Journal of Applied Finance & Banking, vol.1, no.2, 2011, 95-114
ISSN: 1792-6580 (print version), 1792-6599 (online)
International Scientific Press, 2011

Empirical Testing on Uncovered Interest Rate Parity in Malaysia

Jaratin Lily[1], Mori Kogid[2],
Mohd Rahimie Abd Karim, Rozilee Asid and Dullah Mulok[3]

Abstract

Uncovered interest rate parity (UIRP) provides a crucial theoretical concept for many models in international finance and international monetary economics. Using quarterly data span from 1998Q1 to 2010Q3, we run conventional regressions (OLS) and simple GARCH analysis on UIRP for the case of Malaysia-UK, Malaysia-Japan and Malaysia-Singapore. The empirical results show that these relationships do not support the UIRP in all cases. We, therefore, cannot reject the validity of UIRP violation such as in widely documented literature reviews. In addition, we also find that traditional (conventional) regressions on UIRP yield positive slope estimates for both Malaysia-UK and Malaysia-Japan cases, whereby for the case of Malaysia-Singapore, the beta slope estimates has a wrong sign (negative value). Results also show that the UIRP deviation for the case of Malaysia-Singapore has the smallest standard deviation. Moreover, the volatility analysis on the UIRP deviation using simple GARCH analysis revealed that there are significant ARCH and GARCH effects in the case

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[1] Universiti Malaysia Sabah, e-mail: jaratin@ums.edu.my
[2] Universiti Malaysia Sabah, e-mail: morikogid@gmail.com
[3] Universiti Malaysia Sabah, e-mail: dhm@ums.edu.my

Article Info: *Revised* : July 27, 2011. *Published online* : September 30, 2011

of Malaysia-Singapore, and it seem to be persistent in the long term period. In addition, the empirical investigation on the impact of the interest rate volatility shocks on UIRP deviation does not exist in any cases.

JEL classification numbers: C12, C13, C22, E43
Keywords: Malaysia, UIRP, Volatility, OLS, GARCH

1 Introduction

Uncovered interest rate parity (UIRP) is one of the fundamental relationships in international financial markets and constitutes an essential basis of some main exchange rate determination theories [17]. It states that the nominal interest rate differential between two countries must be equivalent to or should be an unbiased predictor of the future change in the spot exchange rate. Therefore, the investors' expected return on the domestic and foreign assets expressed in the same currency should be equal regardless of the national markets within which the foreign deposit is invested. The failure of the interest rate differential to be the unbiased predictor of the future exchange rate change is referred as the uncovered interest rate parity puzzle [8].

If UIRP holds, investors cannot gain an arbitrage opportunity due to high yield currency is expected to depreciate by an amount approximately equal to the interest rate differential between two countries. A violation of this relationship indicates that capital markets are not efficient and there is a possibility of arbitrage opportunity (see [8] and [15]). In addition, any findings reflecting a reverse relationship is called forward premium puzzle (see [3], [8] and [21]).

The basic assumption underlying UIRP is the efficient market hypothesis where the price should fully reflect all the information available to the market participants and thus no profitable opportunities will be possible in the market [13]. This means that exchange rates will quickly adjust to any new information, which should immediately be reflected in the exchange rate. Furthermore, it can be considered as a joint hypothesis that the market participants have rational expectations, and that they are risk neutral. If these assumptions are valid and UIRP holds then the expected return from holding one currency rather than another is cancelled out by the opportunity cost of holding funds in that currency versus another.

Even though many emerging markets have started liberalizing their financial markets in the late 1980s and the early 1990s, their degrees of financial liberalization are still far behind from the developed markets [1]. [1] indicated that emerging markets have weaker macroeconomic fundamentals, more volatile economic conditions, shallower financial markets, and incomplete institutional reforms. These characteristics may violate the assumptions of the efficient market hypothesis contributing to the deviations from the UIRP conditions. In other words, the UIRP condition is less likely to hold in emerging markets than in developed economies but to what extent?

The purpose of this paper is to examine the UIRP conditions in Malaysia following the restructuring Malaysia's economy after the Asian Crisis 1997 using the conventional regressions and simple GARCH analysis by looking at the Malaysia-UK, Malaysia-Singapore and Malaysia-Japan cases. The structure of the paper is as follows: UIRP and the selected review of empirical testing of this condition are discussed in the next section. In section 3, we describe the data set and methodology. Section 4 and 5 present the empirical results and conclusion respectively.

2 Literature Review

UIRP has been studied for many different currencies, time-periods and interest rates maturity horizons (mainly in the developed markets) but the majority of the research rejected the UIRP condition ($\alpha = 0$, $\beta = 1$) empirically (see [9], [20], [23] and [26]). Some of the reasons of this deviation are the existence of (time varying) risk premiums, peso-problems, market inefficiencies and neglected persistent autocorrelation in the interest differential, as well as, small sample problems (see [14] and [20]). Surprisingly, some study results indicated the forward puzzle, which is the interest rate differential, predicted the expected spot exchange rate change in the wrong direction. [13] pointed out that the main factors that cause deviation of UIRP are to transaction costs, the choice in currency pairs and time horizons, and the violation of the joint hypothesis of rational expectations or risk neutrality.

Even though the consensus among the empirical researchers loosely supported the UIRP, theorists and policy makers have often ignored the matter [4]. One of the reasons for the continued use of the hypotheses is the fact that the UIRP deviation is currency and maturity dependent [10]. It may be that irrational behavior or short-term market frictions cause a short-run deviation of the theory but the deviations seem to be less severe at long horizons. However, there is mixed empirical support for this argument. [4] also highlighted that the variability and persistence of risk premiums were different across countries that might influence the deviations of UIRP.

There was evidence of UIRP condition when using long-term interest rate differential, which showed a positive and significant slope coefficient. Using the long term interest rate, [25] found support of UIRP for the case of dollar rates in relation to the other major floating currencies (e.g. Canadian dollar, Swiss franc), but not in comparison to emerging market currencies. Meanwhile, at the medium-term horizon, the paper detected signs of nonlinearities in UIRP condition for the dollar rates in relation to some of the major floating currencies (e.g. Pound sterling). [21] study also reported a similar situation when using the short term and long term interest rate for comparison. The study found that UIRP did not hold for US-United Kingdom, US-Switzerland, US-Japan, US-Germany, US-France and US-Italy cases using the short-term interest rate differential. The relationship also had a negative slope coefficient but this is insignificant except for

US-Italy where the coefficient was positive, though, still significantly less than one. This negative relationship is consistent with the forward premium puzzle. [7] study also indicated the failure of interest differential as the unbiased predictor of the future change in the spot exchange rate over the short horizons with very low R square value. The value of β closed to unity over the longer horizon maturity. [6] findings showed support the UIRP hypothesis over the short horizon of high frequency data, but it was not persistent. However, in [23] study, findings showed support for the UIRP in the case of New Zealand-Australia regardless of the choice of the forecast horizon.

[11] indicated that the UIRP deviation in the emerging markets act as an indicator of the lack of financial market integration. [1] concluded that emerging markets deal with a different situation due to the existence of additional types of risk premium, high inflation, financial contagion and asymmetric information. However, with the financial liberalizations in the last two decades, there is an opportunity to investigate the foreign exchange market efficiency in emerging markets via testing for the UIRP [7]. In other words, there is a possibility that the UIRP hypothesis should hold in emerging markets. [14] pointed out that deviations from UIRP in the emerging markets were indeed characterized by a time-varying component (compensation for non-systematic risks). Surprisingly, they also found that there were contrasting effects of liberalization on UIRP across some Latin American and Asian countries in general. The study results showed that the deviations from UIRP were significantly affected by the liberalization of capital markets. There are few empirical studies testing the UIRP condition in Malaysia (for instance [14], and [16]). Most of these studies used US dollar as foreign currencies for testing the UIRP conditions and showed deviation of UIRP condition. The existence of risk premia was one of the reasons.

In conclusion, even though the UIRP hypothesis has been intensively tested since the creation of the theory, mixed explanations exist in literature. This controversy motivates the conduct of this research on the UIRP condition in

Malaysia by looking into the different types of currency relationship where the empirical evidence explanation is still not clearly developed.

3 Data and Methodology

The data consists of quarterly nominal interest rates for four countries namely Malaysia, United Kingdom (UK), Singapore and Japan, and nominal exchange rates between the MYR and three other currencies (Pound, Singaporean Dollar or SGD and Yen) for the period from 1998:Q1 until 2010:Q3. UK, Singapore and Japan have a significant economic relationship with Malaysia due to their trading activities. The interest rate and exchange rate data are constructed from two sources. The exchange rate and domestic interest rate data have been obtained from the monthly statistical bulletin central bank of Malaysia. Foreign interest rates were collected from their respective central bank database. A 3-month interbank interest rate was used for Malaysia, Singapore and UK. For Japan's interest rate, we used 3-month certificate of deposit. The data is constructed to be non-overlapping at a quarterly interval.

There are vast studies explaining both the UIRP theory and model. However, in this study, the construction of the UIRP model follows closely studies done by [13], [16], [19], and [2]. In this study, we employed descriptive statistics analysis, traditional (conventional) regression, and GARCH in analyzing empirically UIRP theory and its related characteristic (e.g. deviation and volatility).

According to the efficient market hypothesis, in an efficient speculative market, the price should fully reflect the information available to the market participants [13]. Therefore, there are no excess returns via speculation could be earned. Economists tried to find out this idea by testing the joint hypothesis that the market participants have the rational expectations, and they are risk neutral. If the theory holds, then the expected return from holding one currency must be offset by the opportunity cost of holding funds in that currency versus another. In other words, the domestic interest rate must be higher than the foreign interest rate by an amount equal to the expected depreciation of the domestic currency. In general, the uncovered interest rate parity condition is thus:

$$s_{t+k} - s_t = i_t - i_t^* + \varepsilon_{t+k} \tag{1}$$

where *s* is the logarithm of the spot exchange rate at the time *t* (and *k* is the time to maturity), and i and i^* are the nominal interest rates in the domestic and foreign countries respectively. The common means of testing UIRP is via traditional (conventional) regression analysis. Using covered interest rate parity (CIP) condition, we can derive an OLS regression which tests our hypothesis. CIP claimed that the nominal domestic interest rate must be higher than the nominal foreign interest rate by an amount equal to the forward discount on the domestic currency. The difference between CIP and UIRP is that when you take a covered position you are eliminating uncertainty by using a forward rate. Therefore, CIP is:

$$i_t = i_t^* + f_t - s_t \tag{2}$$

where f_t is the logarithm of the k-period ahead forward rate at time t. By substituting equation (2), CIP, into equation (1), UIRP, and adding an error term, ε, we get a regression of the form:

$$s_{t+k} - s_t = \beta_0 + \beta_1(f_t - s_t) + \varepsilon_{t+k} \tag{3}$$

or in other form:

$$\Delta s_{t+k} = \beta_0 + \beta_1(i_t - i_t^*) + \varepsilon_{t+k} \tag{4}$$

Empirical assessments of UIRP as a framework for predicting the future spot exchange rate have distinguished two issues: the size of the prediction errors and the question of whether the predictions are systematically biased. On the first issue, it becomes widely known that interest differentials explain only a small proportion of subsequent changes in exchange rates. On the second issue, the hypothesis of unbiasedness can be assessed by testing whether $(\beta_0, \beta_1) = (0,1)$ in equation (3) or in equation (4). Notably, the test that the slope coefficient is unity receives strong support from studies based on (3) but is soundly rejected by studies based on (4), at least for prediction horizons of a year or less. However, the apparent conflict between the two sets of regression evidence has been resolved in favor of the latter finding, as it is now accepted that (3) is not a legitimate regression equation [22].

This then predicts that the log forward rate is an unbiased predictor of the log future spot rate. In running the OLS regression in (3) we test UIRP via the joint hypothesis that $\beta_0 = 0$ and $\beta_1 = 1$. The existing literature has approached this puzzle from a number of different ways. Empirically, the finding of a negative estimate of β_1 in equation (3) is robust.

For the purpose of volatility analysis, the basis to the formation of the ARCH (p) model introduced by [12] is as follows:

$$y_t = c + x_t^{'}\xi + \varepsilon_t \qquad \text{(Mean Equation)} \qquad (5)$$

where $t = 1,\ldots,T$

$$\varepsilon_t \left| \psi_t \sim N(0, h_t) \right.$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 \qquad \text{(Variance Equation)} \qquad (6)$$

where y_t is a dependent variable and h_t is a conditional variance ($h_t = \sigma_t^2$) and ψ_t is a variable set or information which can be acquired at t time period where $\psi_t = (y_{t-1}, x_{t-1}, y_{t-2}, x_{t-2}, \ldots)$ whereas $x_t^{'}$ is $k \times 1$ external variable vector which can also take the lag value of the dependent variable itself which is y_{t-1} and ξ is $k \times 1$ parameter vector for the external variable used. The coefficients, α_0 , and α_1 have to be positive to ensure a positive variance. The coefficient α_1 must less than 1 otherwise h_t will continue to increase over time, eventually exploding.

The GARCH model was introduced by [5] for the purpose of representing the ARCH process which has stage (q), the higher level. The GARCH model is more appropriate and parsimony when compared with the higher class of ARCH model. The conditional variance equation specified in (6) is a function of three terms namely a constant term, news about volatility from the previous period, measured as the lag of the squared residual from the mean equation, and the last period's forecast variance. All coefficients α_i and β_i must be positive and the coefficients α_1 and β_1 must less than 1 that is $\alpha_1 + \beta_1 < 1$ for stationary; if $\alpha_1 + \beta_1 \geq 1$, we have a so-called "integrated GARCH" process or IGARCH [18]. In addition, if the sum of the coefficients $\alpha_1 + \beta_1$ is very close to one, indicating that volatility shocks are quite persistent. The model for GARCH (p, q) created is presented as follows:

$$y_t = c + x_t^{'}\xi + \varepsilon_t \tag{7}$$

where $t = 1, \ldots, T$

$$\varepsilon_t \left| \psi_t \sim N(0, h_t) \right.$$

$$h_t = \alpha_0 + \sum_{i=1}^{p} \alpha_i \varepsilon_{t-i}^2 + \sum_{i=1}^{q} \beta_i h_{t-i} \tag{8}$$

Meanwhile, the forming of the effects of volatility model based on the GARCH (1, 1) on the UIRP deviation is presented as follows [24]:

$$\Delta y_t = \rho_0 + \rho_1 \Delta y_{t-1} + \rho_2 \Delta y_t^q + \rho_3 \Delta y_{t-1}^q + \varepsilon_t \tag{9}$$

$$\varepsilon_t \left| \psi_t \sim N(0, h_t) \right.$$

$$h_t = \alpha_0 + \alpha_1 \varepsilon_{t-1}^2 + \beta_1 h_{t-1} + \gamma_1 V_t^{2q} + \gamma_2 V_{t-1}^{2q} \tag{10}$$

where:

y = UIRP deviation

y^q = interest rates

q = Japan (JP), United Kingdom (UK) and Singapore (SG).

V^{2q} = variance on shock in nation q after allowing changes effect in three other countries.

For example, the variance shock on the Japan interest rate, V^{2J} where a square error is attained from the following regressed equation:

$$\Delta y_t^{JP} = \alpha_0 + \sum_{i=1}^{n} \beta_i \Delta y_{t-i}^{JP} + \sum_{i=0}^{m} \delta_i \Delta y_{t-i}^{UK} + \sum_{i=0}^{m} \phi_i \Delta y_{t-i}^{SG} + \sum_{i=0}^{m} \gamma_i \Delta y_{t-i}^{MY} \qquad (11)$$

4 Empirical Results

The UIRP deviation in Malaysia for all cases from the first quarter in 1998 to the third quarter in 2010 is shown in Figure 1 (see also Figure 6 to Figure 8). The UIRP deviation for all cases is slightly fluctuated except for Malaysia-Japan, which deviates and goes up from mid 1998 to mid 1999 and later the trend shows stability around -0.8 to -0.4. Moreover, the findings show that for the case of Malaysia-Japan, the depreciation rates are highly volatile compared to Malaysia-UK and Malaysia-Singapore (see Figure 2). In addition, the interest rate differential (Figure 3) for the case of Malaysia-Japan is quite stable after 1998 whilst in Malaysia-UK and Malaysia-Singapore cases, the interest rate differentials are rather fluctuated. The spot exchange rates for all cases are indeed highly volatile during the time periods (see Figure 4).

Table 1 shows the descriptive statistic summary for UIRP deviation in all cases. Malaysia-Singapore has the smallest standard deviation at 0.3064, Malaysia-UK and Malaysia-Japan cases, mark at 0.3953 and 0.4543 respectively. The empirical results also show that the UIRP conditions in all cases are not supported using the traditional (conventional) regression analysis (see Table 2). The joint null hypothesis (H_0: $\beta_0 = 0$, $\beta_1 = 1$) is rejected using Wald test at 1 percent significance level. Finding also show that the regressions on UIRP yield positive slope estimates for both Malaysia-UK and Malaysia-Japan cases, whereas for the case of Malaysia-Singapore, the beta slope estimate has a wrong sign (negative value). The estimated regression coefficients for Malaysia-UK, Malaysia-Japan and Malaysia-Singapore are 0.0149, 0.0041 and -0.0003 respectively. The R-squared (R^2) is low for all cases, especially for Malaysia-Singapore.

Table 3 reflects the volatility analysis on the UIRP deviation for each case in this study. Only Malaysia-Singapore indicates that volatility did exist (ARCH's impact) in UIRP deviation as shown by the coefficients, α_1 which is significant. Indeed, the Malaysia-Singapore case also experiences GARCH's impact as indicated by the coefficient, β_1. Generally, the volatility analysis on the UIRP deviation using simple GARCH analysis revealed that there are significant ARCH and GARCH effects in the case of Malaysia-Singapore, and it seems to be persistence in the long term period.

The impact of the interest rate volatility shocks on the UIRP deviation is shown by the value of γ (see Table 4). The empirical investigation on the impact of the interest rate volatility shocks on UIRP deviation using the GARCH (1,1) model which has been modified in order to take into account the external shock impact, does not exist in any cases.

5 Conclusion

In this paper, we used quarterly data to examine the relationship between expected nominal exchange rate and interest rate differentials (UIRP condition) in Malaysia. Then, we applied volatility analysis on the UIRP deviation using GARCH (1,1) and examined the effect of interest rate volatility on UIRP deviation.

Our study findings indicate that UIRP condition does not hold in all cases, which is consistent with previous studies such as [14] and [16]. Surprisingly, the study also shows the forward puzzle (though not significant) for the case of Malaysia-Singapore indicating the opposite direction that UIRP dictates. Moreover, the volatility analysis on the UIRP deviation revealed that there are significant ARCH and GARCH effects in the case of Malaysia-Singapore, and it seems to be persistent in the long term period. In addition, the empirical investigation on the impact of the interest rate volatility shocks on UIRP deviation does not exist in any cases.

Therefore, there are few conclusions we could make. As indicated in [1], [11] and [14], UIRP condition has a lack of support in emerging markets, as in the present study. This finding implies that there is a possibility of arbitrage opportunity between Malaysia and the studied markets due to the inefficient market as stated in [15]. Interest rate shocks have no impact on UIRP deviations, thus, we believe that time varying risk and asymmetric information as some of the factors behind the deviations. As indicated in our volatility analysis, the variability and persistence of risk are different across the cases. Malaysia also practices managed exchange rate floating, which causes the nominal exchange rate to not provide the true value.

The contribution of this paper is the additional knowledge of UIRP condition in Malaysia using different types of currency relationship. A further contribution is the introduction of interest rate volatility shocks on the UIRP deviation model in the present study. Given both the findings presented here as well as those in the existing literature, there is much work to be done on this puzzle. For future studies, we recommend using a more advanced testing model and approach to testing the UIRP conditions and UIRP deviations using the real term value.

ACKNOWLEDGEMENTS. We would like to thank the editor and two anonymous reviewers of this journal.

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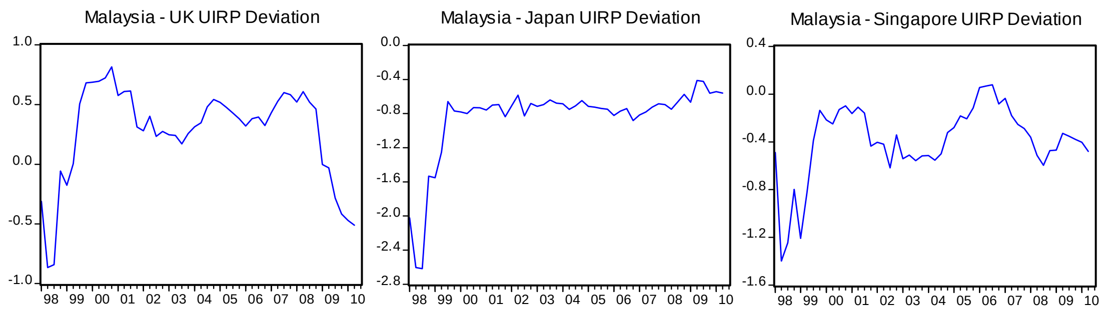

Figure 1: UIRP Deviation, 1998Q1 – 2010Q3

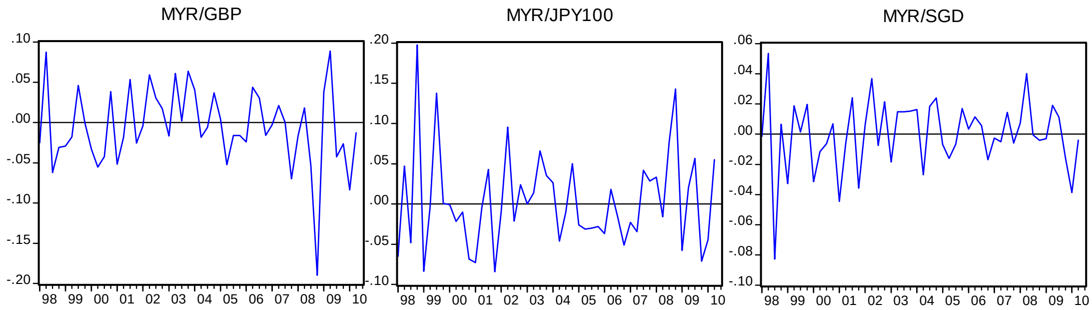

Figure 2: Depreciation Rates, 1998Q1 – 2010Q3

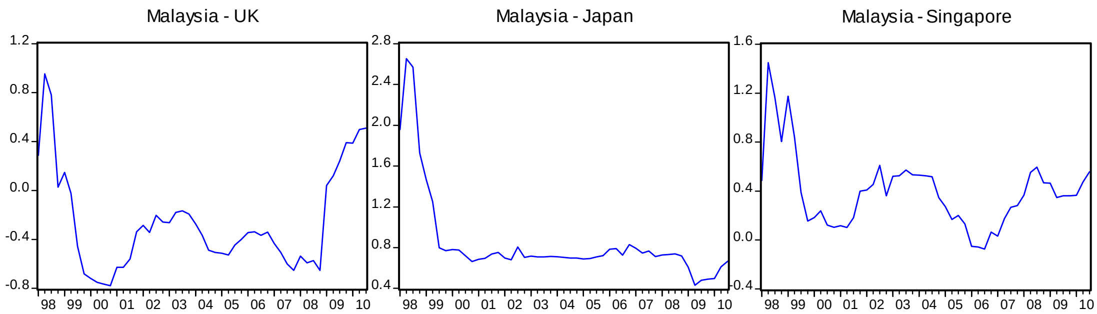

Figure 3: Interest Rate Differential, 1998Q1 – 2010Q3

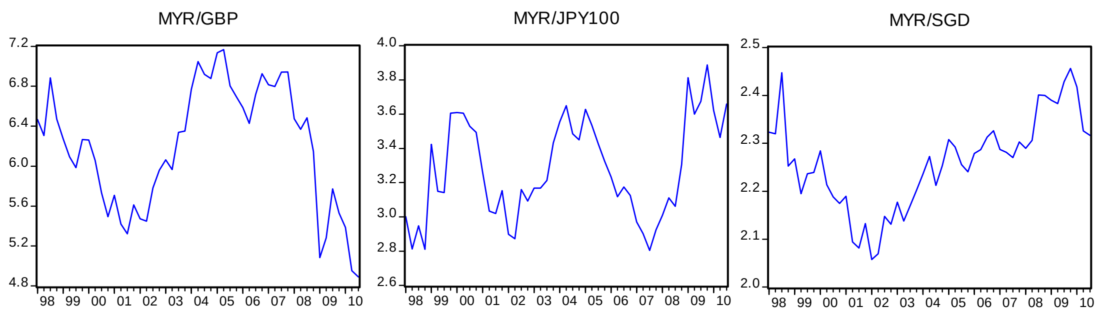

Figure 4: Spot Exchange Rates, 1998Q1 – 2010Q3

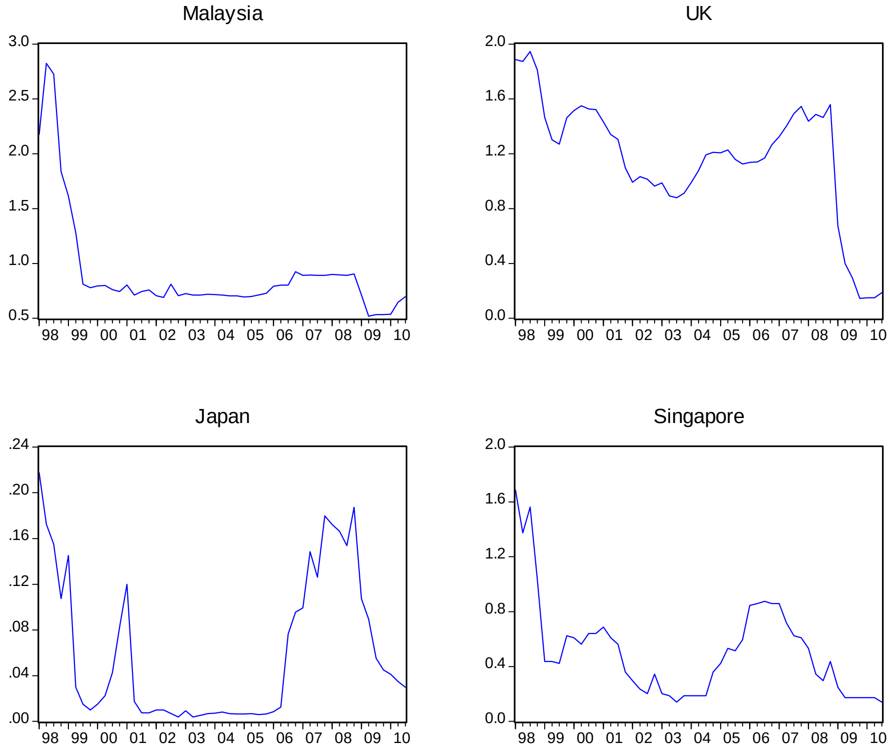

Figure 5: Domestic and Foreign Interest Rates, 1998Q1 – 2010Q3

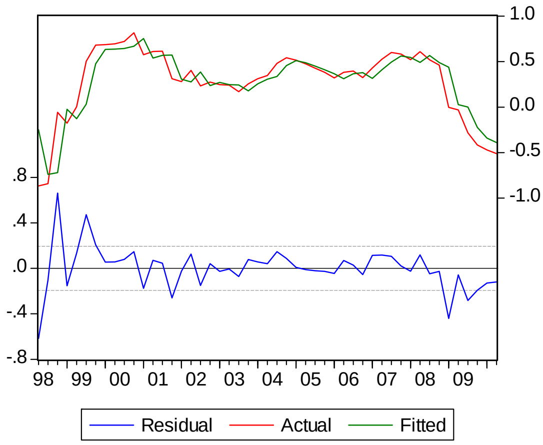

Figure 6: Malaysia – UK UIRP Deviation, 1998Q1 – 2010Q3

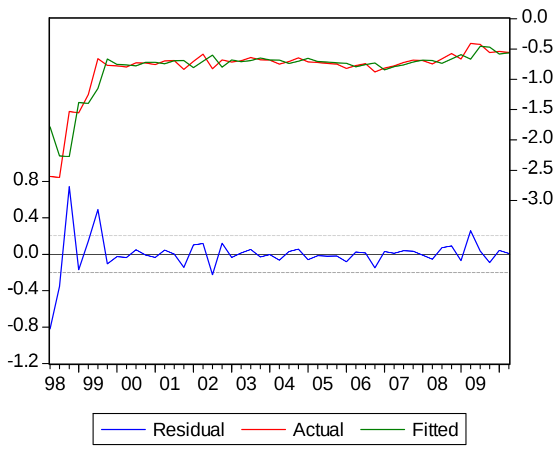

Figure 7: Malaysia – Japan UIRP Deviation, 1998Q1 – 2010Q3

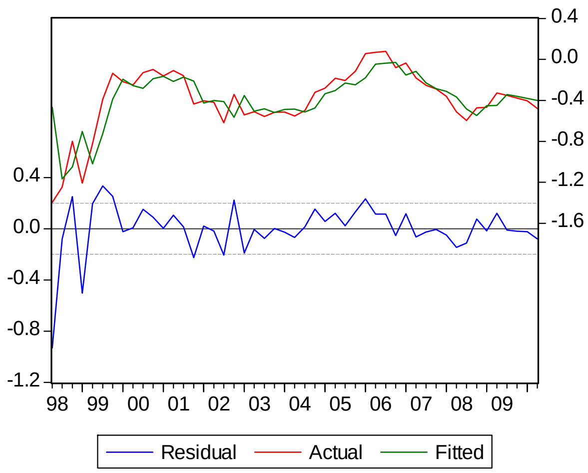

Figure 8: Malaysia – Singapore UIRP Deviation, 1998Q1 – 2010Q3

Table 1: Descriptive Statistics Summary of UIRP Deviation

	Mean	Median	SD	Skewness	Kurtosis	JB
Malaysia-UK	0.2702	0.3813	0.3953	-1.2621	3.9991	15.3529***
Malaysia-Japan	-0.8468	-0.7243	0.4543	-2.8559	10.7153	191.9794***
Malaysia-Singapore	-0.3921	-0.3693	0.3064	-1.3133	5.3474	25.8536***

Notes: ***, **, * denote significant at the 1%, 5% and 10% levels respectively.
SD = Standard Deviation, Max = Maximum, Min = Minimum and JB = Jarque-Bera Statistic.

Table 2: Traditional (Conventional) Regression Using OLS

Parameter	Malaysia-UK	Malaysia-Japan	Malaysia-Singapore
β_0	-0.0015	0.0005	0.00007
β_1	0.0149	0.0041	-0.0003
Wald Test	4715.18***	12897.08***	21974.48***
R^2	0.0148	0.0010	0.00002
DW	1.9131	2.2828	2.5287
SE	0.0487	0.0596	0.0236

Notes: ***, **, * denote significant at the 1%, 5% and 10% levels respectively.
DW = Durbin-Watson Statistic and SE = Standard Error of Regression.

Table 3: GARCH (1,1) Estimation for UIRP Deviation

Parameter	Malaysia-UK	Malaysia-Japan	Malaysia-Singapore
ρ_0	0.3593***	-0.7292***	-0.4230***
α_0	0.0036	0.0036	0.0008
α_1	0.9102	0.6021	0.4650*
β_1	0.1824	0.1253	0.4910***
$\alpha_1+\beta_1$	1.0926	0.7274	0.9560

Notes: ***, **, * denote significant at the 1%, 5% and 10%.
y = UIRP Deviation. The total parameter of $\alpha_1 + \beta_1 \leq 1$ shows the persistence of volatility shocks in the UIRP deviation. Numbers in parentheses are standard error.

Table 4: Modelling the Interest Rate Shocks on UIRP Deviation using GARCH (1,1)

Parameter	Malaysia-UK	Malaysia-Japan	Malaysia-Singapore
ρ_0	0.0496	-0.2877***	-0.0664***
ρ_1	0.8533***	0.5779***	0.8504***
ρ_2	0.5238***	-0.1304	0.7066***
ρ_3	0.1375	-1.2854**	0.0445
α_0	0.0008	0.0013	0.0003
α_1	0.2374	0.4793	-0.1370**
β_1	0.4966	0.1095	0.9016***
γ_1	-0.0106	-0.4894	0.0723
γ_2	0.0763	2.2800	0.0013

Notes: ***, **, ** denote significant at the 1%, 5% and 10% levels respectively.
y = UIRP deviation and number in parentheses are standard error. y^q = UIRP deviation for others cases and V^q = variance shock for others cases.