t$$

Before to estimate, it is preferred to carry out the Dickey-Fuller test prefixed to 29 delays necessary to test if the historic series relative to the five currency explicative, to the dependent currency (SGD).



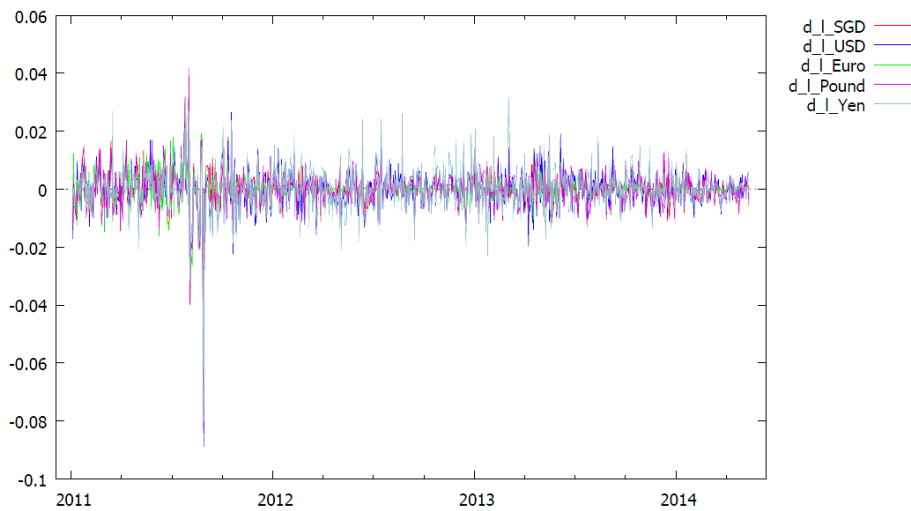
Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data.

The results obtained confirm the necessity of a logarithmic differentiation of the variables whether we consider as the numeraire Special Drawing Right, like that suggested by Frankel (1996).

Nevertheless, although stationary, the outcome of the correlogram provides proof, instead, of the presence of self-correlation between the four explicative.

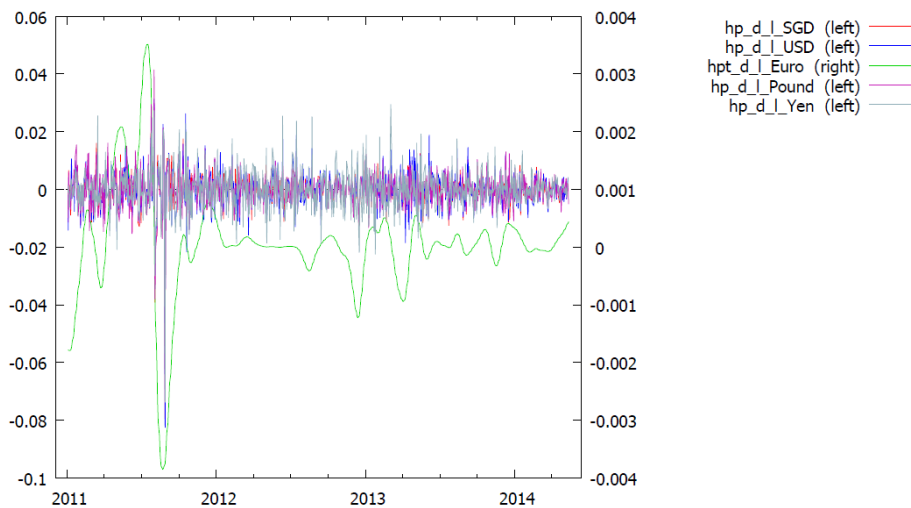
In addition, in order to better stabilize the process of volatility between the independent variables related to exchange rates, we introduced the H-P filter. In this case, better to be able to capture even the cyclical component relative to the pairs of the exchange rate.

Figure 3: Analyses of the stationary movements in prime logarithmic difference



Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data.

Figure 4 Analyses of the stationary movements in prime logarithmic difference and H-P filter



Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data.

A result of this type requires the application of a model different from the generic OLS (instead, it is used by various works which regard it), and more precisely, of an estimation in historic series of the type GARCH with the object of eliminating for each value, the influence of

the one preceding it and volatility process. Therefore, from our analyses that we have carried out, though still widely used, a methodology of regression spoiled by the error of self correlation.

4. Results

Function evaluations: 517

Evaluations of gradient: 222

Model : GARCH, using observations 2011-01-04:2014-05-12 (T = 875)

Dependent variable: hp_d_1_SGD

Standard errors based on Hessian

	coefficient	std. error	z	p-value
const	1.39159e-05	6.97032e-05	0.1996	0.8418
hp_d_1_USD	0.535387	0.0215566	24.84	3.63e-136 ***
hpt_d_1_Euro	0.0838992	0.108711	0.7718	0.4403
hp_d_1_Pound	0.286293	0.0219888	13.02	9.42e-039 ***
hp_d_1_Yen	0.0591650	0.0144305	4.100	4.13e-05 ***
alpha(0)	1.13060e-07	5.61708e-08	2.013	0.0441 **
alpha(1)	0.115511	0.0249626	4.627	3.70e-06 ***
beta(1)	0.874517	0.0248908	35.13	2.03e-270 ***

Mean dependent var 0.000000 S.D. dependent var 0.005961

Log-likelihood 4008.454 Akaike criterion -7998.907

Schwarz criterion -7955.939 Hannan-Quinn -7982.471

Analyzing the results about the model with t=875 it's possible to show as the informative criteria presents similar values, therefore, don't differentiate them self. The model, moreover, don't demonstrate common factors, confirming the reliability of the data obtained.

The values of R^2 adjusted for regression and that derived from the first OLS step is 80% (in appendix), indicating that the explanatory variables justify well the dependant variables; standard errors of regression showed values close to zero, with value of 0.005961.

The use of a GARCH model is proved to be absolutely fit and proper. In fact, if we observe the relative values $\alpha(0)$, $\alpha(1)$ e $\beta(1)$ they appear to be highly significant in the value of the p-value. Discussing now the results of the coefficients obtained from the model, it is immediately evident that the constant is not significant at any level of the p-value.

The currencies that are important in the commercial weight of Singapore and used by us as independent variables of the model, not all are significant. In particular, the model suggests that the weight of the euro turns out to be zero. The euro, therefore, does not affect the employee showing how the Singaporean dollar fluctuates without being affected by the euro.

The other three currencies considered, showing instead a value of the coefficient p-value with respect to the totally meaningful. A first consideration is that we can do the following: all three currencies, dollar, yen and pound, positively influence the dependent, or the Singaporean dollar. Values or the weight of each currency is rather different: the dollar confirms that the reference currency in the foreign exchange market for the type even-peg for Asian countries. In a nutshell it confirms the area of South East Asia as the dollar area. value tells us that each percentage point change in the weight of the dollar, the influence of dependent on 53.3%.

Second currency independent of the model, based on the weight of its coefficient, however, is the pound: it influences the Singaporean dollar at a value of 0.28.

Finally, we can say that the Japanese yen plays an important role in the exchange rate regime of the Singaporean dollar. Albeit marginally, you can clearly see from the results of the model that each percentage point change in the Singaporean dollar is due to the 5% to the change in the yen.

5. Conclusion

Singapore dollar originally was a exchange rate with a fixed link to a single currency. In particular, it was linked to Pound Sterling. After the dismantling of the Sterling Area in early 1970s, the Singapore Dollar

was linked to the U.S. Dollar, but only for a short period of time. From 1973 to 1985, Singapore pegged the value of Singapore Dollar against a fixed and undisclosed trade-weighted basket of currencies. Since 1985, with an aim to a more market-oriented regime, Singapore allowed its currency to float under the monitor of the Monetary Authority of Singapore which retains responsibility for exchange control matters in Singapore.

Now, Singapore' exchange rate regime may be classified as a Monitoring Band (IMF, 2012). With a primary goal to maintain public confidence, the currency in circulation is 100% backed by international assets for notes-issuance. In this contest, Monetary Authority of Singapore shows the Singapore dollar against an undisclosed basket of currencies of Singapore's major trading partners and competitors. The central parity is determined on the basis of countries that are the main sources of imported inflation and competition in export markets.

In this work we employ Garch approach to assess the time-varying weights of Singapore' exchange rate regime using daily data between January 2011 to June 2014 with volatility corrections. The model used has a high goodness highlighting how the data are used so perfectly adapted to the dependent variable.

Conscious of the fact that Singapore's economy appears to be most affected by the financial markets rather than real ones, we have chosen four reference currencies to try to understand what influenced the dependent variable. We thought that the currencies to be used for the Garch model, and then control the volatility, could be the most influence on the exchange rate regimes in Southeast Asia: dollar, yen, euro, pound. The results confirm our predictions: the dollar continues to be the reference currency most used; the euro is not this rather like significance in the model. Very interesting is the weight of the pound, confirming the link still exists between Singapore and the British currency. Finally, even the Japanese currency turns out to be significant in influencing the dependent.

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Appendix

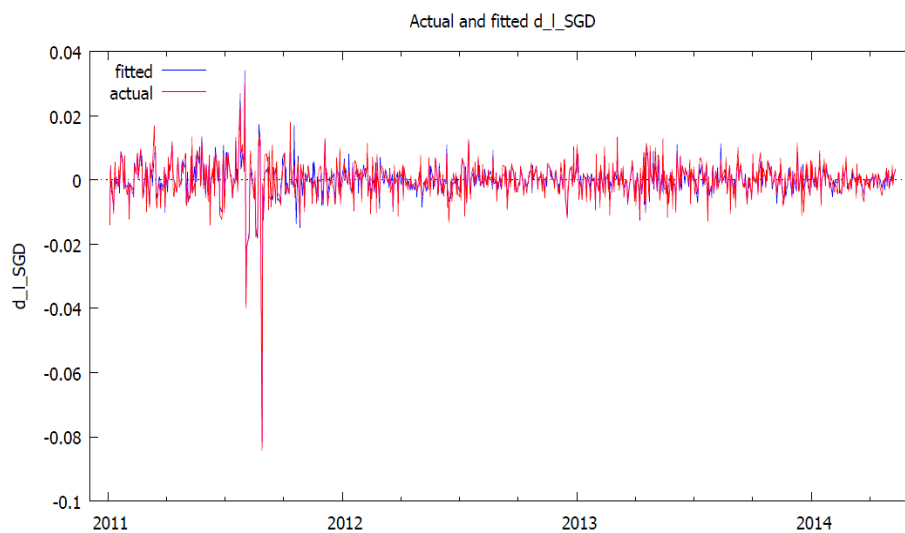
Model 1: OLS, using observations 2011-01-04:2014-05-12 (T = 875)

Dependent variable: d_I_SGD

HAC standard errors, bandwidth 7 (Bartlett kernel)

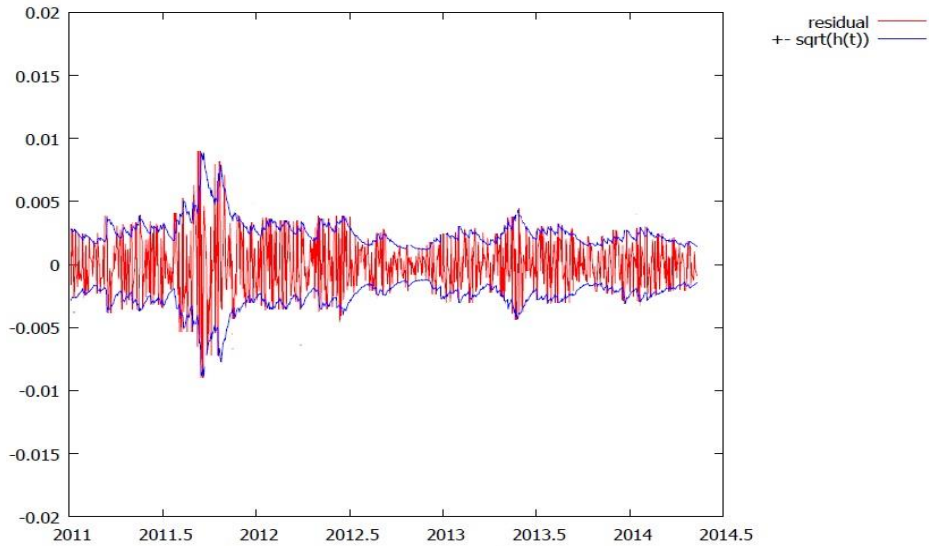
	coefficient	std. error	t-ratio	p-value	
const	-1.82208e-05	9.23898e-05	-0.1972	0.8437	
d_I_USD	0.426138	0.0393789	10.82	1.08e-025	***
d_I_Euro	0.289907	0.0288959	10.03	1.73e-022	***
d_I_Pound	0.231716	0.0374949	6.180	9.84e-010	***
d_I_Yen	0.0614303	0.0199401	3.081	0.0021	***

Mean dependent var	0.000040	S.D. dependent var	0.006138
Sum squared resid	0.006335	S.E. of regression	0.002698
R-squared	0.807618	Adjusted R-squared	0.806733
F(4, 870)	1020.198	P-value(F)	0.000000
Log-likelihood	3936.631	Akaike criterion	-7863.262
Schwarz criterion	-7839.391	Hannan-Quinn	-7854.131
rho	-0.037612	Durbin-Watson	2.074689



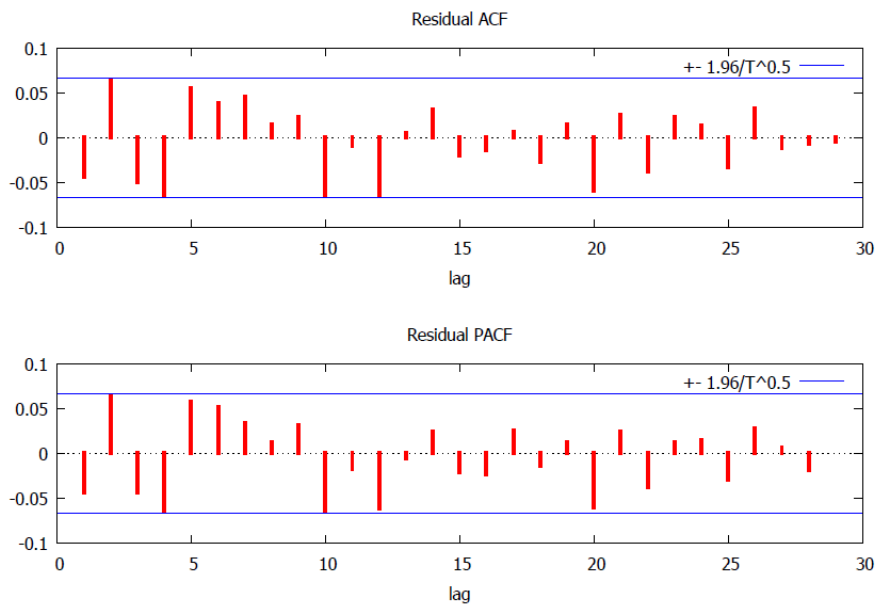
Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data.

Residual Garch Model



Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data.

Residual Correlogram Garch Model



Source: our econometric processing with Gretl. Ver. 1.8.4 software on RBA data.