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Exchange rate misalignment and capital inflows: An endogenous threshold analysis for Malaysia

Noor Zahirah Mohd Sidek
Department of Economics, International Islamic University

Mohammed Yusoff
Department of Economics, International Islamic University, Malaysia

Qaiser Munir
School of Business and Economics, Universiti Malaysia Sabah

Abstract

This study presents an attempt to investigate the impact of exchange rate misalignment on capital inflows in Malaysia. Specifically, a precise threshold value is estimated to examine when exchange rate misalignment suppresses capital inflows. To pursue these objectives, this study relies on the endogenous threshold analysis as of Hansen (1996, 2000). Results suggest that misalignment in terms of currency overvaluation, has a negative and significant effect when overvaluation is more than 15 percent. This estimate is consistent and robust despite the changes in the choice of explanatory variables.

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1. INTRODUCTION

Foreign direct investment (FDI) has served as an important engine of growth via skills and technology transfer, creation of employment opportunities and expanding the capital stock in Malaysia. There was a surge in foreign direct investment (FDI) into Malaysia in the late 1980s and this trend continues until the onset of the 1997 Asian financial crisis. Another acute slump in the influx of FDI occurs in 2001 when the economy was in a slight recession but picks up again in 2002 thereafter. With the recent burgeoning world recession following the American sub-mortgage crisis, it is expected that FDI will contract again (IMF, 2009).

Since early 1980s, real exchange rate misalignment has become a standard concept in international macroeconomic theory and policy (Razin & Collins, 1997). Hence, this study focuses on exchange rate misalignment as an indicator of capital inflow competitiveness in the case of Malaysia. Malaysia provides an interesting case as it is one of the largest recipients of FDI amongst its ASEAN counterparts. Another advantage of undertaking a single country study is the ability to delineate the assumption that countries are similar in terms of social, cultural, economic and politically (Sun *et al*., 2002). Therefore, only relevant economic determinants will be accounted for.

The objective of this paper is to present an empirical content of the relationship between capital inflows and exchange rate misalignment. Whilst existing literature focuses on the role of exchange rate, this study takes a step further to examine the impact of exchange rate misalignment on capital inflows. Specifically, we estimate a threshold value at which misalignment begins to significantly affect capital inflows. To the best of our knowledge, this is the first study to estimate a threshold value for misalignment, hence, constituting the novelty of the study. Based on the endogenous autoregressive threshold (TAR) model developed by Hansen (2000), Results suggest that exchange rate misalignment due to overvaluation is detrimental to the influx of capital inflows. Unlike previous study which utilizes UNCTAD's data and definition of FDI, this study employs the data from Bank Negara Malaysia. Foreign capital inflows or investment inflows comprises three items: (i) equity investment, (ii) loans and (iii) real estate.

The next section provides a brief explication of the theoretical model and review of literature. The third section spells out the method pertaining to the objective. The penultimate section provides results and discussion and the final section concludes.

2. THEORETICAL FRAMEWORK AND REVIEW OF LITERATURE ON DETERMINANTS OF CAPITAL INFLOWS

This study adopts the Markowitz-Tobin model of portfolio selection to identify the determinants of capital flows into Malaysia. This portfolio balance approach models the allocation of wealth between domestic and foreign assets. Branson (1968) postulates that the proportion of foreign assets (K^f) in a given stock of wealth is a function of the domestic and foreign interest rates (I and I^*), the measure of exchange rate expectation or risk (E) and the stock of wealth (W) expressed as:

$$\frac{K^f}{w} = f(I - I^*, E, W) \tag{1}$$

Darby et al. (1999), augment this concept of exchange rate risk (E) into exchange rate misalignment (M). In a compact form, equation (1) is expressed as follows:

$$K^f = \alpha_0 + \alpha_1(I - I^*) + \alpha_2 M + \alpha_3 W + \varepsilon \tag{2}$$

We also include other potential variables that could explain the behaviour of capital inflows in Malaysia, Z,

$$K^f = \alpha_0 + \alpha_1(I - I^*) + \alpha_2 M + \alpha_3 W + \alpha_4 Z + \varepsilon \qquad (3)$$

The enigmatic relationship between FDI and exchange rate nexus has been widely examined and most of the discussions root back to the work of Kohlhagen (1977), Cushman (1985), Froot and Stein (1991), Goldberg (1993) and Darby et al. (1999). The mechanisms that exchange rate affects capital inflows can also be viewed via the wealth effect channel and the relative production cost channel (Xing, 2006). A devaluation of the currency of the host country makes local cost of production lower in terms of foreign currency hence leading to higher returns from export-oriented industries. As for the wealth effect, a devaluation makes local asset cheaper which motivates investors to acquire more. Kohlhagen (1977) static model postulates that following depreciation in host countries, MNEs will increase their production capacity. In a two period dynamic model, Cushman (1985) suggests that adjusted expected real depreciation lowers production costs and as a result, leads to increase in FDI flows. Similarly, Goldberg (1993) illustrates how sectoral profitability, location effects, and portfolio and wealth effects are important factors that determine investment and their links with exchange rates. In her theoretical model, the direction of investment effects triggered by exchange rate movements is ambiguous, therefore, warrants empirical research. Ray (1989) shows that relatively cheap US dollar serves as a significant stimulus for foreign direct investment in the United States. On contrary, in an imperfect information framework, Froot and Stein (1991) show that appreciation induces wealth effect of foreign investors, thus, promotes foreign investors to acquire more local assets. Empirically, there is quite a consensus that a depreciation of the exchange rate in the host country leads to a reduction of the FDI (Dewenter, 1995).

There is however, a dearth of literature of studies that empirically examined the relationship between FDI and exchange rate misalignment. Empirical attempts include Benassy-Quere et al. (2001) who advocate the benefits of depreciation may be offset by excessive volatility of the exchange rate. Blonigen (1997) illustrates how currency depreciation induces foreign firm to acquire firm-specific assets when markets are segmented. Hasnat (1999) study the impact of misalignment on FDI for five developed nations on annual data ranging from 1976-1995. All of these studies use misalignment as a control variable or a counterpart for exchange rate variability and is measured as a deviation from the PPP values. Furthermore, most of these studies are based on the experiences of industrialized economies using panel data analysis framework. In short, a prolonged misalignment may affect long term business decisions with regard to costs. If the exchange rate is overvalued relative to the estimated equilibrium level, then investors may perceived that acquire more domestic assets for future capital gains in home currency terms (Barrell and Pain, 1996). On the other hand, persistent overvaluation may reduce cost competitiveness of production in the host country especially for export oriented products.

Focusing on Z variable, the literature suggests a number of variables that determines capital flows. The determinants of FDI can be demarcated into at least two categories – micro and macro determinants. The list of micro-determinants spans from market size, growth, labour costs, host government policies, tariffs to trade barriers. The macro-determinants include market size (Chakrabarti, 2001), openness (Edwards, 1990; Aseidu, 2002), rate of inflation (Bajo-Rubia and Sosvilla-Rivero, 1994; Urata and Kawai, 2000), government budget, taxes (Gastanaga et al., 1998; Wei, 2000) and infrastructure (Wheeler and Mody, 1992; Urata and Kawai, 2000). Financial deepening is also another catalyst for FDI (Borensztein et al., 1998).

Liquid liability, private credit and M3 serve as proxies. Increase in money supply fuels inflation which increases the cost of production in the host country rendering a negative relationship. Table 1 provides the data used in this study.

[Insert Table 1]

3. EQUILIBRIUM EXCHANGE RATE AND MISALIGNMENT

Exchange rate misalignment is defined as the deviation of the real effective exchange rate from the equilibrium (hypothetical) exchange rate. The equilibrium exchange rate is a function of a set of macroeconomic fundamental variables namely productivity, openness, government spending and net foreign assets (see for example Sekkat and Varaodakis, 2000). Misalignment in this paper follows the estimation in Sidek and Yusoff (2009). The equilibrium real exchange rate derived via vector error correction technique (VECM) is:

REER = 2.3113PRODUCTIVITY + 0.801 OPENESS - 3.1996GOVERNMENT SPENDING – 0.3365NET FOREIGN ASSETS – 0.3610

To derive misalignment, we subtract the actual *REER* from the equilibrium real exchange rate calculated from the above equation. Figure 1 shows the actual and the equilibrium exchange rates. When the actual *REER* is above the equilibrium exchange rate, the currency is overvalued and vice versa.

[Insert Figure 1]

4. METHODOLOGY

The question of when does misalignment begin to significantly affect capital inflows necessitate the existence of a non-linear relationship between these two variables. Thus, if such non-linear relationship exist, then it is possible to estimate an inflexion point, or a threshold value, at which the sign of misalignment may change or become significant. In the non-linear time series modelling, the threshold autoregressive model (TAR) is more popular since it offers a relatively simple specification, estimation and interpretation compared to other non-linear models. Hansen (1996, 2000) derives the asymptotic distribution of the ordinary least squares (OLS) estimates of the endogeneous threshold parameters which will be utilize in this study. According to Hansen (2000), threshold estimation is the act of splitting the sample into two regimes when the threshold value is unknown. In this study, the threshold estimation will split the sample into high misalignment and low misalignment regime. Since misalignment is a continuous variable, TAR model would be appropriate to engender the threshold value. Formally, the two-regime threshold regression model takes the form:

$$y_t = \theta_1^{'} x_t + e_t, \qquad q_t \leq \gamma, \tag{5}$$

$$y_t = \theta_2^{'} x_t + e_t, \qquad q_t > \gamma, \tag{6}$$

where q_t is the threshold variable and is used to split the sample into two regimes, γ is the threshold value which is unknown and must be estimated, y_t denotes the dependent variable, capital inflow, x_t represents a vector of explanatory variables (*m*-vector) and e_t is the error term assumed to be white noise and *i.i.d*. Rewriting equation (5) and (6) in a single equation,

$$y_t = \theta' x_t + \delta_n^{'} x_t(\gamma) + e_t \tag{7}$$

where $\theta = \theta_2$ and $\delta = \theta_1 - \theta_2$. Equation (7) allows all the regression parameters θ, δ_n and γ to be estimated and switch between the two regimes. The least square (LS) technique is used to estimate γ through minimization of the sum of squared errors function.

The second step is to examine whether the derived threshold value (γ) is statistically significant. The confidence interval region is based on the likelihood ratio statistic $LR_n(\gamma)$. Based on Hansen (2000), let C represent the desired asymptotic confidence interval (in this study at 95%) and $c = c_\xi(C)$ be the C-level critical value and set $\hat{\Gamma} = \{\gamma : LR_n(\gamma) \le c\}$. Assuming homoscedasticity, $P(\gamma_0 \in \hat{\Gamma}) \to C$ as $n \to \infty$, therefore, $\hat{\Gamma}$ is the asymptotic C-level confidence region for γ. If the homoscedasticity condition is not fulfilled, then a scale likelihood ratio statistics of the residual sum of squared errors is defined as:

$$LR_n^*(\gamma) = \frac{LR_n(\gamma)}{\hat{\eta}^2} = \frac{S_n(\gamma) - S_n(\hat{\gamma})}{\hat{\sigma}^2 \hat{\eta}^2} \tag{8}$$

and the adjusted confidence region becomes $\hat{\Gamma}^* = \{\gamma : LR_n^*(\gamma) \le c\}$ such that is robust $\hat{\Gamma}^*$ is robust whether or not the heteroscedasticity condition hold. Simulation is set at 1000 replication as suggested by Hansen (2000). Also, $LR_n^*(\gamma)$ is not normally distributed hence, the valid asymptotic confidence intervals of the estimated threshold values in the no-rejection areas defined as $c(\alpha) = -2\ln(1 - \sqrt{1-\alpha}$, where α is a given asymptotic level; and the no- rejection region of the confidence interval is $1-\alpha$. If $LR_1(\gamma_0) \le c(\alpha)$, than the null hypothesis of $H_0 : \gamma = \gamma_0$ cannot be rejected. In addition, to examine the possibility of a second threshold value, the same exercise is repeated.

5. RESULTS AND DISCUSSION

The baseline regression constitutes the exchange rate misalignment, interest differential and a measure of financial development, M3. We present three additional models with different variables added to the baseline regression namely liquid liability, government budget deficit and infrastructure for sensitivity analysis. Hansen (2000) theoretical construct allows for two threshold effects, hence, the first step is to investigate the possible existence of such an effect. Prior to that, a threshold variable needs to be selected. Since the aim of this section is to examine at what percentage exchange rate misalignment actually hurt capital inflows, the appropriate threshold variable is the exchange rate misalignment. Upon choosing the appropriate threshold variable, the next step is to observe any evidence of a threshold effect and whether there exist one or more threshold by employing the heteroscedasticity-consistent Lagrange-multiplier (LM) test for a threshold based on Hansen (1996). To test γ under the null hypothesis of no threshold effect, *p*-values are calculated using a bootstrap analog which generates the dependent variable from the distribution $N(0, \hat{e}_t^2)$, where $\hat{e}_t$ is the OLS residuals from the estimated threshold model. With 1000 bootstrap replications, the *p*-values for the all four threshold model (Table 2) using misalignment strongly suggest the existence of threshold effect at 0.000 significant levels. Subsequently, this suggests that there is a sample split based on the effect of exchange rate misalignment.

[Insert Table 2]

Figure 2, for Model 1, illustrates the graph of the normalized likelihood ratio sequence $LR_n^*(\gamma)$ as a function of the threshold in exchange rate misalignment. The estimated γ is the value which minimizes these graphs which range at $\hat{\gamma}$=15.02-15.44%. The dotted lines on the graphs present the 95% critical values. For example, in model 1, the asymptotic 95% confidence interval set $\hat{\Gamma}^* = [-15.03\%, -9.84\%]$ where $LR_n^*(\gamma)$ crosses the dotted lines. The results suggest that there is ample evidence for a two-regime specification. Also, it is worth noting that 41 of the 71 observations fall into the 95% confidence interval, hence, requires an examination of the possible existence of a second sample split. Results in Table 2, show that second sample split renders insignificant bootstrap p-value thus, indicating no further regime split.

[Insert Figure 2]

Table 3 presents the results for baseline regression. Basically, the variables confer the correct signs in line with the prediction of the theory. Misalignment has a negative and significant effect on capital inflows in the upper regime. Interest differentials only affects capital inflows positively in the lower regime but is insignificant in the upper regime. Similarly, M3 has significant effect in both regime but is positive in the lower regime but the sign switches in the upper regime.

[Insert Table 3]

To check for the sensitivity of the results, Table 4 represents three other models which use different variables in addition to the baseline regression. For comparison, this study provides the linear OLS model without the threshold effect and a two-regime model which accommodates the threshold effect. The results show that below the threshold value of 15%, exchange rate misalignment may be negative but are not statistically significant. However, above the 15% threshold level, misalignment exerts both negative and significant impact on capital inflows. A 1% increase in misalignment (overvaluation) suppresses capital inflows by 1.11% - 1.55%. The negative effect of exchange rate misalignment on capital inflows is consistent with the findings of Hasnat (1999). Barrel and Pain (1996) argue that an apparent currency misalignment persistent over some length of time may affect investment inflows decisions. A reasonable explanation is that the relative production costs may be higher as a result of such misalignment. If the ringgit is thought to be overvalued relative to its estimated equilibrium level, then foreign production may be discouraged by the prospect of future capital loss in home currency terms.

[Insert Table 4]

Another issue which emerges after the 1997 financial crisis is that capital inflows must be managed since reversals are likely to cause severe damage to the economy. Reinhart and Reinhart (1998) calls for greater exchange rate flexibility which is meant to introduce two-way risks, therefore, discouraging speculative capital inflows. It is, however, only possible in the context of de facto peg or a tightly managed float. Furthermore, the effectiveness of this policy depends on how much policymakers are willing to allow the exchange rate to fluctuate. A large band denotes greater flexibility but risks having large nominal appreciation which connotes possible overvaluation of the currency. The result of this study suggests that overvaluation is detrimental to capital inflows if this band exceeds 15%. Hence, policymakers should keep exchange rate fluctuations well below this 15% threshold.

The addition of taxes yields insignificant results without drastically changing the threshold value. Other additional variables such as government budget deficit and liquid liability are only significant in one of the two regimes[1]. Interest rate differential are consistently positive and significant in all specifications and in both regimes in majority of the threshold model. This stresses the role of interest rates in attracting capital inflows into Malaysia. Although the impact may be small, it is significant and the authorities should ensure that interest rates are kept at certain levels to maintain competitiveness of Malaysia as destination for capital investment. In this paper, the estimated impact of a 1% change in interest differential is expected to subdue foreign investment by 0.04%-0.05% in the first regime and 0.02%-0.06% in the second regime. The proxy for financial deepening, M3 is statistically significant in all models and in both regimes. Again, this signifies the importance of financial development in attracting capital investment into Malaysia. Interestingly, M3 is positive during the periods of low misalignment regime but becomes negative at higher misalignment regime. During low misalignment, a 1% increase in M3 is expected to draw in 0.2%-0.3% more investment inflow into Malaysia. This shows that in the lower regime, financial depth acts as an impetus to capital inflows. However, the situation reverse with 0.49%-0.67% lower investment inflows is expected with a 1% increase in misalignment in the second threshold regime. Montiel (1999) explicitly explains this phenomenon where capital inflows increase reserves which then prompt an increase in the monetary base, M2 and M3. Such increases fuels further increments in domestic demand leading to real appreciation. Thus, any overvaluation of the currency may eventually have negative ramifications on capital inflows.

In view of the results, it seems evident that the exchange rate policy has important effect in attracting foreign capital inflows into Malaysia. Specifically, misalignment in terms of overvaluation should be kept lower than 15 percent to ensure that capital inflows remained unhurt.

6. CONCLUSION

The objective of this chapter is to examine the impact of exchange rate misalignment on capital inflows. Results provide evidences of the negative impact of misalignment on capital inflows. To reiterate, overvaluation of the ringgit signals that Malaysia is less competitive vis-à-vis other countries. This paper also estimates a threshold value of approximately 15 percent; that is the degree of overvaluation after which it begins to hurt capital inflows. By employing a recent technique by Hansen (1996, 2000), this study splits the sample into high misalignment and low misalignment regimes. This study shows that misalignments hurt capital inflows in the high misalignment regime or when misalignment is greater than 15 percent. This study also confirms the work of Goh (2005) who suggests that the portfolio balance model can capture the determinants of capital inflows in Malaysia. In particular, the results suggest that interest differential is an important determinant albeit, small, hence, policies should be directed into maintaining a certain level of competitive interest rates. Furthermore, it is evident that financial deepening plays an important role to attract capital inflows. Finally, it is important for the Malaysian authorities continue to intervene the exchange rate and to keep overvaluation at its minimum.

[1] Inclusion of other variables namely openness, real effective exchange rate, bilateral rates between Malaysia and US,inflation, volatility, infrastructure and lagged variables of I(1) regressors yield mostly insignificant results, hence not are reported. Results are available upon request.

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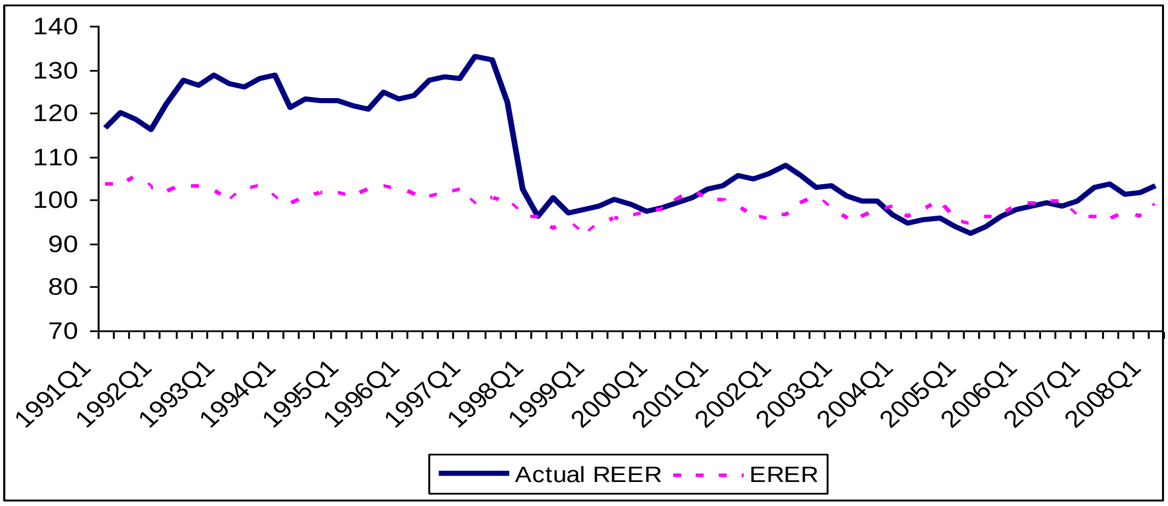
Table 1: Possible Determinants of Capital Inflows - Data description and sources (1991Q1-2008Q3)

Variable	Description	Measurement	Source
I	Foreign investment	Total foreign investment inflow as a percentage of GDP (in logarithms)	BNM
M3	Money supply	M3 as a percentage of GDP	IFS
D	Government deficit	The difference between revenue and expenditure as a percentage of GDP	BNM
R	Interest differential	The difference between Malaysia and US 3-month T-Bill rates	IFS
T	Taxation	Government corporate tax revenue as a percentage of GDP	BNM
LL	Liquid Liability	Log International liquidity: banking institution liability, line. 7b.d	IFS

Notes: IFS: International Financial Statistics, IMF, BNM: Bank Negara Malaysia Monthly Statistical Bulletin, DOS: Department of Statistics, Malaysia.

Figure 1: Actual REER and Equilibrium Real Exchange Rate



Source: Sidek and Yusoff (2009)

Table 2: Threshold Effects

	Model 1	Model 2	Model 3	Model 4
		First Sample Split		
F-Stats	51.4045	71.1442	45.9364	53.3722
Bootstrap *P*-Value	0.000	0.000	0.000	0.000
Threshold Estimates	-15.0260%	-15.4461%	-15.0260%	-15.0260%
95% Confidence Interval	[-15.446% , -9.8360%]	[-15.446%, -15.025%]	[-15.446%, -9.836%]	[-15.446%, -0.0984%]
		Second Sample Split		
F-Stats	16.2171	16.4917	19.7585	22.9710
Bootstrap *P*-Value	0.2890	0.5310	0.3800	0.2420

Note: H_0: No threshold effect. The threshold is based on the minimized sum of squared residuals.

Figure 2: Model 1: First Sample Split – Confidence Interval Construction for Threshold

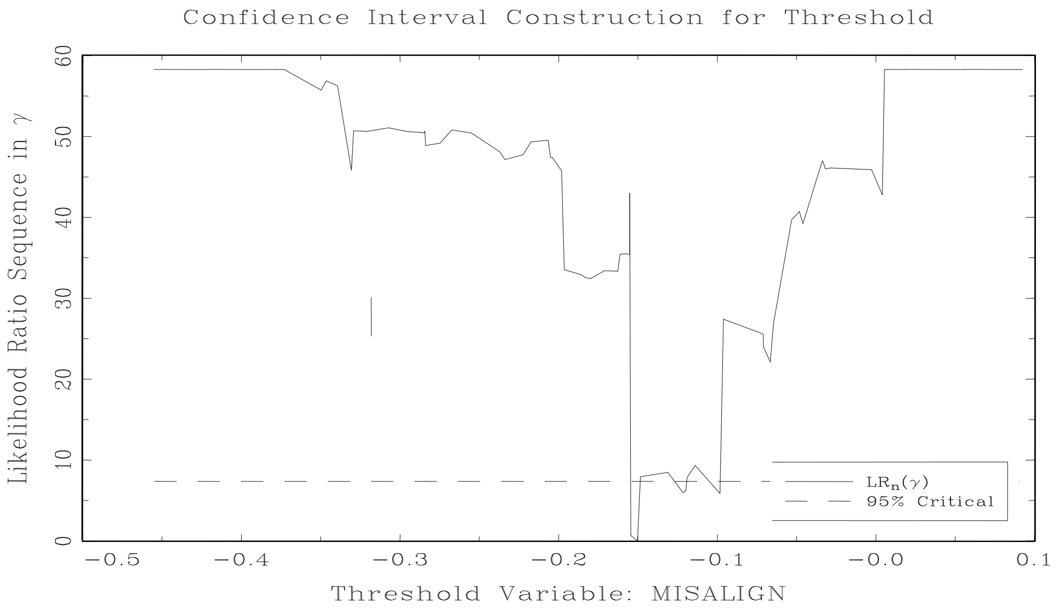


Table 3: Baseline regression results on the effect of misalignment on capital inflows (1991:Q1-2008:Q3)

Model 1	**Linear Model**	**Threshold Model**	
	OLS without threshold	Regime 1 ≤ 15.0259%	Regime 2 > 15.0259%
Misalignment	-0.4267**	-0.3186	-1.1955**
	(-0.2115)	(-0.2573)	(-0.5712)
Interest Differential	0.0250***	0.0438*	0.0261
	(-0.0131)	(-0.01533)	(-0.0193)
M3	0.2964*	0.2644*	-0.5560*
	(-0.0391)	(-0.0516)	(-0.124)
Constant	3.0468*	2.5394*	6.7313*
	(-0.2779)	(-0.2593)	(-0.6099)
No. of Observations	71	42	29
R^2	0.3664	0.6484	0.4218

*Notes: *, ** and *** denote 1%, 5% and 10% significance respectively. Standard errors are in parentheses.*

Table 4: Sensitivity Analysis for threshold estimates

Model 2	**Linear Model**	**Threshold Model**	
	OLS without threshold	Regime 1 ≤ 15.4461%	Regime 2 > 15.4461%
Misalignment	-0.4278***	-0.3497	-1.5593*
	(-0.2216)	(-0.4143)	(-0.3135)
Interest Differential	0.0250***	0.0462*	0.0599*
	(-0.0134)	(-0.0153)	(-0.0131)
M3	0.2966*	0.2732*	-0.5609*
	(-0.0414)	(-0.0488)	(-0.0744)
Liquid Liability	-0.0029	-0.0634	1.1843*
	(-0.1709)	(-0.1932)	(-0.2615)
Constant	2.9780*	2.5259*	6.1799*
	(-0.2713)	(-0.2593)	(-0.3135)
No. of Observations	71	41	30
R^2	0.3842	0.6503	0.5986

Model 3	**Linear Model**	**Threshold Model**	
	OLS without threshold	Regime 1 ≤ 15.0260%	Regime 2 > 15.0260%
Misalignment	-0.4472**	-0.380	-1.1171***
	(-0.2038)	(-0.246)	(-0.6229)
Interest Differential	0.0254*	0.0505*	0.0237
	(-0.0126)	(-0.014)	(-0.0221)
M3	0.2844*	0.2521*	-0.5391
	(-7.4922)	(-0.0472)	(-0.1477)
Deficit	-0.7655*	-0.7380*	-0.1841
	(-0.3059)	(-0.3099)	(-0.7174)
Constant	3.0308*	2.5835*	6.6452*
	(-0.2674)	(-0.2445)	(-0.7337)
No. of Observations	71	42	29
R^2	0.4285	0.6829	0.423

Model 4	**Linear Model**	**Threshold Model**	
	OLS without threshold	Regime 1 ≤ 15.0260%	Regime 2 > 15.0260%
Misalignment	-0.2852	-0.2582	1.2490**
	(-0.2181)	(-0.272)	(-0.5612)
Interest Differential	0.0275**	0.0419*	0.0311
	(-0.0128)	(-0.0165)	(-0.0204)
M3	0.3208*	0.2796*	-0.5489*
	(-0.0401)	(-0.0583)	(-0.1245)
Tax	2.1899**	0.1283	0.126
	(-1.0761)	(-0.1457)	(-0.172)
Constant	3.0274*	2.2463*	6.5027*
	(-0.4383)	(-0.4806)	(-0.7227)
No. of Observations	71	42	29
R^2	0.3665	0.6516	0.43

*Notes: *, ** and *** denote 1%, 5% and 10% significance respectively. . Standard errors are in parentheses*