

# INTEREST RATES AND THE ROLE OF EXCHANGE RATE REGIMES IN MAJOR SOUTHEAST ASIAN COUNTRIES

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## Abstraksi

*Peper ini meneliti apakah perbedaan sistim nilai tukar yang dianut oleh negara-negara Asia Tenggara mempunyai implikasi yang signifikan terhadap bagaimana gejolak pasar keuangan internasional ditransmisikan kedalam suku bunga domestik di negara-negara tersebut. Dengan menggunakan data dari 5 negara utama di Asia Tenggara—Indonesia, Malaysia, Filipina, Singapura, dan Thailand—kami menguji hipotesis bahwa tingkat suku bunga domestik dalam negara dengan sistim nilai tukar yang lebih fleksibel adalah lebih tidak terpengaruh oleh pasar keuangan internasional. Data yang digunakan adalah data harian dari Januari 1995 sampai dengan Desember 2003. Hasil estimasi menunjukkan bahwa sistem nilai tukar tidak mempunyai implikasi yang konklusif tentang bagaimana gejolak pasar keuangan internasional ditransmisikan ke dalam tingkat suku bunga domestik di negara-negara utama Asia Tenggara. Apapun sistem nilai tukar yang mereka anut, faktor domestik adalah merupakan faktor utama dalam pergerakan suku bunga domestik di negara-negara tersebut.*

*Keywords:* Exchange Rate Regimes, Interest Rates, Southeast Asia.

**JEL Classification:** E43, E52, F31, N15

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## I. INTRODUCTION

Over the past two decades or so major Southeast Asian countries have followed different paths of exchange rate regimes. Prior to the crisis in 1997, the Philippines implemented the most flexible exchange rate regime, while Indonesia, Malaysia, Singapore and Thailand followed the less flexible crawling-band or managed-floating arrangements. Specifically, before the crisis, Indonesia followed a crawling-band exchange rate arrangement; Thailand pegged its currency to a currency basket; and Malaysia and Singapore followed a managed float exchange rate regime.

As a response to the currency crisis in 1997, the governments of the major Southeast Asian countries introduced various economic policy instruments, particularly to the policy regarding exchange rate. Following the currency crisis, Indonesia and Thailand have adopted a more flexible exchange rate regime, where the governments in these countries let their exchange rates be determined by supply and demand in foreign exchange markets with occasional unannounced intervention. By contrast, since September 1998 the Malaysian government has formally pegged its currency to the US dollar. The Philippines and Singapore, formally, have followed the same exchange rate regimes before and after the crisis.

In addition to changing its exchange rate regime, as a response to the crisis the Malaysian government also undertook an important change in its policy regarding capital flows. In order to reduce the pressure on its currency—the ringgit—and to regain monetary independence, in September 1998 the Malaysian government introduced a package of capital controls. The controls included a requirement for non-residents to hold the proceeds from sale of Malaysian securities for one year, and a prohibition of some off-shore ringgit trading. The control on capital outflows was removed in May 2001.

The choice of an exchange rate regime is one of the key issues in international finance. A conventional view on the exchange rate regime is that a fixed exchange rate regime can reduce exchange rate volatility and provide a credible anchor for monetary policy. A flexible exchange rate regime, on the other hand, allows for more independent monetary policy. Accordingly, under a fixed exchange rate regime with perfect capital mobility, domestic interest rates move closely with the interest rates of the country to which domestic currency is pegged. Under a flexible exchange rate regime, by contrast, the monetary authority can set domestic interest rates independently. Other things being equal, under a flexible exchange rate regime, shocks to international financial markets do not necessarily cause domestic interest rates to move. In other words, domestic interest rates under a flexible exchange rate regime can be insulated from shocks to international financial markets.

Although the issue of the appropriate exchange rate regime is not new, it is continually debated. So far, there is no agreement among economists on which exchange rate regime should be followed by a certain country. For developing countries in East Asia, a number of economists consider a flexible exchange rate regime is more appropriate (for example, Fischer 2003; Rogoff, 2004). On the other hand, other economists argue that a fixed exchange rate regime is a better choice for those countries (for example, McKinnon 2000). Using data of major Southeast Asian countries, this paper tests the hypothesis that a country with a more flexible exchange rate regime has domestic interest rates less connected with international financial markets. The sample of the countries consists of ASEAN-5 countries: Indonesia, Malaysia, the Philippines, Singapore and Thailand. To capture the effect of the exchange rate regime changes that took place in the sample of the countries, this paper covers the period from January 1995 to December 2003. As proxies for international financial market factors, we use the US short-term interest rate and emerging market risk premium.

Given that Indonesia and Thailand have adopted a more flexible exchange rate regime since the Asian crisis, we expect that their domestic interest rates are less connected to the world interest rate; the effects of the world interest rate are transmitted more into their exchange rate changes. Comparing the implications of the exchange rate regimes between Indonesia and Thailand on the one hand and Malaysia on the other hand is rather problematic because of the presence of capital control in Malaysia following the 1997 crisis. In the presence of capital control, a country with a pegged exchange rate regime—such as Malaysia after the crisis—still has independent monetary policy; therefore its domestic interest rates do not necessarily move closely with foreign interest rates.

Examining the implications of the exchange rate regimes on how domestic interest rates in major Southeast Asian countries responded to external factors—such as the US interest rate and emerging market risk premium—is important to provide a better understanding on the possibility of the spreading of a crisis in the region. Except South Korea, the countries that experienced the currency crisis in 1997 were mostly the major economies in Southeast Asia including Indonesia, Malaysia, the Philippines, and Thailand. Singapore was the only major economy in Southeast Asia that was not seen to be hit by the crisis. The severity of the crisis in the region was quite different from one country to another. Indonesia was the worst affected, where its currency depreciated about 75 percent from the level observed before the crisis. On the other hand, Malaysia can be viewed as the least affected, where its currency depreciated by about 35 percent.

The remainder of the paper is organized as follows. In section II, we provide a review of the related literature. In section III, the Uncovered Interest Rate Parity is described briefly. In

section IV we present econometrics methodology. In section V, data and descriptive statistics are presented. In Section VI, we report the estimation results. Finally, we present concluding remarks in Section VII.

## **II. LITERATURE REVIEW**

A number of empirical studies recently have investigated the way domestic financial markets in emerging economies respond to international financial market shocks. Using monthly and weekly data during the period of 1990s, Edwards (1998) investigates the behavior of the interest rates in three Latin American countries: Argentina, Chile and Mexico. In particular, he investigates volatility contagion from Mexico to Argentina and Chile. He finds that there was a spillover from Mexico's financial market volatility into Argentina's financial market volatility, but not into Chile's financial market volatility.

De Brouwer (1999) assesses time varying effects of foreign interest rates on domestic interest rates in a number of East Asian countries including ASEAN-5 countries. Using monthly data during the period from 1980 to 1994, he finds that except for Malaysia domestic interest rates of the major Southeast Asian countries are cointegrated with the US interest rates. In addition, he shows that the role of foreign interest rates in explaining innovations to the domestic interest rates in ASEAN-5 excluding Malaysia, increased during the period of his study. He infers that this result is associated with the openness of the capital account of the countries rather than their exchange rate regimes.

Borensztein et al. (2001) investigate the implications of the exchange rate regimes on the effects of external factors on domestic interest rates in a number of emerging market economies; their study uses monthly data during the 1990s. As a proxy for external factors, in addition to the US interest rates, they also use risk premia attached to emerging market debt. The results of their study do not show a clear implications of the exchange rate regimes on the effects of external factors on domestic interest rates. That is, the comparison between Hong Kong and Singapore supports the hypothesis that domestic interest rates in a country with a fixed exchange rate regime are more sensitive to external shocks. But that hypothesis is not supported by the comparison between domestic interest rates in Argentina and domestic interest rates in Mexico.

The effects of external shocks on domestic interest rates and exchange rates in a number of Central and Eastern European countries have been investigated by Habib (2002). He examines the effect of external shocks on domestic interest rates and exchange rates in the Czech Republic, Hungary, and Poland during the period from 1997 to 2001. Considering that during the period of his study the Czech Republic adopted a managed floating exchange rate regime while Hungary

and Poland adopted a more rigid regime, he tests whether the Czech Republic is more insulated from external shocks. As proxies for external factors he uses German interest rates and emerging market risk premium—following Borensztein et al. (2001). Habib's (2002) study results in inconclusive evidence on the effects of external shocks on the domestic interest rates in countries under different exchange rate regimes.

While the aforementioned studies use specific countries or specific regions, more recent studies cover a much larger number of countries and longer period of time. Using monthly data during the period from 1970s to 1990s, Frankel et al. (2002) covers 46 countries: 18 industrial countries, and 28 developing countries. They find that the countries under a floating exchange rate regime appear to have a degree of monetary independence temporarily. In the long run, however, international interest rates have large effects on the domestic interest rates in most of the countries regardless of their exchange rate regimes. The exceptions took place only in Japan and Germany, where their domestic interest rates do not exhibit a long-run relationship with the US interest rates.

Using monthly data of more than 100 countries during the period from 1973 to 2000, Shambaugh (2004) finds that domestic interest rates in countries under a pegged exchange rate regime follow the interest rate movements in the country to which their currencies are pegged. Obstfeld et al. (2004) have extended Shambaugh's (2004) paper, and they test whether the trilemma of open economy existed in the period of time that spans from the Gold Standard until the Post-Bretton Woods era. Both Shambaugh's and the Obstfeld et al. findings show that, to some extent, a non-pegged exchange rate regime gives more room for monetary policy autonomy.

In fact, ASEAN-5 countries, which are the countries covered in this paper, have also been included in some of the previous studies (de Brouwer, 1999; Frankel, 2002; Shambaugh, 2004; and Obstfeld et al. 2004). Relative to the studies that cover ASEAN-5 countries, this paper contributes to the literature in a number of respects. First, with respect to the period studied, this paper uses more recent data that cover the period before and after the currency crisis in 1997. While de Brouwer's paper covers ASEAN-5 countries only until 1994, since then there have been major changes in the financial-market policies adopted in ASEAN-5 countries, including the changes in foreign exchange regime and in capital market openness. Therefore, it is necessary to examine the behavior of financial markets in the regions before and after the 1997 crisis.

Second, in this paper we analyze the effects of external factors on the domestic variables not only in terms of the first moments but also in terms of the second moments. That is, in addition to analyzing the relationships of the variables in their means, we also analyze the volatility spillover from international financial markets into the volatility of domestic financial

markets. Finally, following Borensztein et al. (2001) and Habib (2002), in addition to the effects of the world interest rates we also analyze the effects of emerging market risk premium. As argued by Borensztein et al. (2001), the way shocks to the world interest rates enter the reaction function of monetary authorities can be different from the way shocks to emerging market risk premium enter the reaction function.

### III. UNCOVERED INTEREST RATE PARITY

Interest rates and exchange rates are among the most influential variables in open economies. One of the main focuses of empirical studies on small open economies is the effects of external shocks on those two variables, that is, how domestic interest rates and exchange rates respond to external shocks. Empirical studies on this issue are mostly centered on the trade-off between exchange rate regimes, capital mobility, and monetary policy independence. This trade-off is also commonly known as a trilemma in the open economy, meaning that a government cannot pursue a fixed exchange rate regime, perfect capital mobility, and independent monetary policy at once; only two of the choices can be achieved.

As a measure of monetary independence, short-term interest rates have been widely used in the literature. As argued by Obstfeld et al. (2004), monetary policy generally targets the short-term interest rates with little meaningful reference to money supply, and even if the short-term interest rates are not the target, they should be directly affected by a change in monetary policy. Based on that argument, and under the assumption of an open capital market, the relationship between domestic monetary policy independence, exchange rate regimes, and international financial markets can be estimated using the Uncovered Interest Rate Parity (UIRP) equation

$$r_t = r_t^* + Ee_{t+1} - e_t + u_t \quad (II.1)$$

where  $r_t$  denotes the domestic nominal interest rate,  $r_t^*$  denotes the foreign interest rate,  $E(e_{t+1} - e_t)$  denotes the expected value of a change in log nominal exchange rate, and  $u_t$  denotes the risk premium.

In this paper, the relationships between domestic monetary policy independence, exchange rate regimes, and international financial markets are based on the UIRP. In equation (II.1), the behavior of the domestic interest rate and the exchange rate are based on the assumption that  $r_t^*$  and  $u_t$  are exogenous. This assumption is justified by the fact that domestic financial markets of small open economies are very small relative to international financial markets. Therefore, it is quite unlikely that the international financial markets depend on the short-term interest rates in a small open economy.

With perfect capital mobility, equation (II.1) provides the following predictions. Under a fully flexible exchange rate regime, shocks to  $r_t^*$  and  $u_t$  can be absorbed by the changes in the nominal exchange rate ( $Ee_{t+1} - e_t$ ) and/or the changes in domestic interest rates: that is, monetary authority has leeway to whether or not pass the shocks to  $r_t^*$  and  $u_t$  into domestic interest rates. On the other hand, under a fixed exchange rate regime, that is, when  $E(e_{t+1} - e_t) = 0$  shocks to  $r_t^*$  and  $u_t$  are fully transmitted into domestic interest rates. In intermediate cases—when exchange rates are allowed to move within a certain limit—a less flexible exchange rate regime is associated with a larger transmission of external shocks into domestic interest rates.

#### IV. ECONOMETRICS METHODOLOGY

Since both domestic interest rates and expected exchange rate are endogenous, equation (II.1) can be written in a system of three equations: (i) an equation for external variable (foreign interest rates or emerging market risk premia), (ii) an equation for domestic interest rates, and (iii) an equation for exchange rates. To estimate this system of equations, we employ Vector Autoregression (VAR) models that will provide dynamic relationships between the variables. To estimate the spillover of the external variable volatility into domestic interest rate volatility and exchange rate volatility, we employ General Autoregressive Conditional Heteroscedasticity (GARCH) models. While with the VAR we estimate the equations simultaneously, with GARCH we estimate the models for each variable separately. The details of the VAR and GARCH models are described as follows.

##### IV.1 Vector Autoregression

Using VAR models we generate orthogonalized impulse response functions for each sample of the countries. To do so, we take the following strategy. First, since the order of the variables matters in this method, we determine the order of the variables by assuming that neither the domestic interest rates nor the exchange rates have contemporaneous effects on the external variables. The order of the variables is: external variables, domestic interest rates, and exchange rates. Second, we generate impulse response functions by imposing a recursive structure of the model as follows

$$\begin{bmatrix} 1 & 0 & 0 \\ a_{21} & 1 & 0 \\ a_{31} & a_{32} & 1 \end{bmatrix} \begin{bmatrix} x_t^* \\ r_t \\ \Delta e_{t+1} \end{bmatrix} = \alpha' + \sum_{k=1}^k \Pi_i' \begin{bmatrix} x_{t-k}^* \\ r_{t-k} \\ \Delta e_{t+1-k} \end{bmatrix} + u_t' \quad (\text{II.2})$$

where  $x_t$  denotes the variable for the external factors. Using equation (2), the effects of a shock

to the world interest rate and the shocks to emerging market risk premium are estimated separately. Finally, we estimate the model by changing the order of domestic interest rates and the exchange rates; this approach allows us to examine the sensitivity of the model to the order of domestic interest rates and the exchange rate.

## IV.2 Generalized Autoregressive Conditional Heteroscedasticity

Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model is one of the econometric models widely used in measuring the volatility of economics and financial time series data. This model was developed by Bollerslev (1986) based on Autoregressive Conditional Heteroscedasticity (ARCH) model developed by Engle (1982). The advantage of GARCH specification over ARCH specification is parsimony in identifying the conditional variance in GARCH (Wang, 2003).

To capture the spillover of international financial market volatility into domestic financial market volatility, in addition to ARCH and GARCH terms, we embed multiplicative heteroscedasticity components into the standard GARCH model. Specifically, the GARCH model in this paper is formulated as follows. Let  $y_t$  be a domestic variable—either domestic short-term interest rates or exchange rates,  $\psi_t$  be a vector of explanatory variables in the underlying equation, and  $\theta$  be a vector of  $\psi_t$ 's coefficients<sup>2</sup>. Then, the GARCH model we use in estimating the spillover of the international financial markets volatility into the domestic variables volatility can be represented by equations

$$y_t = \theta' \psi_t + \varepsilon_t \quad (II.3)$$

$$\varepsilon_t = \eta_t \sqrt{h_t} \quad (II.4)$$

$$h_t = f(Z_t) + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j h_{t-j} \quad (II.5)$$

where  $\varepsilon_t$  denotes the innovation to the domestic variable,  $h_t$  denotes the conditional variance,  $Z_t$  denotes a vector of exogenous variables embedded into the volatility equation,  $\alpha_i$  denotes ARCH coefficient, and  $\beta_j$  denotes GARCH coefficient.

Before we estimate the GARCH model, a number of issues need to be addressed. The first issue is the specification of the underlying equation; that is, what variables are included in vector  $\psi_t$ . Although there is no strong foundation for choosing the specification of the

2 In practice, this formulation is an extension of the VAR. If we replace this  $\psi_t$  with the lag structure in equation (II.2), in place of  $\psi_t$  we have a VAR specification extended to include GARCH effect.



underlying equation, the most common explanatory variables used in empirical studies are the lags of  $y_t$ . The second issue is the specification of the GARCH model. In empirical application, GARCH (1,1) model is the most popular structure for many financial time series (Poon and Granger, 2003). Finally, we need to specify the functional form of the multiplicative heteroscedasticity embedded into the model. Following Judge et al (1985), the functional form of the multiplicative heteroscedasticity employed in this paper is exponential. Thus, the conditional-volatility equation (II.5) can be written in the form

$$h_t = \exp(\kappa_0 + \kappa_1 z_t + \kappa_2 D_t + \kappa_3 D_t z_t) + \sum_{i=1}^p \alpha_i \varepsilon_{t-i}^2 + \sum_{j=1}^q \beta_j h_{t-j} \quad (\text{II.6})$$

where  $z_t$  denotes the volatility of external factors,  $D_t$  denotes a dummy variable for exchange rate regime, and  $\kappa_i$ 's denote coefficients of the multiplicative heteroscedasticity variables. One of the advantages of using the exponential function for conditional volatility is that using such a function rules out the possibility of negative variance.

The estimates of  $\kappa_1$  and  $\kappa_3$  capture the spillover of the external factor volatility into domestic variable volatility. The comparisons of the spillover effects between countries in the sample are observed from the comparison of the estimates of  $\kappa_1$ . On the other hand, the effects of the changes in the exchange rate regimes on the volatility of the domestic variables are captured by the estimates of  $\kappa_2$  and  $\kappa_3$ . For the interest rate volatility models, we expect to obtain a lower estimate of  $\kappa_1$  in a country with a more flexible exchange rate regime; and, provided that the value of  $D_t$  equals one under a flexible exchange rate regime, the estimates of  $\kappa_2$  and  $\kappa_3$  are expected to be negative. For the equations of exchange rate volatility, the signs of  $\kappa_1$ ,  $\kappa_2$  and  $\kappa_3$  are expected to be positive.

## V. DATA AND DESCRIPTIVE STATISTICS

### V.1 Data

All data used in this paper are obtained from Datastream. The data cover the period from January 1995 to December 2003 with daily frequency. Exchange rate data are daily nominal exchange rates in terms of domestic currency per US dollar. The variables for domestic interest rates are interbank rates in each country in the sample; definitions of the variable for each country are shown in Table II.1. All interest rates data are annualized daily frequency data.

As a proxy for international interest rates, we use the US Interbank 1-month. The use of the US short-term interest rate as a proxy for international interest rate is based on the fact that the US dollar has been the main anchor currency for the countries in Southeast Asia. This can

be seen from the fact that the base currency used by Malaysia to peg its currency at the present is the US dollar; and when other countries in the region followed a managed floating regime, they managed their exchange rates with respect largely to the US dollar.

Country	Interest Rates
Indonesia	Indonesian Interbank Call
Malaysia	Malaysian Interbank Overnight
Philippines	Philippine Interbank Call Loan Rate
Singapore	Singapore Interbank Call
Thailand	Thailand Interbank Call

As mentioned previously, we use emerging market risk premium as another proxy for the external factors. Here, as a measure for the emerging market risk premium we use JP Morgan Emerging Market Bond Index Plus (EMBI+). This index tracks total returns of the traded external

Country	Period	Classification	
		Narrow	Broad
Indonesia	Nov 78 - Jul 97	Managed floating	Intermediate
	Aug 97 - Dec 03	Free floating	Floating
Malaysia	Sep 75 - Mar 93	Limited flexibility wrt USD	Intermediate
	Apr 93 - Aug 98	Managed floating	
	Sep 98 - Dec 03	Pegged to USD	Fixed
Philippines	Oct 81 - Jun 82	Limited flexibility wrt USD	Intermediate
	Jul 82 - Sep 84	Managed floating	
	Oct 84 - Dec 03	Independently floating	Floating
Singapore	Jun 73 - Jun 87	Limited flexibility wrt basket	Intermediate
	Jul 87 - Dec 03	Managed floating	
Thailand	Jan 77 - Feb 78	Pegged to USD	Fixed
	Mar 78 - Jun 81	Limited flexibility wrt basket	Intermediate
	Jul 81 - Mar 82	Managed floating	
	Apr 82 - Oct 84	Limited flexibility wrt USD	
	Nov 84 - Jun 97	Limited flexibility wrt basket	
	Jul 97 - Dec 03	Independently floating	Floating

Source: Frankel et al. (2002), and IMF Annual Report on Exchange Arrangements and Exchange Restrictions.

debt instruments in emerging markets including: US dollar-and other external-currency-denominated Brady bonds, loans, Eurobonds, and local market instruments. Among the countries in the sample, the Philippines was the only country in Southeast Asia included in the EMBI+ where its weight was 1.3 percent.

The classification of exchange rate regimes used in this paper is based on the official classification of the IMF, which is based on the official reports of each member country. Table II.2 presents the exchange rate regime paths followed by the countries in the sample over the past twenty years or so. Recently there have been some caveats on the official exchange rate regimes reported by the IMF, and a number of studies have provided *de facto* exchange rate regimes followed by a specific country. As shown by Shambaugh (2004) the so-called *de facto* exchange rate regimes reported in a number of studies are very much close to the official arrangements for the countries considered in this paper.

## V.2 Descriptive Statistics

Summary statistics of the exchange rates and the domestic interest rates of the countries sample are presented in Table II.3 and Table II.4, respectively.

Year	Indonesia (Rupiah/US\$)		Malaysia (Ringgit/US\$)		Philippines (Peso/US\$)		Singapore (Sg\$/US\$)		Thailand (Bhat/US\$)	
	Mean	Std D	Mean	Std D	Mean	Std D	Mean	Std D	Mean	Std D
1995	2244	26	2.51	0.041	25.71	0.465	1.42	0.021	24.92	0.221
1996	2327	18	2.52	0.023	26.21	0.044	1.41	0.006	25.35	0.111
1997	2891	768	2.82	0.435	29.66	4.174	1.49	0.076	31.06	6.410
1998	10194	2421	3.92	0.220	40.90	1.955	1.67	0.054	41.19	4.418
1999	7843	775	3.80	0.001	39.13	1.028	1.69	0.021	37.87	1.082
2000	8419	759	3.80	0.000	44.27	3.442	1.72	0.022	40.19	2.283
2001	10255	821	3.80	0.000	50.98	1.529	1.79	0.037	44.50	0.939
2002	9319	547	3.80	0.000	51.60	1.148	1.79	0.034	43.00	0.844
2003	8571	242	3.80	0.001	54.19	0.992	1.74	0.018	41.52	1.234

As shown in Table II.3 the yearly average of the exchange rates in all five countries increased sharply in 1998. This fact characterizes the period of the currency crisis that hit the region in mid 1997. Except in Malaysia, however, the exchange rates did not reach the highest means in

1998; instead the highest means took place in 2001 in 3 out of 5 countries: Indonesia, Singapore, and Thailand. The mean of the Malaysian exchange rate reached a peak in 1998 and since then the Malaysian government has pegged the ringgit to the US dollar. In the Philippines, the mean of its exchange rate in 2001 was higher than that of in 1998 and the mean continued rising until 2003.

Except in Indonesia, the standard deviations of the exchange rates for all countries reached their peaks in 1997. The highest standard deviation of the Indonesian exchange rate occurred in 1998. It seems that the worsening political situation in the country in the early 1998 exacerbated the currency crisis. In the Philippines, although the standard deviation of its exchange rate dropped in 1998 following the jump in 1997, it jumped again significantly in 2000.

Year	Indonesia		Malaysia		Philippines		Singapore		Thailand	
	Mean	Std D	Mean	Std D	Mean	Std D	Mean	Std D	Mean	Std D
1995	13.58	1.92	5.75	0.46	11.78	5.77	2.13	0.94	12.47	1.71
1996	13.86	2.09	7.01	0.39	12.71	1.33	2.84	0.57	11.41	2.44
1997	26.53	18.71	7.47	1.71	16.31	10.96	3.97	2.03	17.77	5.67
1998	64.08	15.80	8.51	1.90	14.02	1.37	4.06	2.73	18.37	7.55
1999	23.50	12.20	3.52	1.25	10.18	1.68	1.47	0.60	4.11	1.03
2000	10.50	0.99	2.71	0.14	10.81	2.23	2.40	0.60	2.89	0.61
2001	14.72	1.86	2.82	0.04	9.77	1.25	1.75	0.72	2.48	0.39
2002	14.28	2.05	2.77	0.00	7.16	0.29	0.71	0.19	1.99	0.13
2003	9.92	1.62	2.77	0.00	6.97	0.15	0.52	0.10	1.50	0.26

Note: Mean and standard deviation are calculated from annualized daily data.

As shown in Table II.4, except in Malaysia, the means of the short-term interest rates in the other four countries increased significantly in 1997 and then continued at the high level until 1998. The mean of the short-term interest rate in Indonesia even reached a much higher level in 1998 where it increased by about 200 percent from the mean in 1997. In Malaysia, the short-term interest rate increased sharply in 1996, that is, before the currency crisis hit the country. Since 1998, the short-term interest rates in all countries in the sample have moved toward lower levels.

From 1996 to 1997, the standard deviations of the short-term interest rates for all countries in the sample also increased sharply and reached peaks either in 1997 or 1998. While a relatively high standard deviation of the short-term interest rates lasted only for one year in the Philippines,

it lasted for three years in Indonesia and Malaysia. In Singapore and Thailand, the high standard deviations of the short-term interest rates lasted for two years, that is, until 1998.

Year	Indonesia		Malaysia		Philippines		Singapore		Thailand	
	Mean	Std D	Mean	Std D	Mean	Std D	Mean	Std D	Mean	Std D
1995	9.44	0.70	3.45	0.23	8.01	1.77	1.73	0.66	5.69	1.05
1996	8.00	1.74	3.49	0.18	9.06	1.96	1.38	0.28	5.90	1.18
1997	6.22	2.03	2.66	0.37	5.94	0.86	2.00	0.34	5.56	1.46
1998	57.94	22.72	5.27	0.74	9.69	1.26	-0.26	1.07	8.13	2.23
1999	24.07	23.87	2.75	0.94	6.70	2.34	0.02	0.53	0.33	1.56
2000	3.77	3.96	1.53	0.20	4.31	1.19	1.36	0.50	1.56	0.53
2001	11.47	1.59	1.42	0.20	6.13	0.95	1.00	0.88	1.66	0.60
2002	11.94	1.90	1.81	0.36	3.11	0.49	-0.39	0.48	0.61	0.52
2003	6.61	1.02	1.06	0.29	2.90	0.22	0.51	0.36	1.82	0.26

Note: mean and standard deviations are calculated from annualized monthly data

To give some idea on the dynamics of domestic prices in the sample of the countries, we report summary statistics of the inflation rates in each country. As shown in Table II.5, the inflation rate in Indonesia increased enormously in 1998, and although the rate fell in 1999 but it remained high relative to the rates in other periods. In other four countries, although their inflation rates increased in 1998, it only increased moderately relative to the increase in Indonesia. The standard deviation of the inflation rates in the sample of the countries also increased sharply in 1998.

To take a closer look at the daily interest rate movements and the daily exchange rate movements, we plot the daily changes of those two variables in each country from January 1995 to December 2003 (Figure II.A1). The characteristics of the data we observe in panel A and panel B of Figure II.A1 are as follows. First, during the period of the currency crisis, the interest rates in all countries fluctuated more relative to interest rates before and after the crisis. Second, the fluctuations of the interest rates in all countries since 1999 have been much lower compared to their fluctuations before the currency crisis. In Indonesia, although the short-term interest rates have become more stable since 1999, they fluctuated substantially between January 2001 and October 2003. Third, except in Indonesia, exchange rate fluctuations in all countries reached the highest level in 1997. In Indonesia, the peak of the exchange rate fluctuation that took place in 1998 can be attributed in part to the worsening political situation in the country in early 1998. Finally, not surprisingly, after adopting a flexible exchange rate regime since

1997, the exchange rates of Indonesia and Thailand have fluctuated more than during the periods under the old regime. In Malaysia, the pegged exchange rate regime since September 1998 is reflected by the lack of movements in the value of ringgit against the US dollar.

Year	US Interest Rates		EMBI <sup>+</sup> Changes	
	Mean	Std. Dev.	Mean	Std. Dev.
1995	5.97	0.12	-0.05	13.58
1996	5.45	0.09	41.63	7.11
1997	5.65	0.14	29.18	9.81
1998	5.57	0.16	-1.89	14.82
1999	5.25	0.43	1.45	17.20
2000	6.41	0.32	25.28	6.49
2001	3.88	1.26	9.49	6.95
2002	1.77	0.16	1.92	5.31
2003	1.21	0.1	26.49	9.26

Note: Mean and standard deviation are calculated from annualized daily data

In Table II.6, we report summary statistics of the US short-term interest rates and EMBI<sup>+</sup> returns during the period of January 1995-December 2003. As reported in Table II.6, the US short-term interest rates in 2001 and the subsequent years have been much lower than the rates during the period before 2001. The EMBI<sup>+</sup> returns over the period of 1995-2003 fluctuated substantially, where the highest returns took place in 1996 while the lowest returns took place in 1998.

## **VI. ESTIMATION RESULTS**

### **VI.1 Estimation Results of the VAR Models**

In this section we present the estimation results of the impulse response functions based on the VAR models formulated in section IV.1. The effects of the changes in exchange rate regimes in Indonesia, Malaysia, and Thailand are captured by estimating the impulse response functions for each of the old and new exchange rate regimes. For the Philippines, although it did not experience a change in the exchange rate regime during the period of the study, we also estimate the models for two set of samples: before and after the crisis. This approach is based on the fact that the Philippines was also hit hard by the crisis in 1997. For Singapore, since it neither changed its exchange rate regime nor experienced the crisis during the period

of the study, we estimate the impulse response functions using all periods of data. All variables in the models are in the first difference. To capture the possible effects of different days in a week, we include dummy variables for days.

The first step we undertake in estimating the models is determining the lag length of each model. Akaike Information Criterion (AIC), Hannan-Quinn Criterion (HQC), and Schwartz Information Criterion (SIC) are the most common criteria used in determining lag length of time series models. The lag lengths obtained from those three criteria, however, are often inconsistent among each other. In general, the relationship of the lag lengths based on the AIC, HQC, and SBC is given by the inequality:  $\text{lag(SIC)} \leq \text{lag(HQC)} \leq \text{lag(AIC)}$  (Lütkepohl and Krätzig, 2004). The lag lengths we use in this paper are based on the SIC. The maximum lag length chosen is 20 that can be considered as a reasonable maximum length for daily data, where it covers four weeks of business days. Under general conditions, SIC estimates the lag length consistently when the data generation process has a finite VAR lag length and the true lag length is less than the maximum lag length (Lütkepohl and Krätzig, 2004).

The impulse response functions for each country under the old and new exchange rate regimes are shown in Figure II.A2 through Figure II.A7. The solid lines in the figures depict the point estimates of the impulse responses, and the dashed lines depict their  $\pm 2$  standard error bands that capture an approximately 95 percent of the confidence interval of each point estimates. As shown in Figure II.A2, the results of the impulse response functions show that, regardless of the exchange rate regimes, the impact effects of a shock to the US short-term interest rate on the domestic interest rates of the countries in the sample do not differ significantly from zero. Similarly, as shown in Figure II.A3, the impact effects of a shock to the US short-term interest rate on the exchange rates of the countries in the sample do not differ significantly from zero. These results indicate that the exchange rate regimes do not have significant implications for how the US short-term interest rate affects domestic interest rates and exchange rates in major Southeast Asian countries. In other words, regardless of the exchange rate regime, shocks to the US short-term interest rate are not transmitted either to the domestic interest rates or to the exchange rates of major Southeast Asian countries.

The impulse response functions of a shock to the emerging market risk premium are presented in Figure II.A4 and Figure II.A5. As shown in Figure II.A4, except for Thailand under the new exchange rate regime, a shock to the emerging market risk premium does not have significant effects on the domestic interest rates in all countries in the sample. In Thailand under the new exchange rate regime, a one point increase in the emerging market risk premium results in a 0.03 point increase in domestic interest rate in period one, and the effect fades away in the second period and after.

Figure II.A5 shows that, in most cases, a shock to the emerging market risk premium has significant and negative effects on the exchange rates, and the effects fade away in less than five days. This pattern is observed for the data under the new exchange regimes as well as for the data under the old exchange rate regimes. In Indonesia and Malaysia, the effects of a shock to the emerging market risk premium on the exchange rates are more pronounced under more flexible exchange rate regimes. In Thailand, before its government adopted a flexible exchange rate regime, a shock to the emerging market risk premium did not have a significant effect on the exchange rate. But, the effect becomes significant and negative under a flexible regime. Looking back to equation (1), when there is an increase in the external factor, in order to mitigate the transmission of that increase into domestic interest rates, exchange rate should be decreased. Thus, the estimates of the impulse response functions tell us that, to some extent, the countries in the sample insulated their domestic interest rates from shocks to the emerging market risk premium by letting their currencies appreciate.

In Figure II.A6 and Figure II.A7 we present the impulse response functions of a shock to the interest rates and exchange rates on themselves. In all countries in the sample, regardless of the exchange rate regime, a shock to the domestic interest rates significantly affects the domestic interest rates, and a shock to the exchange rates significantly affects the exchange rates. The effects reach the peaks in period 0 and fade away in less than five days.

<b>Table II.7</b>		
<b>Wald-Tests for the Structural Changes of the VAR models</b>		
<b>Country</b>	<b>External Variables</b>	
	<b>US Interest Rates</b>	<b>Emerging Market Risk Premium</b>
Indonesia	481.8	481.6
Malaysia	66.8	478.9
Thailand	1052.0	740.5

Note: Critical value at 5 percent confidence level is 59.7

To test whether the VAR models under the new exchange rate regime differ significantly from the VAR models under the old exchange rate regime, we employ the Wald test—which is an extension of Chow test (Boivin, 1999). In Table II.7, we report the results of the Wald-tests for the countries where an exchange rate regime change took place during the period of this study. For all countries we reject the hypothesis that the structures of the VAR models under the new and old exchange rate regimes are not different.

While the effects of the external factors on domestic variables do not seem to be the source of the structural changes, a closer look at the coefficient estimates tells us that the



source of the changes are mainly autoregressive coefficients of the domestic variables. As shown in Figure II. A7, the magnitudes of the contemporaneous effects of a shock to the exchange rates on themselves decrease significantly when a country adopted a more flexible regime.

The stability of the VAR models is checked by examining their eigenvalues: the estimation results of a model are stable if all of its eigenvalues lie inside the unit circle. The estimation results show that all models satisfy the stability condition, that is, for each model all eigenvalues lie inside the unit circle. In addition to the stability of the estimates, we also test the residual autocorrelation of the models. The Lagrange-Multiplier tests show that in each model there is no residual autocorrelation.

The robustness of the models is examined in two ways. One way is by changing the order of the domestic variables, that is, we change the order of domestic interest rates and exchange rates. It turns out that changing the order of domestic interest rates and exchange rates does not change the qualitative results of the models. Regardless of the order between domestic interest rates and exchange rates, a shock to the US interest rates does not have significant effects either on domestic interest rates or on exchange rates of the countries in the sample. Similarly, changing the order of the domestic variables also does not change the qualitative results of the effects of a shock to emerging market risk premium.

Another way we use to check for the robustness of the models is by changing the lag lengths of the models based on criteria other than SBC. For this purpose, we estimate the impulse response functions with lag lengths based on AIC, and HQC. In most cases, the lag lengths obtained from AIC, HQC and SBC are different. However, using those different lag lengths does not change the qualitative results of the model. In addition to the lag lengths determined by information criteria, we also estimate the model with a fixed lag length, where for each country in the sample we estimate the models with lag length 10<sup>3</sup>. Still, the qualitative results of the model do not change.

Provided that domestic factors significantly drive the daily movements of the interest rates in the countries of the sample, we need to take a closer look at the operations of monetary policy implemented in those countries; such operations in turn may guide the daily interest rate movements. To some extent, the operation of monetary policy in major Southeast Asian countries shares similarities. As reported by Borio and McCauley (2002), for example, the monetary authorities of Indonesia, Malaysia, and Thailand undertake market operations once or more in a day. This indicates that the operational frameworks of their monetary authorities play an important role in the movements of their daily interest rates.

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<sup>3</sup> Borenztein et al (1999) and Habib (2001), for example, use lag length 10 and 11, respectively

In spite of the similarities in their operation of monetary policy, the extents to which they influence the markets are not necessarily the same. Thailand is the only country that followed different monetary operation measures after 1997 while Indonesia and Malaysia did not show any difference (Borio and McCauley, 2002). Following the 1997 crisis, the Thai authority changed its operational instruments from exchange swap to repurchase agreement. The operational frameworks of Thailand do not bound to over night rate from below and above. In Indonesia and Malaysia, monetary authority influence overnight and one-month interbank rates. This difference in the operational framework leads daily interest rates in Thailand to be affected by external factors—as can be seen from the impulse response functions of Thai models.

Other than Thailand, the results of the estimations for Singapore also show the significant effects of external factors on its domestic short-term interest rates. This can be attributed to the lack of the control in its money markets. Based on the IMF's Exchange Arrangements and Exchange Restrictions (2003), Singapore doesn't impose any control on money market securities while the other four countries impose a control on money market securities.

Home bias in national investment portfolios can also be another explanation for the role of domestic factors in the movements of domestic interest rates. Despite the increase in international activity of financial markets, a large number of studies provide empirical supports on the presence of home bias in investment portfolios (Lewis, 1999; Karolyi and Stulz, 2002). While the increase in international activity of financial markets can result in an increase effect of international financial markets, the presence of home bias can make domestic factors as the important driving forces in the movements of domestic asset prices such interest rates.

## **VI.2 Estimation Results of the GARCH Models**

The first step we undertake in estimating the GARCH models is specifying the underlying equation (II.3). All variables in the mean equations are in the first difference. The presence of conditional heteroscedasticity for each underlying equation is tested using Lagrange Multiplier test. The results of the LM tests show that for each underlying equation we fail to reject the presence of the conditional heteroscedasticity.

In all models, the lags of the dependent variables are included as explanatory variables for the underlying equations<sup>4</sup>. For Indonesia, Malaysia, and Thailand, in addition to the lags of the dependent variables, we also include a dummy variable to capture the exchange rate regime changes that took place in those three countries during the period of the study. For the Philippines,

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4 We do not report the coefficients of lag variables in the tables, but they are available on request.

although it did not experience an exchange rate regime change during the period of this study, we include a dummy to capture a major increase in the fluctuations of its exchange rate following the currency crisis in 1997. Based on Panel B of Figure A1, we define a dummy variable for the Philippines' models with value of one started from July 1997, and zero otherwise. Similar to the VAR models, to capture the day effects we also include dummies for days in the underlying equations.

The second step is obtaining the proxies for international financial market volatility. Here, we calculate rolling window variances of the US short-term interest rates ( $vUS_t$ ) and rolling window variances of the EMBI+ returns ( $vEM_t$ ). For the purpose of this study, this approach can be considered to be sufficient in capturing the volatility of the exogenous variables. The rolling window variances of each variable at time  $t$  are calculated as the variance of the data at time  $t$  and the previous four days<sup>5</sup>.

After the first and second steps are done, finally we estimate the GARCH models for each country in the sample. The estimates of the conditional-variance models based on equation (II.6) are reported in Table II.8 through II.11. In Table II.8 and II.9,  $vUS_{t-1}$  and  $D_t \times vUS_{t-1}$  refer to  $z_t$  and  $D_t \times z_t$  in equation (II.6), respectively; and  $vEM_{t-1}$  and  $D_t \times vEM_{t-1}$  in Table II.10 and II.11 refer to  $z_t$  and  $D_t \times z_t$  in equation (II.6), respectively.

In each tables, we report Wald  $\chi^2$  and Log-likelihood of each equation. Based on the Wald  $\chi^2$  test we reject the hypothesis of the presence of Integrated GARCH in all equations. The coefficients of ARCH and GARCH in all equations are significant at 5 percent. The effects of the external variables and exchange rate regimes on the volatility of domestic variables are as follows.

Estimation results for the effects of the US short-term interest rate volatility on domestic interest rate volatility and exchange rate volatility are reported in Table II.8 and Table II.9, respectively. Since the functional forms of the multiplicative heteroscedasticity of the conditional variance equations (II.6) are exponential then the coefficients of the external variables are not the measures of marginal effects of the external variables on the conditional volatility of the variables in questions. The marginal effects of the external variables are obtained by multiplying the magnitudes of the coefficients with the magnitudes of the exponential terms. Thus, based on equation (II.6), marginal effect of  $z_t$  on  $h_t$  is given by  $(\kappa_1 + \kappa_3 D_t) \times \exp(\kappa_0 + \kappa_1 z_t + \kappa_2 D_t + \kappa_3 D_t z_t)$ . And therefore, in addition to the values of the coefficients, the marginal effects of the external variables also depend on the values of the external variables.

5 In calculating rolling window variances we experimented with a larger number of days, but using such variance did not result in better models—in many cases, the model cannot be estimated using rolling variance with greater number of days due to the lack of variability of the variances.

As shown in Table II.8, the volatility of the US short-term interest rates significantly affects domestic interest rate volatility in Singapore and Thailand; but not in Indonesia, Malaysia, and the Philippines. The magnitude of the effect in Thailand is larger than that of in Singapore. This evidence indicates that the spillover of the US interest rate volatility into domestic interest rate volatility in Thailand is higher than the spillover into domestic interest rate volatility in Singapore.

Variabel	Indonesia	Malaysia	Philippines	Singapore	Thailand
$vUS_{t-1}$	-401.93 (-1.38)	13.63 (1.22)	-426.30 (-0.14)	51.32* (8.36)	118.19* (3.27)
$D_t$	-0.917* (-9.47)	8.57* (13.79)	0.698 (0.67)	-	-3.10* (-39.63)
$D \times vUS_{t-1}$	235.81 (0.77)	-1554.66** (-1.80)	416.50 (0.13)	-	-88.22* (-2.44)
Constant	-0.556* (-5.72)	-13.28* (-22.79)	-7.41* (-6.76)	-10.12* (-15.88)	-3.86* (-52.39)
$\epsilon_{t-1}$	1.27* (21.00)	1.40* (87.64)	4.12* (83.12)	0.17* (40.67)	0.25* (30.62)
$\epsilon_{t-2}$	-	-1.07* (-178.20)	-	-	-
$h_{t-1}$	0.45* (41.68)	0.88* (509.93)	0.47* (215.84)	0.88* (423.49)	0.83* (236.80)
Wald $\chi^2$	1014.37	2002.76	12195.81	150.82	102.50
Log-Likelihood	-4481.3	1517.6	-836.5	709.8	479.68

Note: Numbers in the parentheses are z-statistics. Coefficients marked by "\*" and "\*\*" are significant at 5 percent and 10 percent confidence levels, respectively.

The effects of the exchange rate regime changes on the domestic interest rate volatility are as follows. Under a more flexible exchange rate regime, Indonesia, and Thailand have lower domestic interest rate volatility; on the other hand Malaysia has lower interest rate volatility under a pegged regime. While the lower interest rate volatility in Indonesia and Thailand can be attributed in part to their more flexible exchange rate regime, in Malaysia the lower interest rate volatility under a pegged exchange rate regime can be as a result of the capital control.

The interaction between the dummy variable with the US short-term interest rate volatility in the equations for domestic interest rate volatility is only significant in Thailand where the sign is negative. Thus, the transmission of the US short-term interest rate volatility on Thai interest rate volatility has declined since the Thai government followed a more flexible exchange

rate regime. This evidence supports the hypothesis that in Thailand domestic interest rates under a more flexible exchange rate regime are less connected to international financial markets.

The fact that domestic interest rate volatility in Malaysia under a peg regime was not significantly affected by the US interest rate volatility can be a result of the capital control. Based on the trilemma of a small open economy, with the presence of capital control, the Malaysian government still has independent monetary policy while at the same time pegs its currency to the US dollar.

Variabel	Indonesia	Malaysia	Philippines	Singapore	Thailand
$vUS_{t-1}$	-1567.57** (-1.87)	-32.64 (-0.02)	171.69 (1.40)	2.65 (0.05)	-285.1 (-1.08)
$D_t$	2.38* (28.46)	8.77* (21.52)	5.89* (31.39)	-	2.15* (16.77)
$D \times vUS_{t-1}$	1567.48** (1.87)	513.52 (0.36)	-178.53 (-1.45)	-	293.85 (1.12)
Constant	-15.79* (-197.69)	-26.36* (-142.18)	-18.26* (-95.00)	-17.41* (-83.65)	-16.15* (-120.46)
$\epsilon_{t-1}$	0.717* (23.08)	0.15* (49.05)	0.23* (17.78)	0.03* (19.97)	0.16* (20.96)
$\epsilon_{t-2}$	-0.579* (-19.86)	-	-	-	-
$h_{t-1}$	0.897* (298.20)	0.89* (1358.13)	0.77* (104.31)	0.96* (661.37)	0.83* (121.30)
Wald $\chi^2$	51.30	325.95	101.34	25.92	11.15
Log-Likelihood	8171.0	14626.7	9720.42	10286.7	9821.2

Note: Numbers in the parentheses are z-statistics. Coefficients marked by "\*" and "\*\*" are significant at 5 percent and 10 percent confidence levels, respectively.

As reported in Table II.9, the US short-term interest rate volatility does not have a significant effect on the exchange rate volatility in any of the countries in the sample. Not surprisingly, dummy variable itself has a positive significant effect on the exchange rate volatility, meaning that the exchange rate volatility is higher under a more flexible exchange rate regime. The interaction between the dummy and the US interest rate volatility does not have a significant effect in any of the exchange rate volatility equations. This evidence tells us that the exchange rate regime changes that took place in Indonesia, Malaysia, and Thailand following the currency

crisis in 1997 did not change significantly the degree of the transmission of the US interest rate volatility into their exchange rate volatility.

The estimation results for the effects of emerging market risk premium volatility on domestic interest rate volatility and exchange rate volatility are reported in Table II.10 and Table II.11, respectively. As shown in Table II.10, the emerging market risk premium volatility has significant and positive effects on the short-term interest rate volatility in Malaysia, and Thailand; and the magnitude of the effect in Malaysia is higher than the magnitude in Thailand. The interaction between the dummy and emerging market risk premium volatility has a significant and negative effect on the volatility of Indonesian and Thai domestic interest rates. In the Malaysia and the Philippines, the interaction between the dummy and the emerging market risk premium also have negative signs, but insignificant. This evidence indicates that the degree of the transmission of the emerging market volatility into domestic interest rate volatility in Thailand is lower under a more flexible exchange rate regime.

Variabel	Indonesia	Malaysia	Philippines	Singapore	Thailand
$vEM_{t-1}$	0.059 (1.21)	0.428* (65.61)	0.196 (1.47)	-6.23 (-0.57)	0.109* (5.75)
$D_t$	3.31* (24.52)	7.48* (11.46)	0.583 (1.39)	-	-1.96* (-28.43)
$D \times vEM_{t-1}$	-15.03* (-45.90)	-0.419 (-1.46)	-0.124 (-0.91)	-	-0.805* (-14.44)
Constant	-1.60* (-12.73)	-13.19* (-120.84)	-7.24* (-16.86)	-7.95* (-4.81)	-3.87* (-61.98)
$\varepsilon_{t-1}$	0.39* (32.09)	0.62* (76.20)	4.05* (85.58)	0.17* (39.93)	0.27* (36.21)
$h_{t-1}$	0.74* (274.36)	0.85* (879.24)	0.47 (0.46)	0.87* (413.88)	0.82* (368.06)
Wald $\chi^2$	280.99	104.55	12089.16	176.33	26.40
Log-Likelihood	-4137.4	1704.4	-835.2	-712.66	-497.3

Note: Numbers in the parentheses are z-statistics. Coefficients marked by "\*" and "\*\*\*" are significant at 5 percent and 10 percent confidence levels, respectively.

As shown in Table II.11, the effects of emerging market risk premium volatility on the exchange rate volatility are significant and positive in Malaysia and Singapore. On the other hand, in Indonesia, Philippines, and Thailand — which have relatively more volatile exchange rates than the exchange rates of Malaysia and Singapore — the effects are not significant. The

dummy for the exchange rate regime changes has significant effects on the domestic exchange rate volatility in all three countries where the exchange rate regime change took place during the period of the study. These results are not surprising given that Indonesia and Thailand have moved to a more flexible exchange rate regime while Malaysia moved to a peg exchange rate regime. In the Philippines, although it did not change its exchange rate regime, the dummy is also significant that indicates this country experiences higher exchange rate volatility after the crisis. The coefficients of the interaction between the dummy and emerging market risk premium volatility is only significant in Indonesia. This indicates that the change in the exchange rate regimes following the currency crisis in 1997 only affects the extent of transmission of the emerging market risk premium into the exchange rate volatility in Indonesia.

Variabel	Indonesia	Malaysia	Philippines	Singapore	Thailand
$vEM_{t-1}$	-0.017 (-0.21)	0.205* (3.40)	-4.06 (-0.83)	0.139* (22.51)	-0.082 (-0.60)
$D_t$	2.39* (28.97)	9.94* (56.31)	6.71* (6.77)	-	2.10* (18.00)
$D \times vEM_{t-1}$	0.16* (1.96)	-0.055 (-0.90)	0.172 (0.04)	-	0.162 (1.18)
Constant	-15.43* (-216.23)	-26.17* (-155.66)	-17.90* (-18.14)	-17.26* (-89.75)	-16.06* (-134.33)
$\varepsilon_{t-1}$	0.17* (30.35)	0.14* (41.35)	0.22* (23.00)	0.04* (18.24)	-0.19* (19.21)
$h_{t-1}$	0.842* (252.97)	0.886* (1370.32)	0.819* (189.26)	0.96* (484.79)	0.80* (92.62)
Wald $\chi^2$	18.10	406.86	78.74	26.90	11.41
Log-Likelihood	8178.6	14629.8	9810.5	10297.2	9824.8

Note: Numbers in the parentheses are z-statistics. Coefficients marked by "\*" and "\*\*" are significant at 5 percent and 10 percent confidence levels, respectively.

## VII. CONCLUSIONS

In this paper, we investigate the implications of exchange rate regimes on the spillover of shocks to international financial markets on domestic interest rates and exchange rates in major Southeast Asian countries. The results of the impulse response functions show that neither domestic interest rates nor exchange rates in major Southeast Asian countries respond significantly to the US short-term interest rate shocks. The effects of the shocks to the emerging

market risk premium on the domestic interest rates only occur in Thailand under the new exchange rate regime. In most cases, shocks to the emerging market risk premium have negative and significant effects on the exchange rates, and the effects are larger under a more flexible exchange rate regime.

The results of the GARCH models show that the volatility of the US short-term interest rates is transmitted to the short-term interest rate volatility in Singapore and Thailand. The extent of the transmission in Thailand is lower under the new exchange rate regime. This evidence supports the hypothesis that domestic financial markets under more flexible exchange rate regimes are less connected to international financial markets. The US short-term interest rate volatility does not have significant effects on the exchange rates in any countries of the sample regardless of their exchange rate regime. The volatility of emerging market risk premium is transmitted into the short-term interest rates in Malaysia, and Thailand; the change in the exchange rate regime toward a more flexible regime has lowered the extent of the transmission in Thailand. The transmission of the emerging market volatility into the exchange rate volatility occurs in Indonesia under the new exchange rate regime, in Malaysia, and in Singapore.

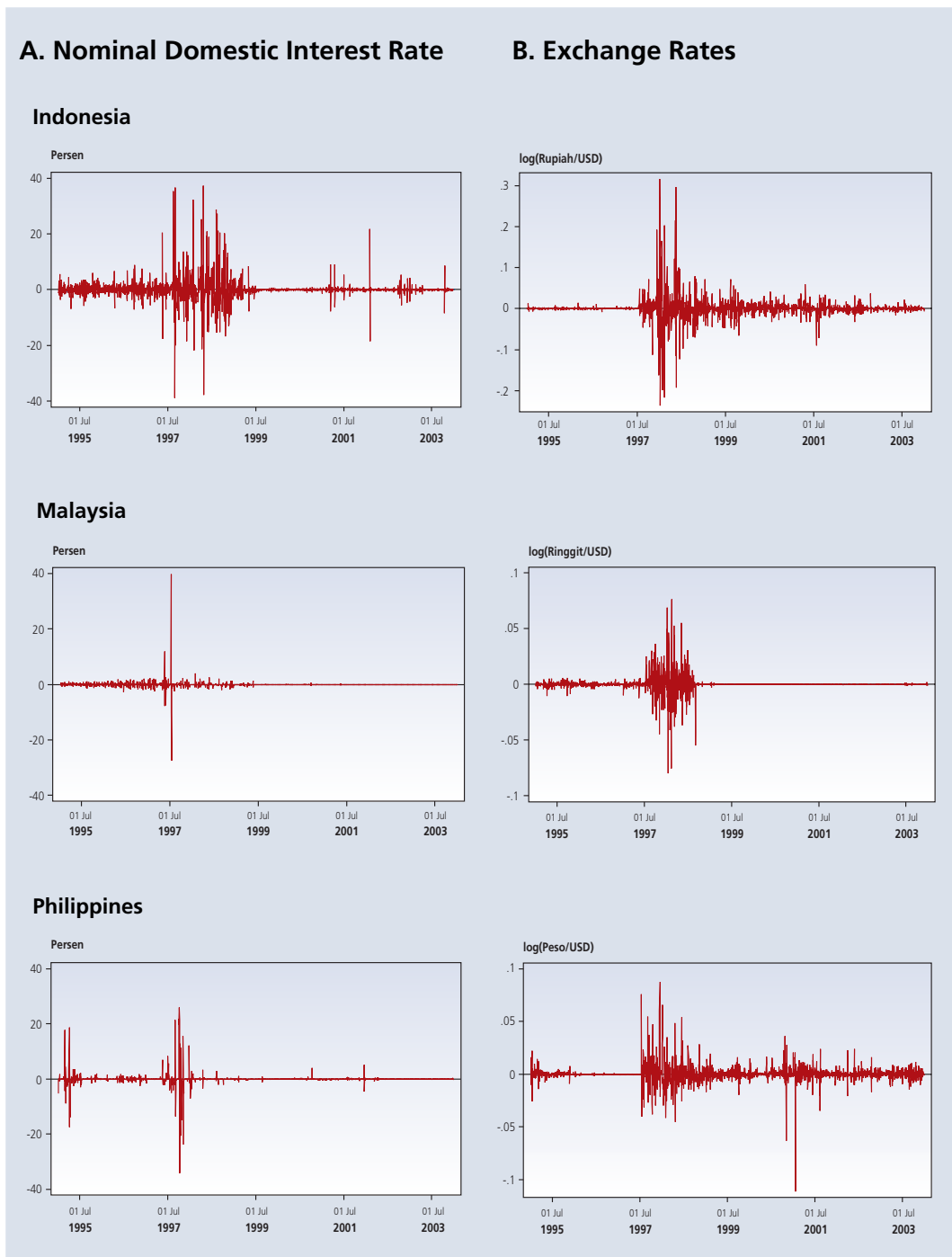
In sum, the results of this paper do not show a clear-cut conclusion on the implications of the exchange rate regimes on domestic financial markets in major Southeast Asian countries. Only the evidence from Thailand shows, to some extent, that exchange rate regime does matter for the transmission of the volatility of international financial markets into domestic interest rates. With regard to the exchange rate regime, the obvious observations from the estimation results are: exchange rates are more volatile under more flexible exchange rate regimes, and the autoregressive coefficients of the exchange rate equations are larger under a more flexible regime.

A number of issues that we do not answer in this paper seem to be worth pursuing for further research. First, this paper does not examine the implications of capital mobility and exchange rate regime on output. As argued by Stiglitz (2004), the loss of control over monetary policy/exchange rate policy as a result of capital mobility can be very costly to economic growth. Investigating the implications of the exchange rate regimes on economic growth in Southeast Asia is an interesting avenue for future research. Second, in this paper we do not examine the implications of the exchange rate regimes on the volatility of capital flows. As argued by Fischer (2003), flexible exchange rate regime can mitigate the volatility of capital flows through reducing short-term capital inflows. Examining the implications of the exchange rate regimes on capital flows seems to be another avenue for future research.

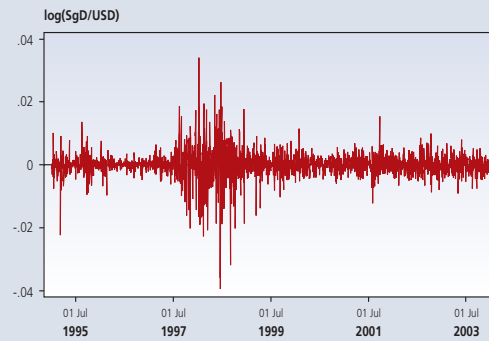
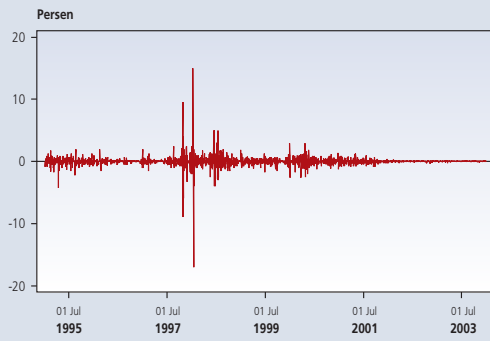


## APPENDICES

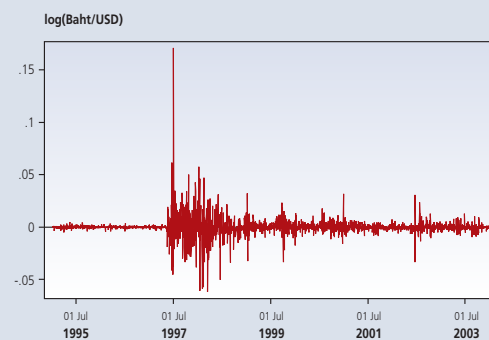
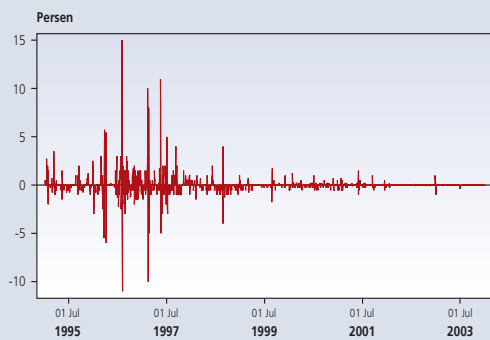
Figure II.A1: Domestic Nominal Interest Rate and Exchange Rate Changes



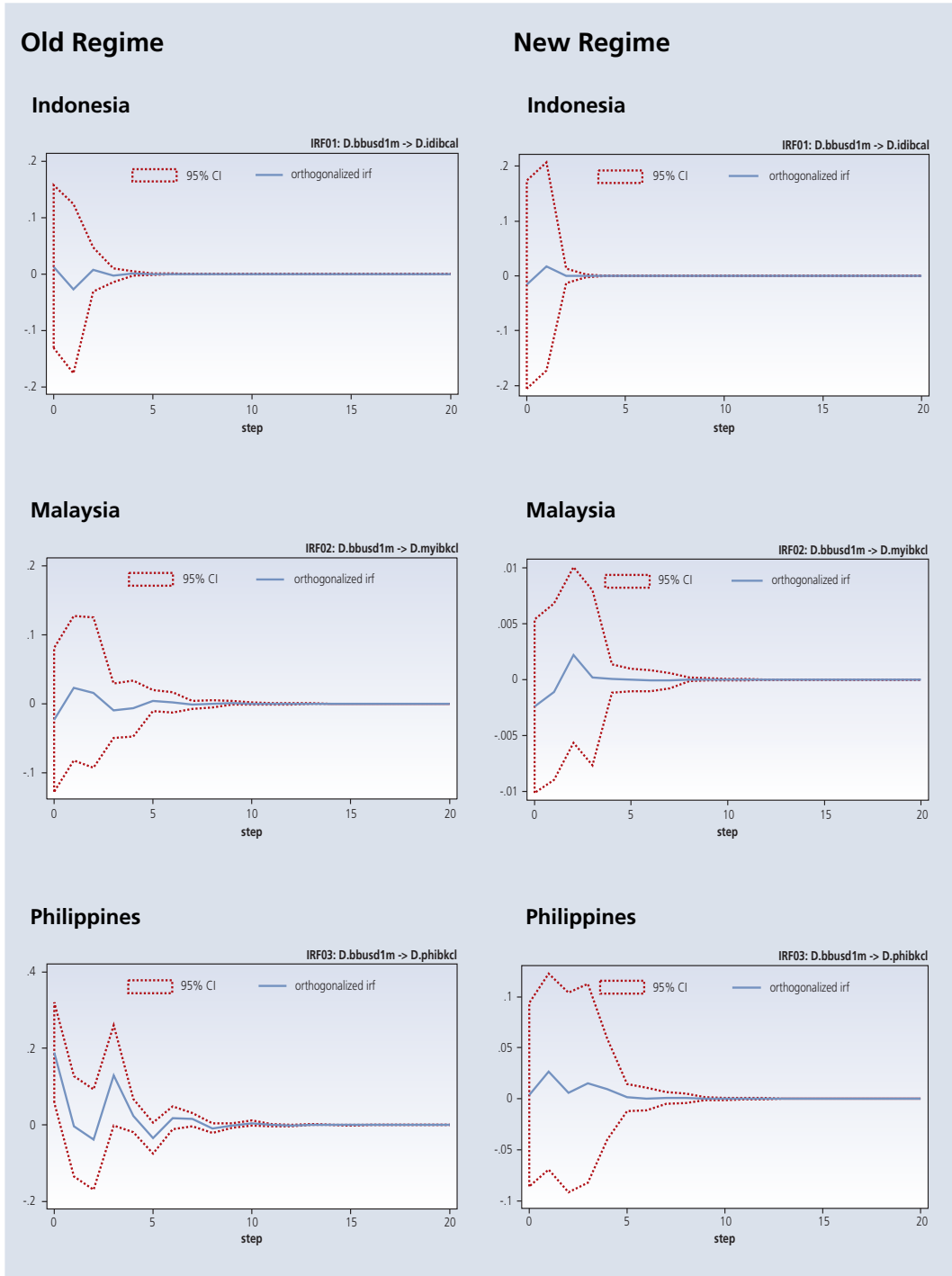
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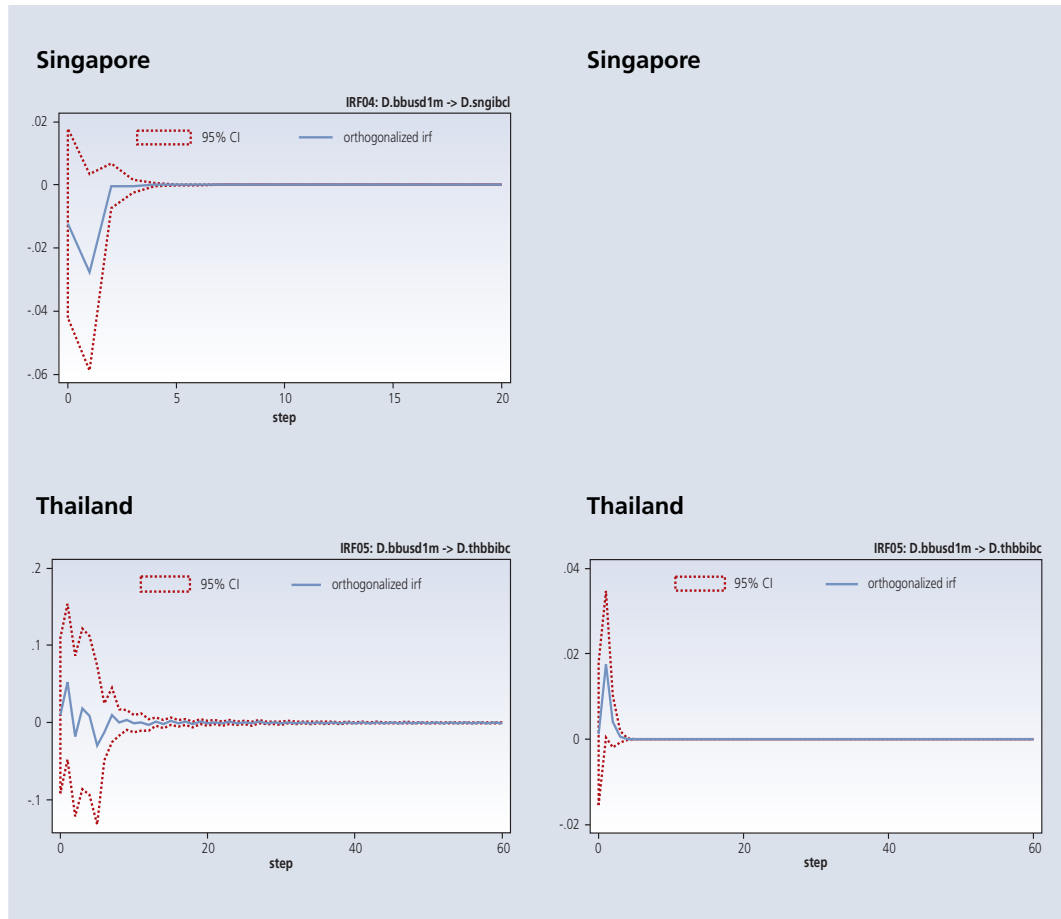


### Thailand

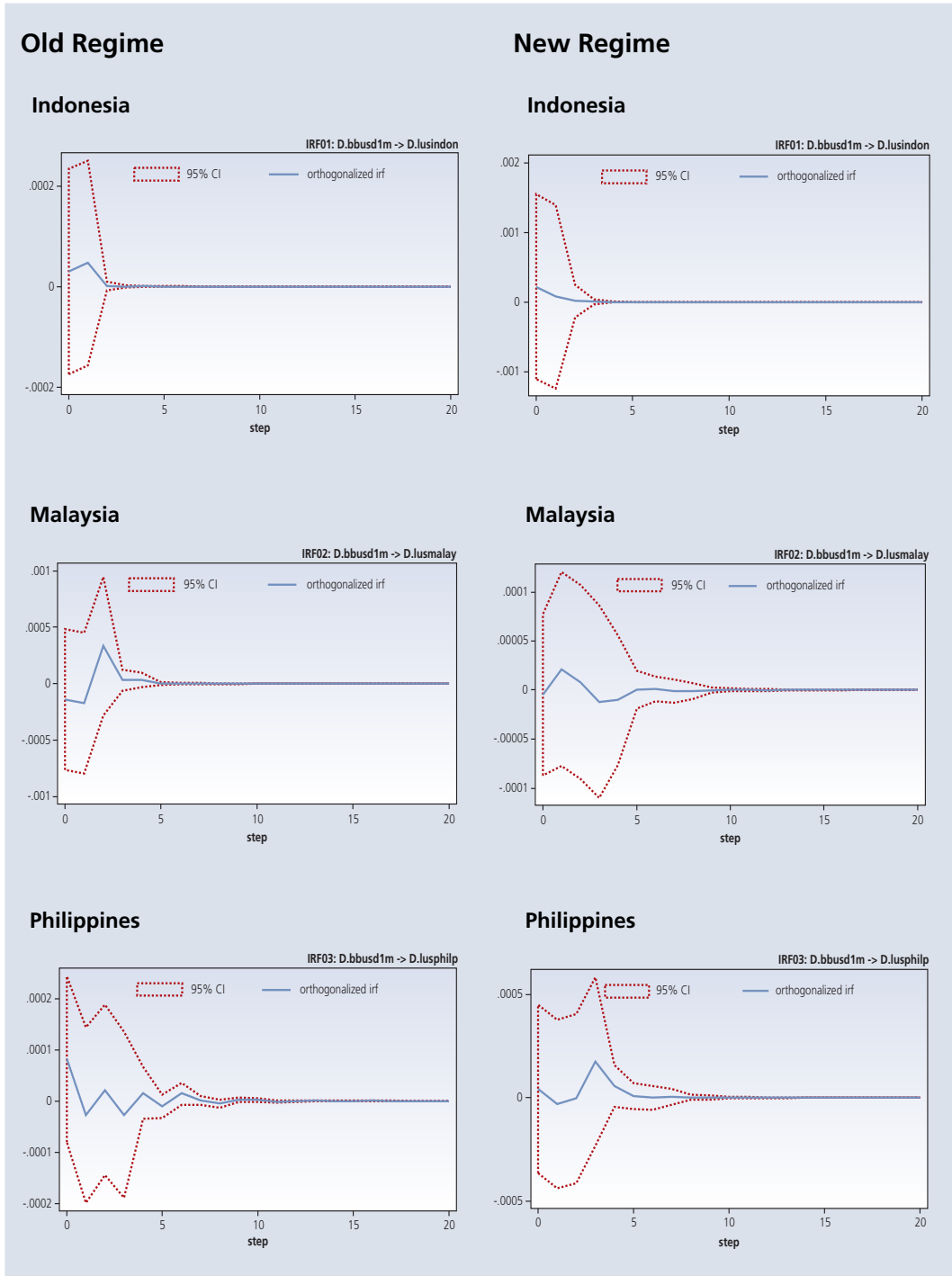


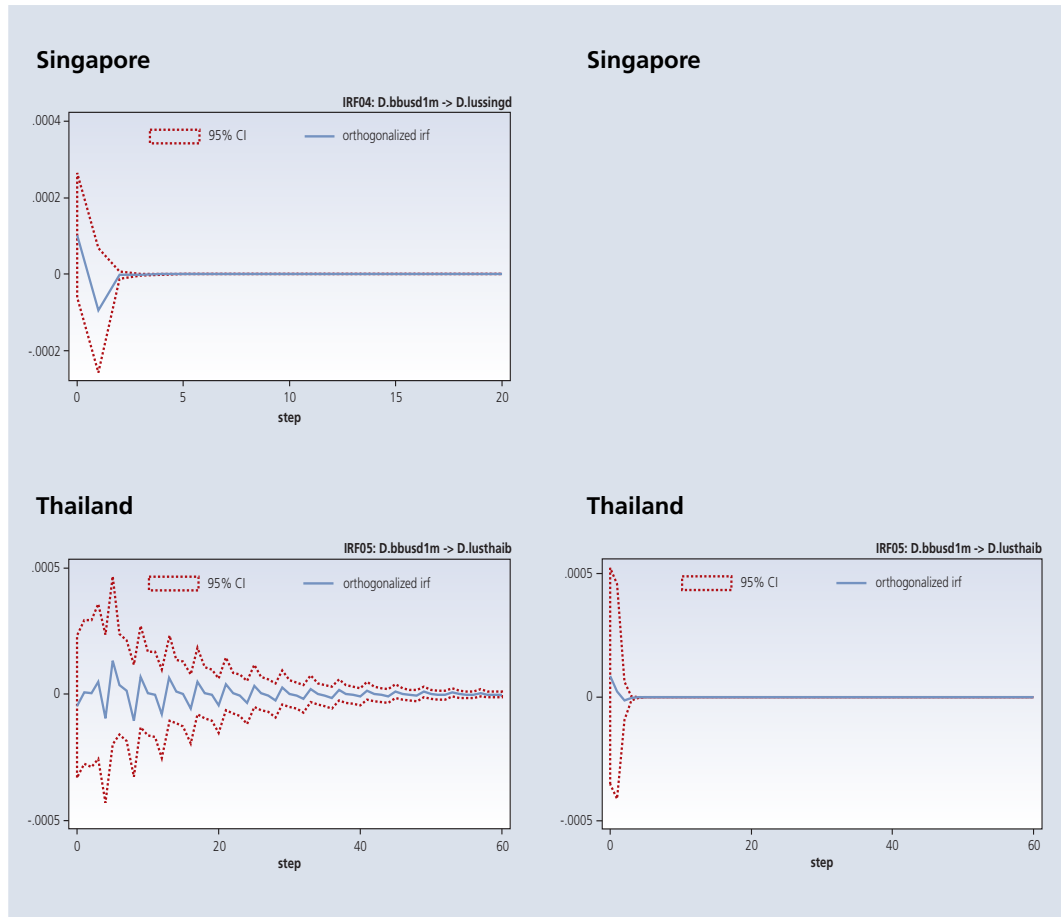
**Figure II.A2: Impulse Response Functions of the Domestic Interest Rates to One Percentage Point Shock to the US Interest Rate**



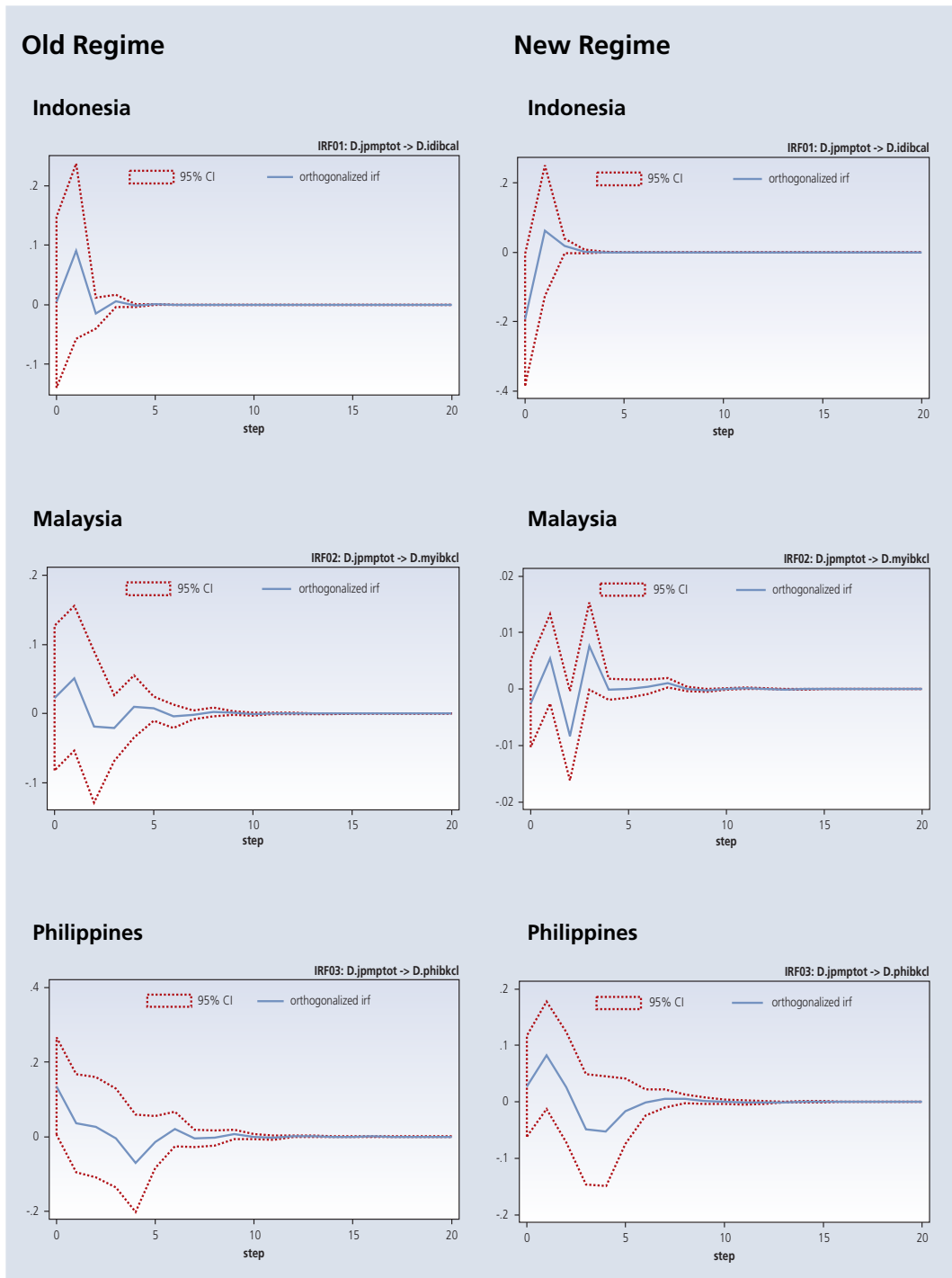


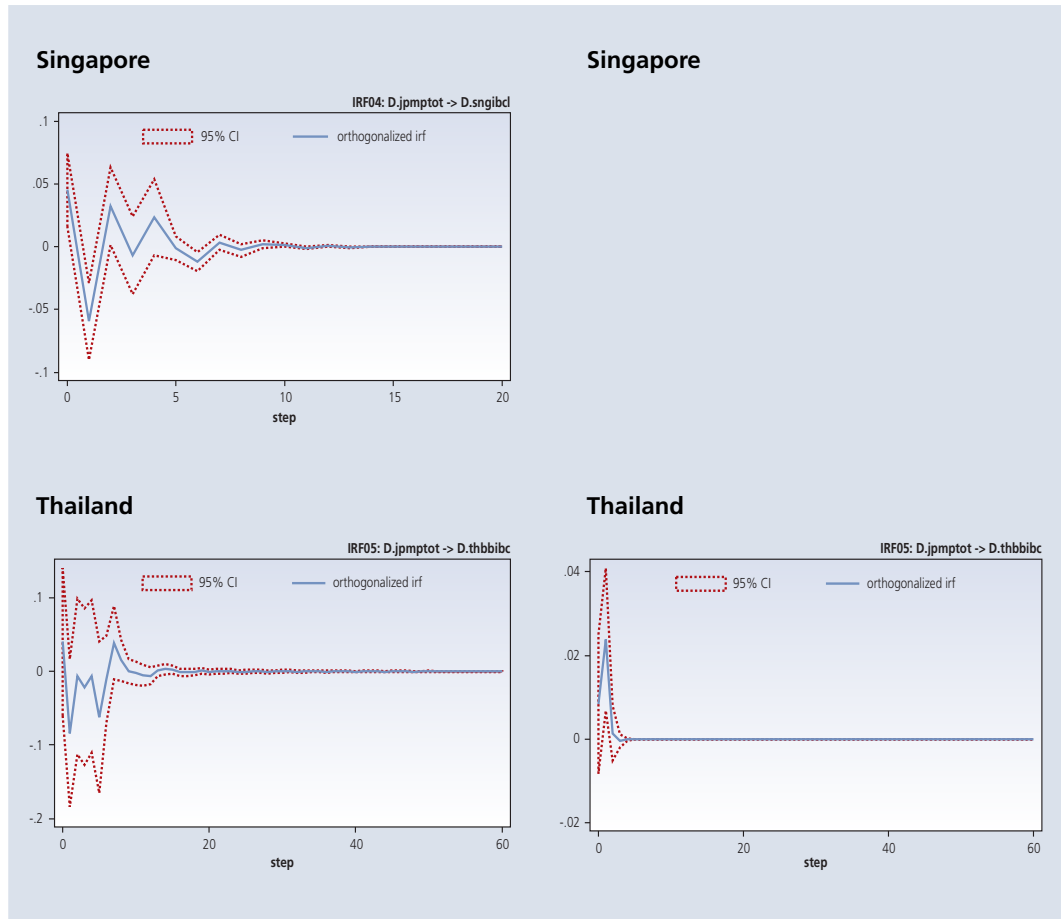
**Figure II.A3: Impulse Response Functions of the Exchange Rates to One Percentage Point Shock to the US Interest Rate**





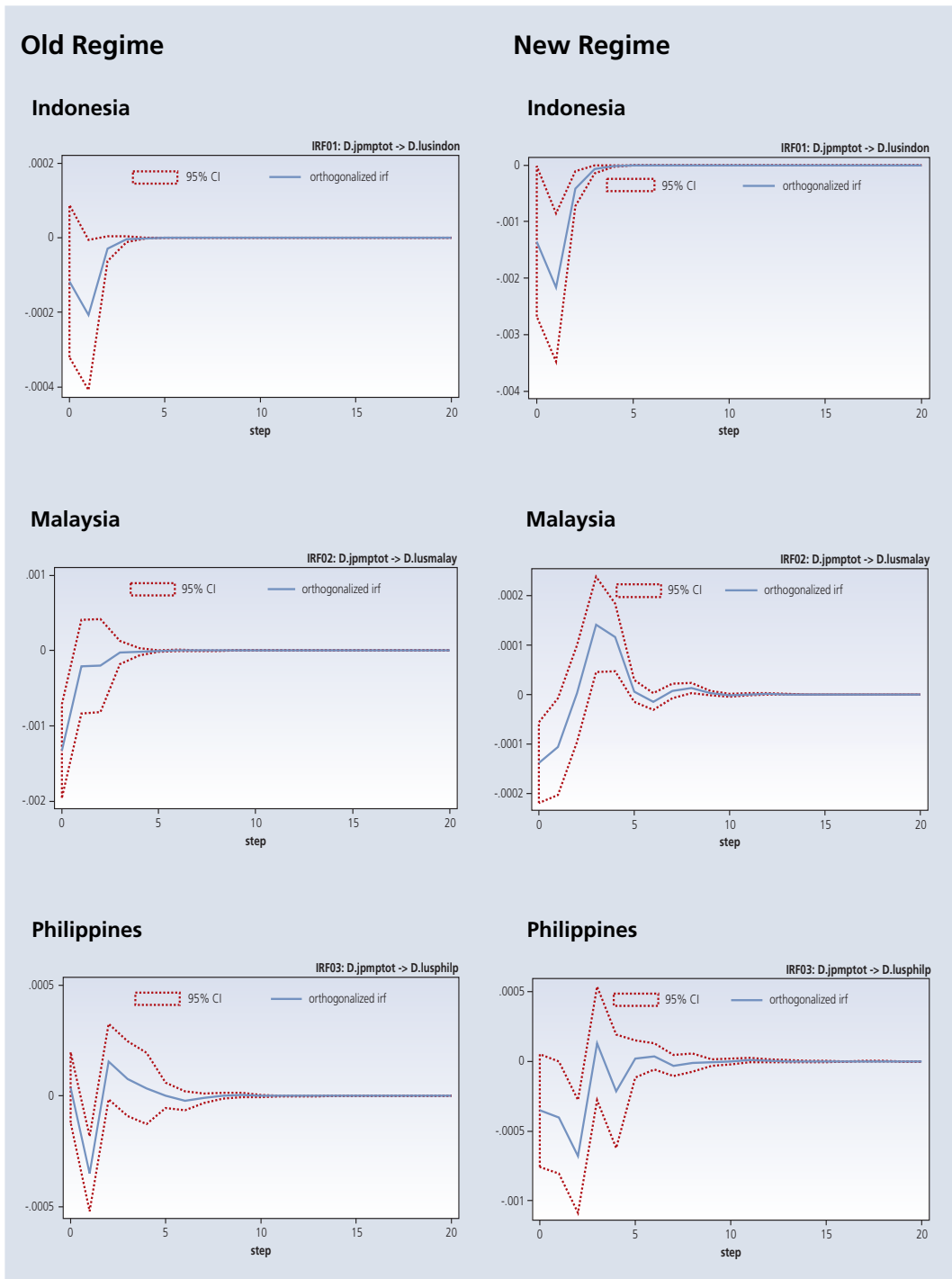
**Figure II.A4: Impulse Response Functions of the Domestic Interest Rates to One Percentage Point Shock to EMBI<sup>+</sup>**

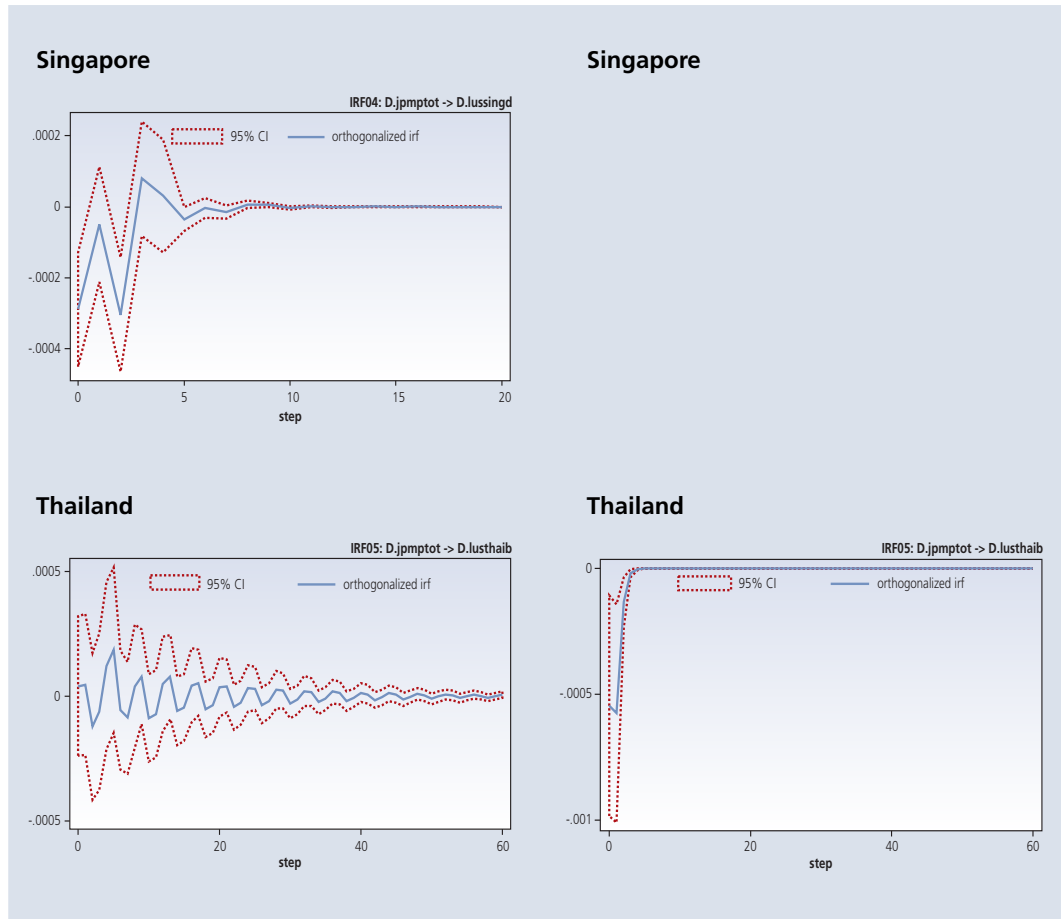




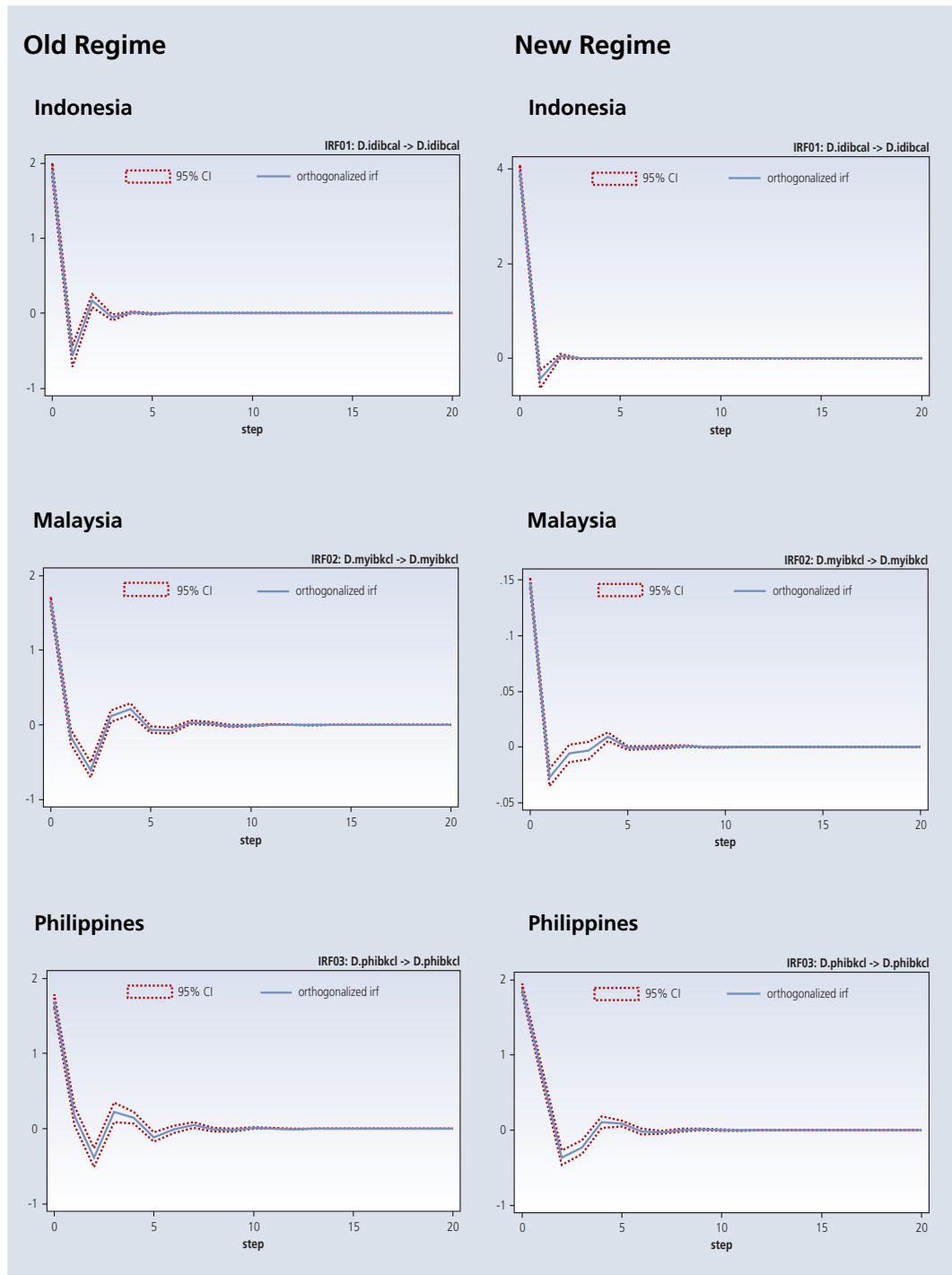


**Figure II.A5: Impulse Response Functions of the Exchange Rates to One Percentage Point Shock to EMBI<sup>+</sup>**



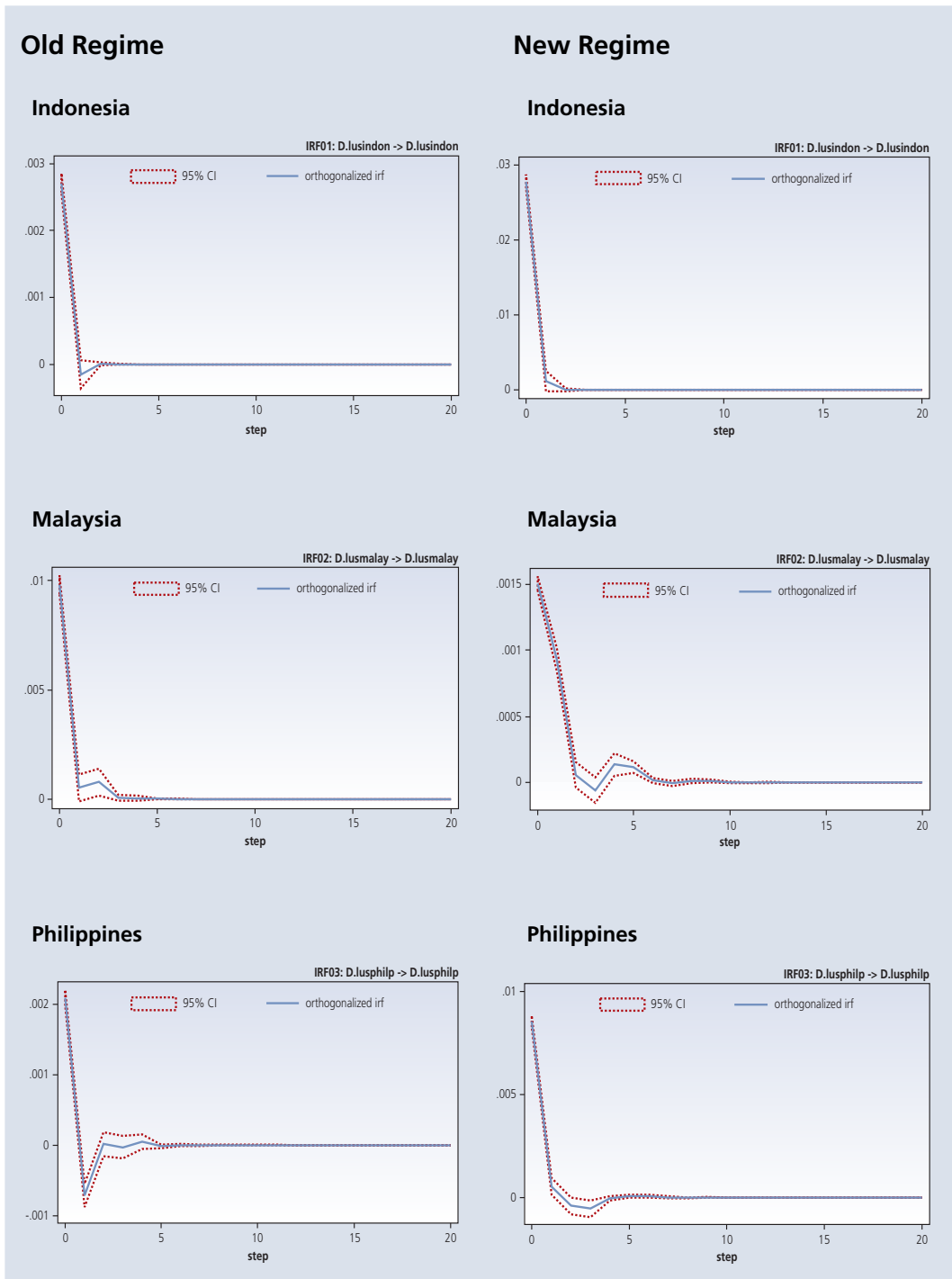


**Figure II.A6: Impulse Response Functions of the Domestic Interest Rates to One Percentage Point Shock to Domestic Interest Rates**

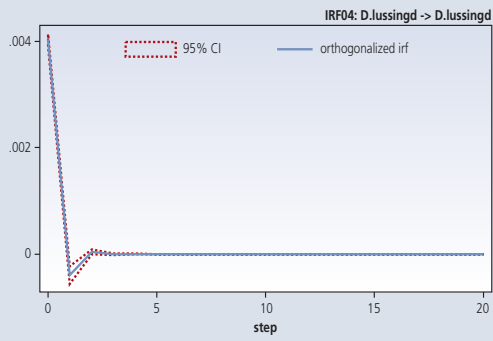




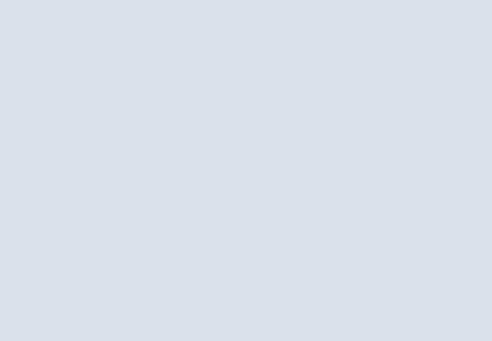
**Figure II.A7: Impulse Response Functions of the Exchange Rates to One Percentage Point Shock to the Exchange Rates**



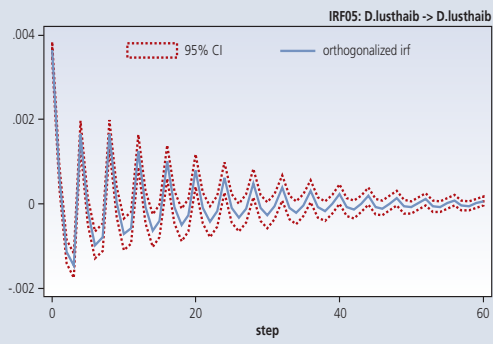
### Singapore



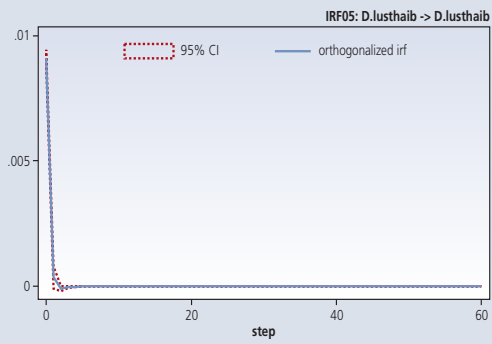
### Singapore



### Thailand



### Thailand



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