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Article

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IMPACT OF USA AND CHINESE EXCHANGE RATE SHOCKS ON MACROECONOMIC FUNDAMENTALS OF ASEAN+3+3 COUNTRIES: The Combine Forecasting Analysis

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Abstract

The study assesses the macroeconomic fundamentals of ASEAN+3+3 countries in light of exogenous shocks from the U.S. and Chinese exchange rates. The research also delves into the impacts of the Asian Financial Crisis (AFC) and the Global Financial Crisis (GFC) on selected macroeconomic variables. The exogenous shocks/crises cause deterioration in the exchange rate and, via trade and financial channels, fetch immediate fluctuations in the foreign demand for domestic goods, ultimately resulting in the volatility of output, interest rate and prices. The findings reveal that these shocks have a profound impact on macroeconomic fundamentals, but the repercussions of U.S. shocks wane over time for a majority of the countries. Intriguingly, in the aftermath of the AFC and GFC, the ramifications of the Chinese economy intensified across various metrics and nations. In a nutshell, the study signifies that ASEAN+3+3 countries under an open economy framework are sensitive to the changes in the exchange rate of major international currencies, i.e., the U.S. dollar and Yuan.

Keywords: Macroeconomic Fundamentals, Exogenous Shocks, Forecasting.
JEL Classification: O11, F20, C53.

I. Introduction

The ASEAN+3+3 consortium represents a varied mix of developed and burgeoning nations, evolving into a central global nexus for manufacturing and commerce. As the 20th century dawned, this trading bloc embarked on an ambitious journey towards comprehensive economic and monetary integration. This commitment extended their external trade liaisons, underlining their dedication to achieving convergence and sustainability milestones. Significantly, these nations maintain robust trade connections with Asian, European, and American countries. Yet, the landscape shifted dramatically in late 1997 when the financial collapse of the Thai baht, leading to the Asian Financial Crisis, unsettled the ASEAN economies. Predomi-

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nantly, in the pre-AFC era, many ASEAN currencies were tightly anchored to the U.S. dollar Gimet (2011) and Allegret, et al., (2012), culminating in stock market crashes, burgeoning sovereign and private debt, deteriorating exchange rates, and looming fears of a global economic downturn [Allegret et al., (2012)]. In response, the idea of the Asian Monetary Fund emerged [AMF (1997)]. In 2000, these nations sought to bolster liquidity availability, devising swap arrangements as alternatives to IMF bail-outs, leading to the inception of the Chiang Mai Initiative (CMI) [Bergsten and Park (2002)]. Expanding their collaboration, ASEAN+3 invited India, Australia, and New Zealand, reinforcing their commitment to stimulating trade, amplifying economic integration, and bolstering competitiveness [Bacha (2008)]. However, the end of 2007 witnessed the advent of another crisis, the Global Financial Crisis, originating from the USA. This upheaval suppressed economic activity, induced a nationwide banking emergency, and propagated financial ramifications across emerging nations [Frank and Hesse (2009)]. This underscored the adage, 'When the USA sneezes, emerging economies catch the cold' [Mackowiak (2007) and Timmermann (2007)]. Nations like Malaysia and Singapore, with strong financial ties to the USA, grappled with a swift downturn in export demand [Shirai (2009)]. As a pivotal extra-regional trading partner of ASEAN+3+3, the USA significantly influenced these economies, especially amid escalating trade tensions.

Furthermore, China's ascendancy in the region is undeniable. Favorable conditions in China prompted ASEAN economies to explore monetary alternatives like AMF, CMI, Chiang Mai Initiative Multilateralization CMIM (2010), and the ASEAN+3 Macroeconomic Research Office AMRO (2010) to mitigate balance of payment and liquidity challenges. Presently, China stands as a paramount trading partner for numerous ASEAN nations [Lardy (2018)]. ASEAN, aiming to bolster trade and enhance economic vigour, has forged free trade agreements (FTAs) with countries like India, Australia, and New Zealand. China's progressive policies and trade agreements have subtly shifted the global balance of power [To (2001) and Jia, et al., (2009)]. They are influencing the macroeconomic dynamics of the ASEAN+3+3 landscape.

The emphasis on external shocks is understandable because ASEAN+3+3 economies are super trading nations with trade shares over 100 per cent of GDP, remarkable export shares, and financial integration [Nidhiprabha (2015)]. With the expansion of trade, the performance of the domestic exchange rate in response to exogenous shocks can make this study an additional unique analysis of the transmission channel of exogenous shocks on the macroeconomic fundamentals in the presence of financial crises. Considering the open economy framework, the more the economy is open, the more it is vulnerable to external shocks. Moreover, fluctuation in an economy's trading partner will induce a considerable variation in that economy. Up until now, there have been researches that have stressed particularly the responses (symmetric or asymmetric) of economic variables to exogenous shocks [Kim et al., (2000), Canova (2005) and Maćkowiak (2007)].

Moreover, the impact of international disturbances and their implications for industrialised or emerging countries have also been analysed by Canova (2005) and Maćkowiak (2007). However, the real impact of the financial crisis as a result of high trade openness in emerging and industrialised economies has yet to be studied. Hence, the study primarily seeks to discern the repercussions of USA and Chinese exchange rate shocks on the macroeconomic behaviours of ASEAN5+3+3 nations, especially in light of pivotal financial crises, namely AFC (1997Q2-1998Q2) and GFC (2007Q2–2008Q2). Additionally, the research delves into the efficacy of combined forecasting, leveraging multiple individual methods to enhance accuracy [Jordan and Savioz (2003)]. Employing the multivariate Structural Vector Autoregressive (SVAR) model, the study sheds light on the transmission mechanisms of exogenous shocks on macroeconomic variables using an a priori theoretical link with an open economy framework [Pfaff (2008), Peersman, et al., (2012) and Peersman, et al., (2001)]. SVAR serves as a coherent economic model, integrating structural identification restrictions in alignment with established economic theories.

The subsequent sections encompass a literature review in Section II. Section III presents the theoretical background and variable selection, while the methodology and empirical results are discussed in Section IV. Finally, conclusions and recommendations are provided in Section V.

II. Literature Review

The empirical literature shows manifolds, but we here mentioned the literature regarding the extent of exogenous shocks on domestic variables and the exploration of the best forecast method that can produce efficient forecasts.

Blanchard and Quah (1989), for the first time, investigated the sources of macroeconomic fluctuations using a bivariate SVAR model for real GNP growth and the unemployment rate of the USA for the post-war period 1950:2 to 1987:4. They assume that A.D. and AS shocks are neither uncorrelated nor have long-run effect, however, induce idiosyncratic impacts. Jordan and Lenz (1999) used this methodology for the USA and selected European countries. They employed a tri-variate SVAR model of output, nominal interest rate, and price level to observe the dynamic adjustment of macroeconomic variables in response to supply, monetary, and fiscal shocks. They concluded that shocks impart idiosyncratic impacts across countries. Similarly, Maćkowiak (2007) examined the dynamic effects of external shocks on macroeconomic fluctuations using the SVAR model for eight emerging countries[1]. The study finds that U.S. monetary shocks impart a robust effect on the variance of emerging market variables.

[1] Korea, Malaysia, Philippine, Thailand, Singapore, Hong Kong, Chile and Mexico.

Canova (2005) estimates the effects of external shocks (USA monetary policy shocks) on emerging markets in Latin America. The study corroborates the importance of USA shock as observed by Calvo, et al., (1993) and Kim (2001). He finds that contractionary U.S. monetary policy adversely strikes interest rates and depreciates the currency of emerging markets, which further induces inflation with a short delay.

Gimet (2011) analysed the dynamic impact of international financial crises on ASEAN countries, i.e., the Thai crisis (1997-1999) and the USA subprime crisis (2007-2009). The SVAR is used to investigate the impact of speculative attacks and their spillover effects in the banking and financial market of these economies vis-à-vis developed countries. The results demonstrate that crises have substantial asymmetric impacts on developed countries while revealing insubstantial and limited impacts on emerging countries."Nusair (2012) utilised the G-PPP theory to check the suitability of the Optimal currency area among ASEAN5+3 using the real exchange rates of China, Japan and the U.S. as base countries separately. Rafiq (2016) suggests that Chinese growth and exchange rate shocks have risen since GFC.

Shamseldin, et al., (1997) combined the forecast of five different econometric models to predict the accuracy of annual peak rainfall in eleven areas of eight countries for the period of 1955 to 1980. They found that combined forecast MAPE is minimised compared to individual forecast models. Armstrong, et al., (2000) performed a combination forecast technique from four different econometric models of automobiles and wireless telephone service in the USA and France. They covered forecast horizons from two to four months to estimate 65 forecasts from 1961 to 1996. They found a reduction in the RAE by 5.5 per cent vis-a-vis the component forecast models.

Hibon and Evgeniou (2005) present a forecast combination as an efficient alternative to the individual forecast approach. They suggested selecting a single forecast model from different individual forecast models is a bit riskier. Thus, in such ambiguity, a combination forecast is proved to be the best option. Zou and Yang (2004) performed a combined forecast through the ARIMA model for new one-family houses in the USA for a time range of 1987M1- 1995M11. They suggested that individual forecast models are prone to instabilities because of uncertainty factors, while a combined forecast approach tends to improve forecast accuracy.

Mayr and Ulbricht (2007) analysed the performance of combining forecasts for G4 countries in the presence of structural shocks in VAR models. It is confirmed that combining forecasts with suitable weights outperforms single-model forecasts and confirms reliability and accuracy when subjected to structural shocks. Clark and Mccracken (2010) evidenced that combinations of forecast methods outperform the univariate or VAR model forecasts with structural changes because they minimise root mean square errors with more reliability.

Clemen and Winkler (1986) performed forecasting for real and nominal GNP by covering forecast horizons from one to four quarters ranging from 1971 to 1982.

The results confirm that the simple average approach outperforms other competing combination approaches. Moreover, they imposed appropriate restrictions on both the constant term and weights in order to yield more forecast accuracy and reliability. Jordan and Savioz (2003) performed an unconditional out-of-sample inflation forecast for Switzerland through VAR models for 1974Q1-2000Q3. They used five different approaches, i.e. simple average method (S.A.), ordinary least square method (L.S.), constant restricted least square method (CRLS), equality restricted least square method (ERLS) and non-negativity inequality restricted least square method (NRLS). They concluded that S.A. and NRLS methods perform quite well for each forecasting horizon. Hence, it is evident that combining more individual forecast models results in minimising forecast errors.

III. Theoretical Background

The 'New open economy macroeconomics (NOEM)' provides a new theoretical framework which overcomes the limitation of the Mundell-Fleming Model[2]. The NOEM (for more details, see Krugman et al. (2023) reconsider the conventional views on the exchange rate shocks, i.e. the emerging open economies with high levels of trade volume are sensitive to the global impact of changes in the exchange rate of major international currencies (i.e. U.S. dollar and Chinese Yuan). Therefore, it is possible to utilise this theoretical framework to analyse the extent of macroeconomic fluctuations caused by external shocks in the ASEAN+3+3 economies. So, trade integration and exogenous exchange rate fluctuations play a pivotal role in shaping domestic economic performance [Kim (2001), Galesi and Lombardi (2009) and Gimet (2011)]. The volatility of exchange rates directly influences the domestic economy due to its inherent connection with the domestic currency [Kim and Roubini (2000)]. Such variations can sway the balance of exports and imports, culminating in trade deficits or surpluses.

Consequently, this impacts a country's macroeconomic fundamentals. For instance, a depreciating domestic currency inflates import prices, bolstering demand for local goods and driving up prices. Disturbances in the U.S. dollar or Chinese exchange rates can amplify inflation in ASEAN+3+3 countries, either due to heightened foreign demand for domestic products or rising input costs. Globally, escalating short- and long-term interest rates denote heightened long-term borrowing costs for this trade bloc's members, curbing investment. In scenarios where depreciating domestic currencies isn't feasible—owing to fixed rates or currency board agreements—inflation rates plummet, leading to an uptick in domestic interest rates. External shifts in these rates can spur exchange rate volatility, which might manifest immediately or after a lag.

[2] It shows 'how an economy can use fiscal and monetary policies to achieve both internal and external balance without any change in the exchange rate' [for detail see Salvatore (2020)].

Furthermore, dwindling international reserves can stress domestic exchange rates. Such currency rate oscillations can, in turn, induce fluctuations in output and prices, highlighting the need for adept monetary policies. Addressing the nuanced impacts of these shocks requires a two-pronged consideration. Firstly, the pronounced global ramifications underscore the vulnerability of these small, open economies to the flux of major international currencies like the U.S. Dollar and Yuan. Secondly, it prompts the query: which exchange rate regimes are dominant in these economies? To encapsulate, economies deeply intertwined with the USA or China grapple with pronounced macroeconomic fundamental fluctuations [Kim and Roubini (2000), Kim, et al., (2011) and Nidhiprabha (2015)].

1. Data Sources

Table 1 shows the variables and data sources used in the study, along with the time period.

TABLE 1

Variables Description

Variables	Symbol	Data Sources	Sample Time period	Subsample Time Period
GDP Growth Rate (Real Output)	y	International Financial Statistics (IFS), National University of Singapore (NUS) online data for China and India	1990Q1-2018Q4	**Based on crisis episodes:** 1990Q1-1997Q2: (Pre AFC) 1998Q2-2008Q2: (Post AFC) 2009Q2-2018Q4: (Post GFC)
Consumer Price Index	π	IFS	1990Q1-2018Q4	
Interest Rate (Money Market Rate)[3]	i	IFS	1990Q1-2018Q4	
Real Effective Exchange Rate	ex_r	IFS	1990Q1-2018Q4	
Exogenous Shocks:				
U.S. Exchange Rate	US	IFS	1990Q1-2018Q4	
China Exchange Rate	CHINA			

Source: Author's estimation.

[3] Money market rate is not available for China, so we use deposit rate.

2. *Descriptive Analysis of Macro-fundamentals*

Table 2 shows the mean, standard deviation (S.D.) and coefficient of variation[4] (CV) of all macro-fundamentals for each economy. Among ASEAN5, only Indonesia faces high average inflation, followed by the Philippines, with the lowest inflation observed in Japan. Similarly, among +6 countries, only India shows relatively high average inflation. The CV of inflation shows significant variation among ASEAN+6 countries. Among the +6 countries, China has the highest growth rate, followed by Korea and Indonesia.

The CV suggests relatively high variation in the GDP growth rate of all countries. The average exchange rate is most robust for Australia, China, Malaysia, Singapore, and New Zealand. CV suggests that the exchange rate is more volatile among ASEAN countries for Indonesia and the Philippines. Likewise, among +6 countries, China, India, and Japan have the most volatile exchange rates. Soyoung and Yang (2009) analysed that the exchange rate is more volatile in floating countries (Indonesia, Philippines) than in non-floating countries (China, Malaysia, and Japan). India's average interest rate is highest, followed by Indonesia and the Philippines. The interest rate is more volatile for Japan, Singapore, and Thailand. Japan,

TABLE 2

Mean and Standard Deviation of Macro-Fundamentals

Country		GDP Growth Rate			Inflation			Exchange Rate			Interest Rate		
		Mean	SD	CV	Mean	SD	CV	Mean	SD	CV	Mean	SD	CV
ASEAN	IDN	5.49	3.80	0.69	10.1	9.14	0.90	5427	4068	0.75	6.99	1.39	0.20
	MYS	5.95	3.73	0.63	3.05	1.95	0.64	3.02	0.57	0.19	2.9	0.55	0.19
	PHL	3.53	3.41	0.97	8.96	8.82	0.98	33.29	14.88	0.45	6.2	1.45	0.23
	SGP	6.74	4.12	0.61	2.23	2.23	1.00	1.71	0.30	0.18	1.44	1.19	0.83
	THA	5.72	4.40	0.83	4.18	3.67	0.88	30.73	6.96	0.23	2.56	1.39	0.54
+3	CHN	9.82	2.72	0.28	5.58	6.76	1.21	5.98	2.37	0.4	2.63	0.69	0.26
	JPN	2.04	2.48	1.22	1.05	1.85	1.76	135.7	49.47	0.36	0.18	0.20	1.14
	KOR	6.24	3.98	0.64	5.26	5.43	1.03	953.1	212.5	0.22	3.55	1.15	0.32
+3	AUS	3.19	1.56	0.49	4.39	3.06	0.70	1.30	0.25	0.19	5.31	1.18	0.22
	IND	6.28	2.17	0.35	8.19	3.10	0.38	32.93	16.34	0.50	11.22	4.14	0.37
	NZL	2.45	2.00	0.82	5.03	5.15	1.02	1.60	0.31	0.19	5.81	2.23	0.38

Source: Author's estimation.

[4] It is the ratio of SD to the mean; it measures the extent of volatility of all variables across countries. Moreover, it's a unit free (a relative) measure as compare to mean and SD. Ling (2001) also used CV as an indicator of volatility for EACs.

Singapore, and Thailand have lesser volatility in exchange rate vis-à-vis the interest rate. According to Soyoung and Yang (2009), floaters should have low-interest rate volatility, so policy interest rates show vague results regarding volatilities for Japan, Singapore, and Thailand. On the other hand, Indonesia, Korea and the Philippines are all floaters with less interest rate volatility.

3. SVAR Model

As mentioned earlier, SVAR models are estimated using four endogenous and two exogenous variables. The VAR model is as follows in Equation (1):

$$BX_t = b_0 + \beta_{10} X_{t-1} + \cdots + \beta_s X_{t-s} + \delta_0 y_t + \cdots + \delta_P y_{t-P} + \varepsilon_t \quad (1)$$

Where B is an invertible (6×6) matrix representing the contemporaneous relationship amid variables; X_t is a (6×1) vector of endogenous variables, b_0 is a (6×1) vector of constant terms; β_{10} to β_s is a (6 ×6) matrix of coefficients of lagged endogenous variables (where $i = 1 ....s$); δ_0 to δ_p and $y_t .....y_{t-P}$ correspondingly, vectors of current and lagged exogenous variables capture external shocks. ε_t is a vector of uncorrelated white-noise disturbances. Equation (1) is the long form of SVAR and cannot be directly estimated as endogenous variables have contemporaneous impacts on each other. Sharifi and Renani (2010) have argued that reduced-form models are the basis for structural analysis that must be identified before estimating SVAR analysis. Now, pre-multiplying Equation (1) by B^{-1} to transform into a reduced form in Equation (2).

$$X_t = \alpha_0 + B_1 X_{t-1} + \cdots + B_s X_{t-s} + A_1 y_t + \cdots + A_P y_{t-P} + \mu_t \quad (2)$$

where,

$$\alpha_0 = B^{-1} b_0$$

$$B_i = B^{-1} \beta_{10} \text{ (where } i=1,\dots,s)$$

$$A_i = B^{-1} \delta_0 \text{ (where } i=1,\dots,p)$$

$$\mu_t = B^{-1} \varepsilon_t$$

Equation (2) is a reduced form SVAR, in which no variable has a contemporaneous impact on each other. Moreover, the error term is a composite of shocks in X_t [Enders (2004)]."The triangular structure of the structural innovation is as follows:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 \\ \beta_{21} & 1 & 0 & 0 & 0 & 0 \\ \beta_{31} & \beta_{32} & 1 & 0 & 0 & 0 \\ \beta_{41} & \beta_{42} & \beta_{43} & 1 & 0 & 0 \\ \beta_{51} & \beta_{52} & \beta_{53} & \beta_{54} & 1 & 0 \\ \beta_{61} & \beta_{62} & \beta_{63} & \beta_{64} & \beta_{65} & 1 \end{bmatrix} \begin{bmatrix} \mu_t^{logUSA} \\ \mu_t^{logch} \\ \mu_t^{logy} \\ \mu_t^{log\pi} \\ \mu_t^{logz} \\ \mu_t^{i} \end{bmatrix} \begin{bmatrix} \varepsilon_t^{logUSA} \\ \varepsilon_t^{logch} \\ \varepsilon_t^{logy} \\ \varepsilon_t^{log\pi} \\ \varepsilon_t^{logz} \\ \varepsilon_t^{i} \end{bmatrix}$$

where, μ_t^{logUSA}, μ_t^{logch}, μ_t^{logy}, $\mu_t^{log\pi}$, μ_t^{logz} and μ_t^{i} are reduced form error terms, that incorporates both domestic and exogenous shocks. And ε_t^{logUSA}, ε_t^{logch}, ε_t^{logy}, $\varepsilon_t^{log\pi}$, ε_t^{logz} and ε_t^{i} are structural shocks of respective simultaneous equations.

Multi-step ahead forecasts of a SVAR model has the following form in Equation (3):

$$X^f_{t+T} = \widehat{B}_1 X_{t+T-1} + \dots + \widehat{B}_P X_{t+T-p} \tag{3}$$

X^f_{t+T} denotes the T -step-ahead forecast of X_t derived at time t and $\widehat{B}_1$ where i = 1…..p, denote the estimated coefficient matrices of the system.

4. *SVAR Restrictions*

SVAR model implies the imposition of contemporaneous restriction on the structural parameters; to identify the n^2 elements of the B matrix, it's necessary to impose $(n^2 - n)/2$ restrictions. So, $(6^2 - 6)/2 = 15$ restrictions are imposed on matrix B, which restricts the covariance matrix of the reduced form errors. The traditional restrictions are 'N.A.' for the contemporaneous lagged relationship and '0' for the sluggish lagged relationship [Kutu, et al., (2016)].

Cholesky decomposition requires all elements above the principal diagonal to be zero, therefore,

$$\beta_{12} = \beta_{13} = \beta_{14} = \beta_{23} = \beta_{24} = \beta_{34} = 0$$

The matrix A is the finite-order lag polynomial matrix. It demonstrates how the structural restrictions are being estimated with the diagonal constrained to be '1'. And the B matrix is the diagonal matrix that is orthogonal (uncorrelated). Six by Six matrices are formed using the AB-model Amisano and Gianini (1997), Sims and Zha (1999), Kim and Roubini (2000), Kutu, et al., (2016), Amisano and Gianini (2012) to impose short-run structural restrictions [Enders (2004)].

5. *Variance and Covariance Matrix*

The variance-covariance matrix of the structural error term is normalised such that:

$$E\,(\epsilon_t, \epsilon_t{'}) = \Sigma_\epsilon$$

This implies that the number of structural shocks is the same as that of variables. Σ_ϵ is diagonal because shocks are mutually uncorrelated, and to normalise the variance of all structural shocks, they are set to unity. It does not involve a loss of generality if the diagonal elements of the B-matrix remain unrestricted.

$$E(e_t\,, e_t{'}\,) = \mathrm{B}^{-1}\,E(\epsilon_t\,, \epsilon_t{'})\,\mathrm{B}^{-1\prime}$$

$$\Sigma e_t = \mathrm{B}^{-1}\,\Sigma_\epsilon\,\mathrm{B}^{-1\prime}$$

$$\Sigma = \begin{bmatrix} \theta_1^2 & \theta_{12} & \theta_{13} & \theta_{14} & \theta_{15} & \theta_{16} \\ \theta_{21} & \theta_2^2 & \theta_{22} & \theta_{23} & \theta_{24} & \theta_{25} \\ \theta_{31} & \theta_{32} & \theta_3^2 & \theta_{33} & \theta_{34} & \theta_{35} \\ \theta_{41} & \theta_{42} & \theta_{43} & \theta_4^2 & \theta_{44} & \theta_{45} \\ \theta_{51} & \theta_{52} & \theta_{53} & \theta_{54} & \theta_5^2 & \theta_{55} \\ \theta_{61} & \theta_{62} & \theta_{63} & \theta_{64} & \theta_{65} & \theta_6^2 \end{bmatrix}$$

where $\mathrm{var}(e_{it}) = \theta_i^2$ and $\mathrm{cov}(e_{it}\ e_{it}) = \theta_{12} = \theta_{21} = \theta_{31} = \theta_{41} = \theta_{51} = \theta_{61}$

Diagonal elements of $\Sigma_\in$ are left unconstrained and set the diagonal elements of matrix B to unity [Keating (1992)].

6. *Forecast Models*

In this study, forecasts of interest are a combination of forecasts from a wide range of approaches of univariate models, i.e. ARIMA and multivariate models, i.e. VAR and SVAR.

a) <u>ARIMA Model</u>

ARIMA models capture the historic autocorrelations of the data and extrapolate them into the future. They usually outperform other forecast models when the time series of data is long, not highly irregular, and the autocorrelations are strong [Stellwagen and Goodrich (1993)]. The general form of ARIMA (p, d, q) models is:

$$A_t = \alpha_0 \textstyle\sum_{i=1}^{p} \alpha_i A_{t-i} + \sum_{i=0}^{q} b_i\, \epsilon_{t-i} \qquad (4)$$

where, A_t is the value of the variable of interest at time t; and ε is the error term at time q, p is the order of the autoregressive (A.R.) term; d is the degree of differencing involved to achieve stationarity; q is the order of the moving average (M.A.)

term. Identification of the appropriate model is usually based on Box & Jenkins (1976) methodology. We built ARIMA models using the approximate maximum likelihood algorithm of McLeod and Sales (1983). Multi-step ahead forecasts of the ARIMA model has the following form in Equation 5:

$$A^{f}_{t+T} = \widehat{\alpha}_{1} A_{t+T-1} + \ldots\ldots + \widehat{\alpha}_{1} A_{t+T-P} \quad (5)$$

A^{f}_{t+T} denotes the T -step-ahead forecast of A_t derived at time t and $\widehat{\alpha}_1$ where i = 1…..p, denote the estimated coefficient of the system.

b) VAR Model

The general form of the VAR model is Equation 6:

$$X_t = b_0 + \beta_1 X_{t-1} + \beta_2 X_{t-2} \ldots\ldots + \beta_s X_{t-s} + \varepsilon_t \quad (6)$$

where $X_t = a$ (6×1) a vector containing each of the n variables included in the VAR, b_0 = (6×1) vector of intercept terms. β_2 = (6×6) matrices of coefficient and ε_t = (6×6) vector of error terms. AIC is used for appropriate lag length. We have not taken the differences of variables despite the unit root presence Sims (1980), Sims et al., (1990) to devoid the co-movements of the variables. Multi-step ahead forecasts of has the following form Equation 7:

$$X^{f}_{t+T} = \widehat{\beta}_1 X_{t+T-1} + \ldots\ldots + \widehat{\beta}_p X_{t+T-p} \quad (7)$$

X^{f}_{t+T} denotes the T -step-ahead forecast of X_t derived at time t and $\widehat{\beta}_i$ where i = 1…..p, denote the estimated coefficient matrices of the system.

c) Combining Forecast

In literature, several forecast combination approaches have been employed. This study uses two combination approaches: Simple Average approach (S.A.) and NRLS approach (L.S. regression with a constant term; nonnegative weights because these are highly acceptable in empirical studies of general forecasting literature [Jordan and Savioz (2003), Blanc and Setzer (2016)]. Lag lengths are selected using the Akaike Information Criterion (AIC). The period 1990Q1-2010Q4 is holding out to evaluate forecasting performance. Following Newbold and Granger (1974), each series has been bisected; the first part manages to fit an opposite model, and then this model is run over the second part of the series to generate individual out-of-sample forecasts; see Diebold and Pauly (1990), Sankaran (1989). Such divisions assist in evaluating forecasting methods, providing actual forecasts instead of some fitted values over some estimation period. Conclusively, the decision about the usefulness of the forecasting model must come from its ability to forecast out-of-sample [Bernanke and Blinder (1992) and Thoma and Gray (1994)].

i. Simple Average Method (uniform weights)

Following Clemen (1989), the first and simplest way of combining forecasts is to assign equal weights to the individual forecast series $w^{i}_{j,t+h} = 1$.

Let the series f_{it} contain the one-step-ahead forecast of x_t from model i ($i = 1, 2, \dots n$), composite forecast f_{cft} with uniform weights will be constructed as Equation 8:

$$f_{cf\_t} = w_1 f_{1t} + w_2 f_{2t} + \cdots + w_n f_{nt} \tag{8}$$

where w_i are weights such that $\sum_{i=1}^{n} w_i = 1$.

ii. Non-negativity Inequality Restricted Least Square Method (NRLS)

Following Diebold (1988), this method attains coefficient weights of combined forecast via linear regression with the actual variable as the dependent and the individual out-of-sample forecast as explanatory variables. The constant term is restricted to zero to obtain an unbiased forecast, and nonnegative weights are eliminated [Enders (2004)]. The Equation for the composite forecast series with weights based on regression will be as follows Equation 9:

$$x_t = w_1 f_{1t} + w_2 f_{2t} + \cdots + w_n f_{nt} \tag{9}$$

where x_t is the actual data series; f_{it} are forecasted values from ARIMA, VAR and SVAR models. Unbiased forecast produces, i.e., $E_{t-1} f_{it} = x_t$, then the combined forecast is also unbiased Equation 10:

$$f_{ct} = w_1 x_{1t} + w_2 x_{2t} + \cdots + w_n x_{nt} \tag{10}$$

To extract composite forecast error from the composite forecast series, the actual series is subtracted from both sides Equation 11:

$$f_{ct} - x_t = w_1 (f_{1t} - x_t) + w_2 (f_{2t} - x_t) + w_3 (f_{3t} - x_t) + w_4 (f_{4t} - x_t) \tag{11}$$

Let e_{1t}, e_{2t}, e_{3t} and e_{4t} denote the series containing the one-step-ahead forecast errors from models 1 and 2. e_{ct} is the composite forecast error given as Equation 12:

$$e_{ct} = w_1 e_{1t} + w_2 e_{2t} + w_3 e_{3t} + w_4 e_{4t} \tag{12}$$

IV. Empirical Estimation

This section portrays the estimates of the impulse responses to the USA and Chinese exchange rate shocks. The vertical axis denotes simultaneously the GDP (y), exchange rate (ex_r), interest rate (r) and inflation rate (π). In contrast, the horizontal axis denotes time in quarters (12). The optimal lags are four, as per AIC.

1. USA Exchange Rate Shock (Pre-AFC Period)

In the pre-AFC period, the impulse responses [Figure A-1 to A-11 (Appendix A)] of most of the variables of ASEAN+3+3 countries to USA exchange rate shock exert a sizeable fraction of variation as the shock following a huge loss of investor confidence and fall of demand in ASEAN. The results are particularly important for Indonesia, Malaysia, Thailand and the Philippines as they faced massive out-flow of short-term capital. However, emerging industrialised countries such as China and Singapore are not much affected. Because in the early 1990's, these countries have been main creditors of emerging ASEAN's economies and immediately removed their short-term capitals from their market [Wang (2004)]. Additionally, Japan, Korea, India, Australia, and New Zealand are not affected because of the limited financial openness of these countries and the controlled flow of international reserves. The shock represents a devaluation of the exchange rate, particularly in Indonesia, Malaysia and Thailand. To combat the negative consequences of the shock, the countries yield their interest rate for the first few months—the yield in interest rates results in declining consumption and investment and inducing inflation.

In contrast, devaluation of the exchange rate results in a gain of net exports [Maćkowiak (2007)]. In the pre-AFC period, countries' responses to a common USA shock were divergent, adhering to different trade dependency ratios and diverse exchange rate regimes. The response of inflation is positive for Indonesia, Singapore, the Philippines, Malaysia and Korea. However, it remains fluctuating for Thailand, Japan and New Zealand. The variable exchange rate is significant and negative and interest rates remain positive, particularly for Indonesia, Malaysia, and the Philippines [Figure A-1, A-3 & A-5 (Appendix A)]. Finally, the fall of international reserves and the yield of interest rates to combat exchange rate devaluation results in GDP decline, particularly for the Philippines, Thailand, Malaysia and Indonesia. The response of GDP is considerable and negative, which stresses the actual impact of exogenous exchange rate shock. In this period, the variance decomposition displays that the shock accounts for 16 per cent variation in the Philippines and Thailand and 8 per cent in other sample countries. Irrespective of the exchange rate regime or trade dependency ratio, the shock is transmitted to real domestic sectors through financial channels. All the countries faced devaluation of their exchange rates, an increase in interest rates (tight monetary policy) and a fall of output. This confirms that the USA exogenous exchange rate shock is an important source of real (domestic) and financial dynamics for all ASEAN+3+3 countries. It underlines their vulnerability to exogenous fluctuations in the pre-AFC period and their incapability to restrict the damaging upshots of this shock.

2. USA Exchange Rate Shock (Post-AFC period)

In the post-AFC period, the emerging ASEAN countries took preventive measures such as ARMO, CMI and CMIM to mitigate the negative consequences of the USA exchange rate shock. They also decreased their trade shares with the USA and signed Free Trade Agreements (FTAs) with many other European and American countries. This can be witnessed in the result of impulse responses [Figure B-1 to B-11 (Appendix B)] as well. The exchange rate response is significant and positive for Thailand, Indonesia, Philippines, India and New Zealand. However, it remains fluctuating with China (it is the only sample country that maintains a pegged exchange rate regime with the USA).

The response of interest rates is positive and significant for Indonesia, Thailand, the Philippines, Malaysia, Japan and Australia. However, Indonesia and Malaysia did not receive a pronounced impact as the countries rely on the USA's monetary (i.e. Lowering the interest rate to stimulate the growth of the domestic economy). The response of inflation is negative for Thailand, the Philippines, Malaysia, China, Korea, Japan, New Zealand and Australia. The response of GDP is significant and negative in the short run, indicating the presence of GFC. However, the countries achieved stability over the long horizon, particularly for Indonesia, Thailand, Philippines, Malaysia, Korea, Japan, Australia and New Zealand. All the countries display a better convergence to the USA exchange rate shock. In this period, the variance decomposition shows that the shock accounts for 10 per cent variation in China and 7 per cent in other sample countries.

3. USA Exchange Rate Shock (Post-GFC period)

In the post-GFC period till 2015, emerging ASEAN countries witnessed a fall in trade shares. However, a yielding trade pattern is observed later [Figure C-1 to C-11 (Appendix C)]. The exchange rate response is negative, particularly for Indonesia, Thailand, Philippines, Singapore, China, Japan, India, Australia and New Zealand. The response of interest rate is negative yet remains close to stability, exhibiting no strict monetary policy. The response of the inflation rate is also negative yet remains close to the stability for all sample countries. Finally, the response of GDP is positive yet remains close to stability, particularly for Indonesia, Singapore, China, India, Australia and New Zealand. However, the results display a cyclic pattern for Thailand, Japan and Malaysia. None of the sample countries faced devaluation of their exchange rates, nor increase in interest rates (tight monetary policy) and nor fall of output. In this period, the table of variance decomposition display that the shock accounts for

15 per cent variation in China and 5 per cent variation in other sample countries. This confirms that impact of USA exogenous exchange rate shock is lessened in post-GFC period (except that for China) and underlines the capability of ASEAN+3+3 countries in limiting the damaging upshots of this shock.

In post-AFC and post-GFC periods, a better convergence is witnessed due to some reasons [Gimet (2011), Rana (2014)]. First, most ASEAN+3+3 countries lessened their trade shares and adopted a floating exchange rate regime. Second, they took many monetary measures to guard their countries from short-term capital flow. Third, to minimise the risk of financial crisis the countries reinforce financial surveillance (Asian Monetary Regional Organization, (AMRO)) and develop assistance mechanism and promote their financial integration (Chiang Mai Initiative (CMI), Chiang Mai Initiative Multilaterization (CMIM).

4. Chinese exchange rate shock (Pre-AFC Period)

In the pre-AFC period, the impulse responses in Figure D-1 to D-10 (Appendix-D) of Chinese exchange rate shock do not underline considerable vulnerability in any of the ASEAN+3+3 countries. It is because, in the early 1990s, China was an emerging economy, so its influence on other economies was of little significance in the Pre-AFC period. Consequently, the impact of Chinese exchange rate shock on the macroeconomic variables of emerging ASEAN is insignificant (as compared to USA exchange rate shock): the variable exchange rate and inflation rate do not vary significantly. Moreover, the impact on GDP is also limited (Thailand) and insignificant (Malaysia, Korea, Indonesia, Malaysia, and the Philippines). And the monetary policy is also not altered massively. The variance decomposition showed that the shock accounts for only 0.5 per cent of the variation in all ASEAN countries.

5. Chinese exchange rate shock (Post-AFC Period)

In the post-AFC period, with the collaboration of China, the emerging ASEAN countries took many initiatives, such as AMRO, CMI, CMIM, and FTAs, to boost their economic growth. The response of exchange rate [Figure E-1 to E-10 (Appendix E)] is positive and significant, particularly for Malaysia, Japan, India, Australia and New Zealand. The response of interest rates is positive and significant, particularly for Thailand, Indonesia, Malaysia, Japan, Korea, India, Australia and New Zealand. The response to inflation remains positive and significant for Thailand, Indonesia, Singapore, the Philippines, Japan, Korea, India, Australia and New Zealand. Finally, the response of GDP exhibits cyclic fluctuations for Thailand, Indonesia and the Philippines. However, it remains significant and positive for the rest of the sample countries. During this period, the Chinese exchange rate shock accounted for more than 8 per cent of the variation in GDP of sample countries.

6. Chinese Exchange Rate Shock (Post-GFC period)

In the post-GFC period, the shock [Figure F-1 to F-10 (Appendix F)] exerts a full impact on ASEAN+3+3 countries. It is mainly because of yielding trade partnerships and being the one establishing a well-coordinating economic and financial monitoring system with ASEAN. The exchange rate response remains positive and significant for Thailand, Indonesia, Malaysia, Singapore, Korea, India and New Zealand. It is because after signing FTA with China in 2008, China has been the largest trading partner for most of the ASEAN+3+3 economies. The response of interest rates is positive and significant for Indonesia, Philippines, Singapore and Korea. The response of inflation is negative for Thailand, Indonesia, Philippines, Malaysia, Singapore, Korea, India and New Zealand. Lastly, the response of GDP displays cyclic fluctuation for Thailand, Indonesia, the Philippines, Malaysia, Singapore, Korea, India and New Zealand. In this period, the variance decomposition displays that the shock accounts for up to 17 per cent variation in emerging ASEAN countries. This confirms that the Chinese exchange rate is highly endogenous for all ASEAN+3+3 economies, accounting for yielding volatility in domestic variables to varying degrees.

7. Performance of Individual Forecast Methods

The result of individual forecasting models is shown in Tables 1 to 11. The tables display the root mean square error (RMSE) values secure from the univariate and multivariate out-of-sample forecast for 2, 3 and 4 quarters ahead, for the period 1990: Q4 – 2018: Q4. As expected, the results confirm that, on average, forecast errors increase on longer forecast horizons [Smith and Sincich (1991)]. The SVAR model is considered to be a benchmark model. Comparing ARIMA, VAR and SVAR, the ARIMA model displays the highest values of RMSEs for all the countries. Because variables in the ARIMA model only rely on its current and past realisations. Therefore, it is a low-dimensional model that tends to omit important variables which are accessible to economic forecasters, owing to constraints in fitting a large number of variables. However, on average, the forecast of the benchmark model systematically delivers the lowest RMSEs for all ASEAN+3+3 countries [Robinson (1998), Bonilla Bolaño (2014), Kutu and Ngalawa (2016)]. This ties in with the fact that SVAR forecasting facilitates the propagation of changes (increases or decreases) within the economy and provides small forecasting improvements as compared to other forecast methods [Armstrong (1989)]. It also ensures forecast accuracy and good predictive power as it imposes adequate restrictions so that the number of estimated parameters is kept small [Stock and Watson (2002), Stock and Watson (2004), Forni, et al., (2003)]. In particular, interest rate tends to display higher RMSEs than other endogenous variables as it is the most sensitive variable. We draw two main conclusions. First, taking into account structural economic change is important for forecasting. Second, the SVAR model is a powerful tool for real-time forecasting [Kim and Roubini (2000)].

8. Performance of Combined Forecast Methods

Starting with the technique of combining forecasts by Bates and Granger (1969) and further supported by Newbold and Granger (1974), Makridakis and Hibon (1979) and seminal works on forecast combination Clemen (1989), Dickinson (1973), Dickinson (1975), Granger and Ramanathan (1984), Min and Zellner (1993). The conclusion has been upheld that combining more than one forecasting model delivers more accurate out-of-sample forecasts. Tables 1 to 11 report the combined forecasts RMSEs of the ASEAN+3+3 macroeconomic variables for two different combination methods. The results reveal that simply averaging the forecasts for short horizons of the various methods with constant weights is as accurate as combining them according to the regression-based procedure [Makridakis and Winkler (1983)]. The table also indicates the improvement from combining forecasts relative to the individual forecast models. The simple average method (S.A.) performs quite well for short forecasting horizons, i.e. one-quarter ahead. An advantage of this method is that the weights do not have to be estimated. However, letting the weights change for longer forecasting horizons seems important. Therefore, the method of restricting the constant to zero and restricting the weights of the forecasts to be nonnegative (NRLS) achieves good results and improves the performance of the combined approach for long forecasting horizons. The improvement in combined results may be due to either the diversification effect (more forecasts) or the information effect (more variables) [Jordan and Savioz (2003)].

9. Performance of Individual vs. Combined Forecast Methods

The empirical results reveal that combined forecasts outperform most of the benchmark models. RMSEs of both the individual and combined forecasts are computed for each series. The combination forecasts that outperform the best single forecasts are labelled by an asterisk (Table 3 to 13). The results suggest that the NRLS approach performs extremely well in the Indonesia, Japan, Korean, Malaysia, New Zealand, Philippine, Thailand and Singapore models in which almost all the combined forecasts are at least as good as the benchmark model forecasts. S.A. and NRLS combination forecast models frequently dominate individual forecast models. On the other hand, S.A. and NRLS models dominate each other in general with insignificantly different frequencies. The out-of-sample simulations account for uncertainty in forecasts regarding the exogenous shocks during the forecast period [Doan (2012)].

TABLE 3

Indonesia RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Indonesia (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	1.048	1.043	1.038	0.251	0.249	0.249	0.079	0.078	0.079	0.179	0.179	0.178
SVAR	1.062	1.057	1.052	0.239*	0.238*	0.237*	0.078*	0.078*	0.078*	0.176*	0.176*	0.175*
ARIMA	0.208*	0.207*	0.206*	0.528	0.526	0.524	0.202	0.201	0.2	13.895	13.893	13.89
	Combined Out of Sample Forecast (RMSE)											
SA	0.198**	0.204	0.202	0.239**	0.239**	0.239	0.049**	0.048	0.045	0.133**	0.133**	0.131**
NRLS	0.204	0.201**	0.197**	0.239	0.239	0.239**	0.043	0.043**	0.043**	0.178	0.176	0.165

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 4

Thailand RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Thailand (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.373	0.372	0.37	0.029*	0.029*	0.030*	0.035	0.035	0.035	1.537	1.531	1.524
SVAR	0.362	0.361	0.359	0.032	0.034	0.032	0.032*	0.033*	0.033*	1.055*	1.051*	1.050*
ARIMA	0.087*	0.087*	0.087*	0.048	0.047	0.047	0.188	0.186	0.185	2.905	2.904	2.903
	Combined Out of Sample Forecast (RMSE)											
SA	0.022**	0.022**	0.023	0.021**	0.021**	0.022**	0.019	0.018	0.018	1.962**	1.951	1.939
NRLS	0.024	0.025	0.023**	0.023	0.024	0.024	0.017**	0.018**	0.017**	1.944	1.931**	1.919**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 5

Philippine RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Philippine (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.499	0.497	0.495	0.486	0.484	0.482	0.195	0.194	0.193	1.645	1.638	1.631
SVAR	0.499	0.496	0.494	0.456*	0.454*	0.452*	0.194	0.193	0.192	1.518*	1.511*	1.504*
ARIMA	0.156*	0.156*	0.155*	0.739	0.736	0.733	0.147*	0.146*	0.146*	1.529	1.539	1.549
	Combined Out of Sample Forecast (RMSE)											
SA	0.138**	0.138**	0.138**	0.459**	0.459**	0.446**	0.12	0.119	0.12	1.476	1.492	1.506
NRLS	0.147	0.149	0.149	0.461	0.461	0.614	0.119**	0.118**	0.119**	1.409**	1.407**	1.409**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 6

Singapore RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Singapore (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.0428	0.042	0.043	0.474*	0.478*	0.479*	1.899	1.889	1.881	1.956*	1.947*	1.938*
SVAR	0.063	0.063	0.063	0.504	0.509	0.508	1.993	1.984	1.975	2.033	2.023	2.014
ARIMA	0.037*	0.037*	0.037*	0.862	0.858	0.855	0.076*	0.076*	0.076*	2.60103	2.589	2.576
	Combined Out of Sample Forecast (RMSE)											
SA	0.013	0.013	0.0131	0.564	0.5649	0.562	0.048**	0.486**	0.048	1.784	1.778	1.728
NRLS	0.013**	0.013**	0.013**	0.467**	0.466**	0.471**	0.049	0.0464	0.047**	1.584**	1.578**	1.574**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 7

Malaysia RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Malaysia (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.442	0.44	0.438	0.565	0.564	0.561	0.151	0.152	0.154	0.435	0.433	0.433
SVAR	0.439	0.437	0.435	0.554*	0.552*	0.549*	0.151	0.153	0.155	0.429*	0.427*	0.426*
ARIMA	0.093*	0.093*	0.092*	0.848	0.845	0.842	0.102*	0.102*	0.102*	1.547	1.547	1.546
	Combined Out of Sample Forecast (RMSE)											
SA	0.026**	0.026**	0.026**	0.579	0.576	0.575	0.109	0.109	0.109	0.353	0.359	0.362
NRLS	0.0317	0.03	0.027	0.553**	0.552**	0.552**	0.104**	0.107**	0.101**	0.351**	0.352**	0.359**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 8

China RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	China (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.135*	0.134*	0.134*	0.438	0.438	0.438	0.204	0.203	0.202	0.436	0.436	0.438
SVAR	0.258	0.256	0.255	0.437*	0.438*	0.438*	0.200*	0.199*	0.199*	0.429	0.429	0.431
ARIMA	0.251	0.254	0.249	0.925	0.92	0.916	0.214	0.214	0.213	0.191*	0.189*	0.189*
	Combined Out of Sample Forecast (RMSE)											
SA	0.127**	0.127**	0.127**	0.246	0.246	0.246	0.154**	0.156	0.157	0.028	0.028	0.029
NRLS	0.128	0.128	0.128	0.229**	0.231**	0.235**	0.154	0.154**	0.154**	0.027**	0.027**	0.028**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 9

Korea RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Korea (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.938	0.936	0.934	0.277*	0.276*	0.275*	1.635	1.634	1.634	1.220*	1.215*	1.209*
SVAR	0.938*	0.936*	0.933*	0.277	0.276	0.275	1.633	1.633	1.626	1.228	1.222	1.216
ARIMA	1.229	1.233	1.237	0.446	0.445	0.443	0.219*	0.219*	0.218*	1.659	1.649	1.639
	Combined Out of Sample Forecast (RMSE)											
SA	0.554	0.565	0.573	0.246**	0.246**	0.246**	0.248**	0.249**	0.252**	1.015	1.022	1.026
NRLS	0.528**	0.535**	0.567**	0.259	0.259	0.261	0.265	0.269	0.269	1.009**	1.014**	1.018**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 10

Japan RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Japan (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.805	0.802	0.799	0.676	0.678	0.681	0.189	0.192	0.195	0.072	0.072	0.007
SVAR	0.804	0.801	0.798	0.637*	0.641*	0.645*	0.189*	0.192*	0.195*	0.068*	0.068*	0.067*
ARIMA	0.087*	0.081*	0.080*	1.037	1.032	1.027	0.293	0.293	0.292	1.112	1.101	1.089
	Combined Out of Sample Forecast (RMSE)											
SA	0.045	0.045	0.045	0.661	0.658	0.656	0.164	0.163	0.163	0.041**	0.044**	0.043**
NRLS	0.041**	0.041**	0.042**	0.632**	0.633**	0.625**	0.159**	0.160**	0.161**	0.041	0.043	0.043

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 11

Australia RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	Australia (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
Individual Out of Sample Forecast (RMSE)												
VAR	0.195	0.194	0.193	0.509	0.507	0.506	0.322	0.322	0.321	0.509	0.507	0.505
SVAR	0.179*	0.179*	0.178*	0.304*	0.303*	0.305*	0.317	0.316	0.315	0.289*	0.288*	0.287*
ARIMA	0.196	0.196	0.195	1.509	1.639	1.787	0.151*	0.150*	0.149*	1.84	1.898	1.956
Combined Out of Sample Forecast (RMSE)												
SA	0.177	0.172	0.172	0.309	0.309	0.309	0.145	0.145	0.145	0.203	0.208	0.209
NRLS	0.172**	0.172**	0.172**	0.302**	0.302**	0.302**	0.144**	0.144**	0.144**	0.204**	0.206**	0.209**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 12

India RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	India (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
Individual Out of Sample Forecast (RMSE)												
VAR	0.493	0.497	0.502	0.493	0.491	0.489	0.974	0.971	0.968	4.161	4.141	4.122
SVAR	0.493	0.499	0.503	0.469*	0.467*	0.465*	0.938	0.972	0.969	3.830*	3.814*	3.798
ARIMA	0.085*	0.085*	0.085*	0.667	0.664	0.661	0.280*	0.278*	0.277*	4.662	4.657	4.628
Combined Out of Sample Forecast (RMSE)												
SA	0.056	0.056	0.056	0.351**	0.351**	0.351	0.273	0.27	0.273	3.077	3.076	3.079
NRLS	0.051**	0.051**	0.052**	0.351	0.355	0.355**	0.266**	0.261**	0.271**	2.873**	2.888**	2.895**

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

TABLE 13

New Zealand RMSE's of Individual and Combined Out-Of-Sample Forecast Analysis

Forecast Method	New Zealand (1990Q1-2015Q4)											
	CPI			GDP			Exchange Rate			Interest Rate		
	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4	h=2	h=3	h=4
	Individual Out of Sample Forecast (RMSE)											
VAR	0.301	0.299	0.298	0.585	0.583	0.58	0.031	0.031	0.031	0.678	0.675	0.672
SVAR	0.305	0.304	0.302	0.584*	0.581*	0.579*	0.031*	0.031*	0.031*	0.605*	0.602*	0.599*
ARIMA	0.022*	0.022*	0.022*	1.601	1.609	1.623	0.116	0.115	0.114	0.869	0.856	0.842
	Combined Out of Sample Forecast (RMSE)											
SA	0.017	0.017	0.017	0.579	0.5763	0.5737	0.0322	0.034	0.0345	0.511**	0.524	0.540**
NRLS	0.017**	0.017**	0.017**	0.568**	0.562**	0.560**	0.030**	0.0302**	0.034**	0.539	0.523**	0.541

Source: Author's estimation.
Note: **, * significant at 5 and 10 per cent respectively.

V. Conclusion and Recommendation

This research examines the dynamic effects of ASEAN+3+3 countries' macroeconomic fundamentals to the USA and Chinese exchange rate shocks for the time period 1990Q1-2016Q4. To estimate the dynamic effects of the shocks, the study employs the SVAR model with contemporaneous restrictions. It also provides a comparative assessment of which of the two shocks exert more variation than the other. Our results highlight the negative and considerable impact of the exogenous exchange rate shocks on all ASEAN+3+3 countries. It incorporates two breaks (AFC and GFC), so the total time period is divided into three data sets, i.e. pre-AFC period (1990Q1-1997Q2), post-AFC period (1998Q2-2008Q2) and post-GFC period (2009Q2-2016Q4). The exogenous shock originating from the USA in the first two periods (1990Q1-2008Q2) exerts a significant and negative impact.

However, in the third time period, the impact of the shock is limited on certain ASEAN+3+3 members. Only industrialised countries are affected significantly, including China. This palliation in a variation of macroeconomic fundamentals over time adheres to the falling trade shares of ASEAN+3+3 economies with the USA. However, the results display a rising impact of the Chinese exchange rate shock. In the pre-AFC period (19901-1997Q2), Chinese shock wields no significant variation in the macroeconomic fundamentals of any country. However, after the AFC, a significant variation was observed in most of the ASEAN+3+3 countries. The variation caused by the Chinese exchange rate became more prominent in the post-GFC period. It is because of the yielding trade pattern amid China and ASEAN countries. Thus, the variation caused by the Chinese economy is vigorous across variables and countries. This study finds that after the GFC, the impact of exogenous shocks from the USA in ASEAN+3+3 economies declined. However, for some member countries, Chinese exchange rate shock tends to exert considerable variation compared to that of the USA.

Moreover, the rising trade dependencies of ASEAN+3+3 economies have made them prone to exogenous shocks. In the face of such volatility, a variety of forecasting methods are combined to improve the forecast accuracy. The forecasting techniques employed are reasonable and relatively simple to predict macroeconomic variables for analysis. The research shows that the forecasting performance of each econometric forecast model (ARIMA, VAR and SVAR) varies across countries and variables. Furthermore, two forecast combination approaches (S.A. & NRLS) were used to minimise forecast errors. It is observed that the results of each forecast combination approach also vary across countries and variables. However, on average, the NRSL forecast approach tends to outperform the S.A. approach for most time series. Comparing individual forecasts with the best-combined forecasts reveals that the combination forecasts outperform the best individual forecasts. This suggests that a forecast combination can considerably reduce the risk of forecasting failure. The conclusion also implies that combined forecasts are likely preferred to single-model forecasts in many practical situations. Finally, given the well-documented robustness of the S.A. combination method in the literature, the findings of this study confirm the theoretical evidence that the NRLS method is a viable alternative combination method. The study recommends that the region de-dollarise their currencies and adopt new trade patterns in emerging local currencies. Moreover, the forecasting macroeconomic fundamentals suggest that a practical forecaster should practice a combination forecasting method and pay close attention to the weights assigned to the individual forecasts.

APPENDIX-A

FIGURE A-1
INDONESIA_USA

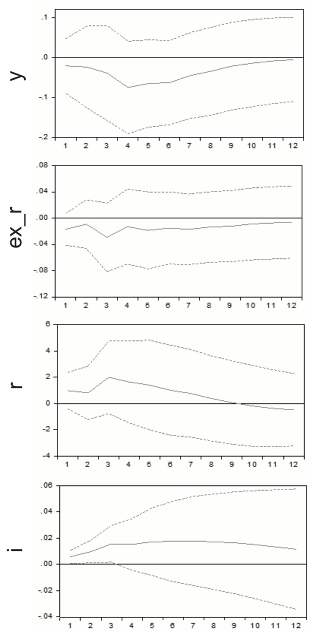


FIGURE A-2
THAILAND_USA

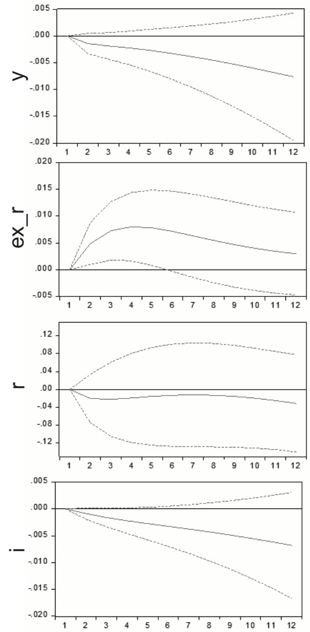


FIGURE A-3
PHILIPPINE_USA

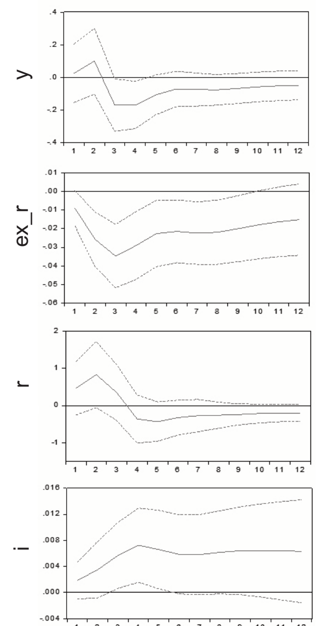


FIGURE A-4
SINGAPORE_USA

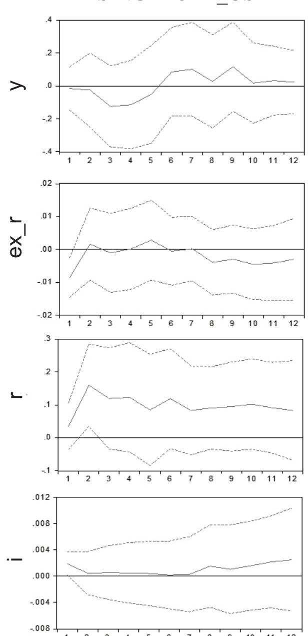


FIGURE A-5
MALAYSIA_USA

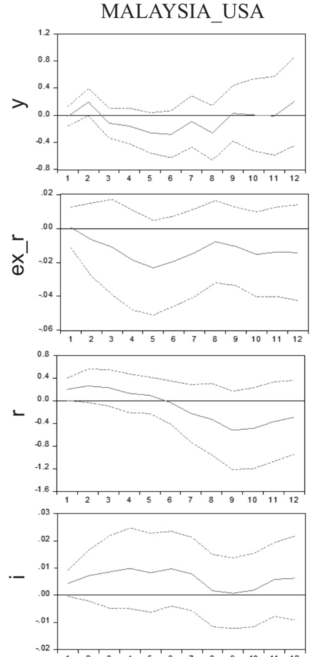


FIGURE A-6
CHINA_USA

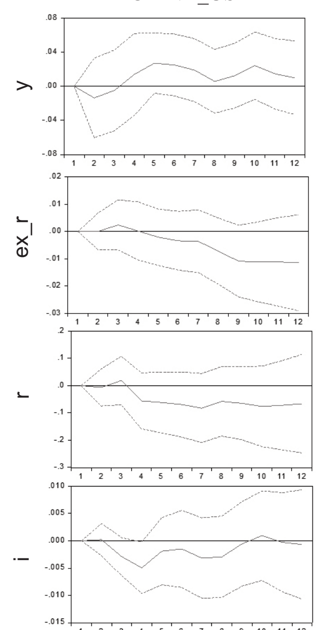


FIGURE A-7
KOREA_USA

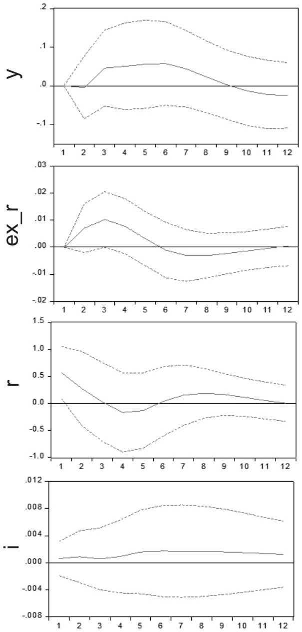


FIGURE A-8
JAPAN_USA

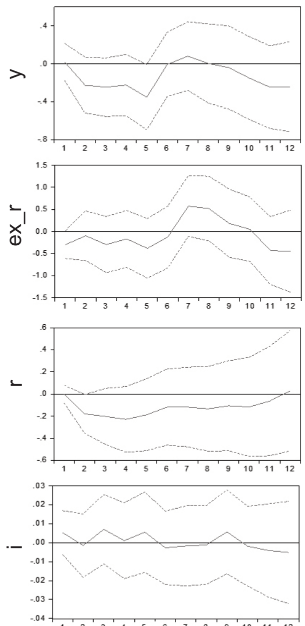


FIGURE A-9
INDIA_USA

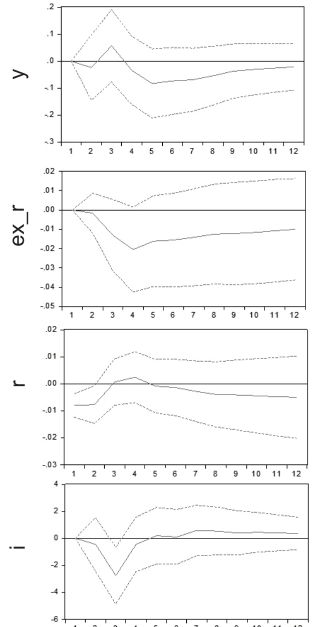


FIGURE A-10
AUSTRALIA_USA

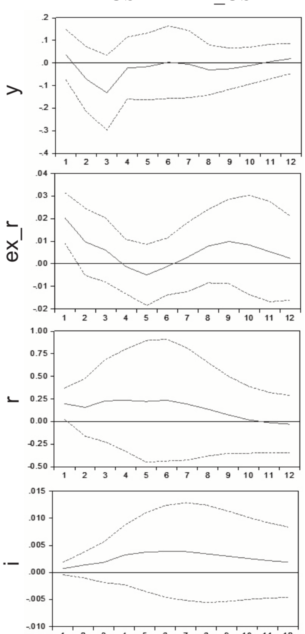
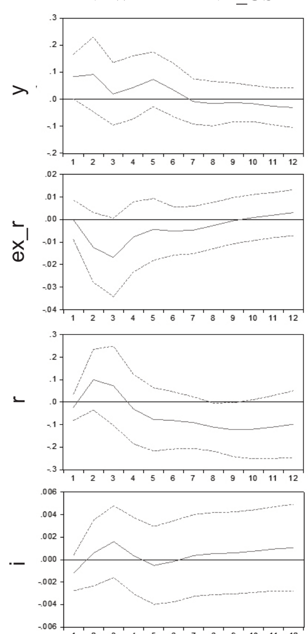


FIGURE A-11
NEW ZEALAND_USA



APPENDIX-B

FIGURE B-1
INDONESIA_USA

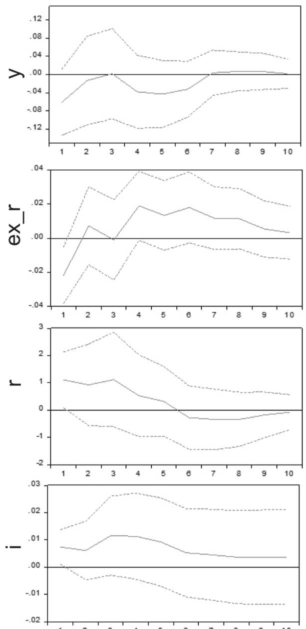


FIGURE B-2
THAILAND_USA

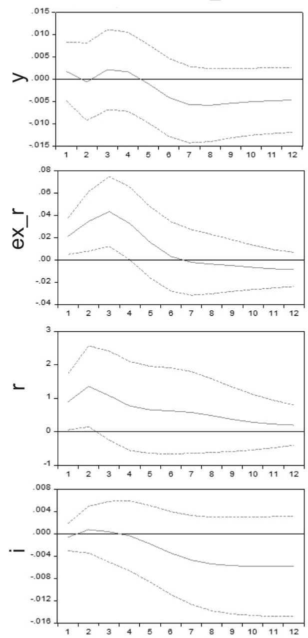


FIGURE B-3
PHILIPPINE_USA

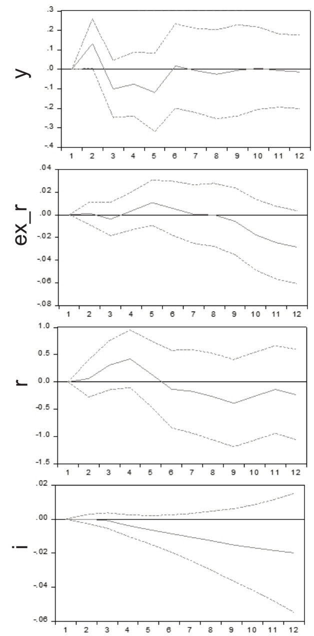


FIGURE B-4
SINGAPORE_USA

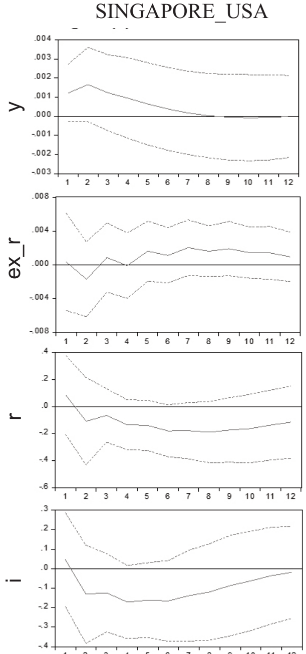


FIGURE B-5
MALAYSIA_USA

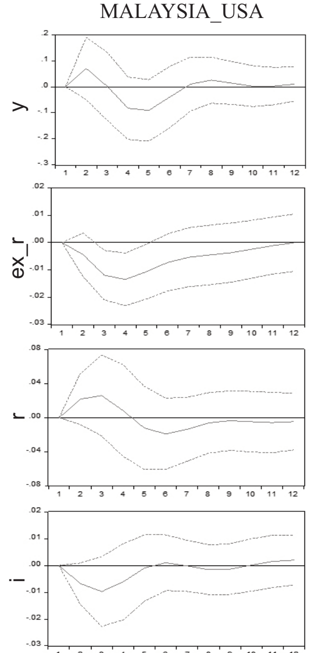


FIGURE B-6
CHINA_USA

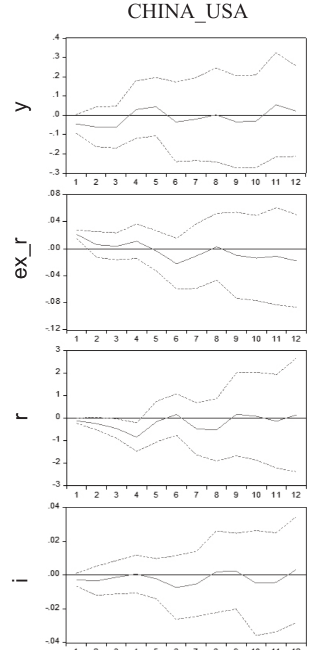


FIGURE B-7
KOREA_USA

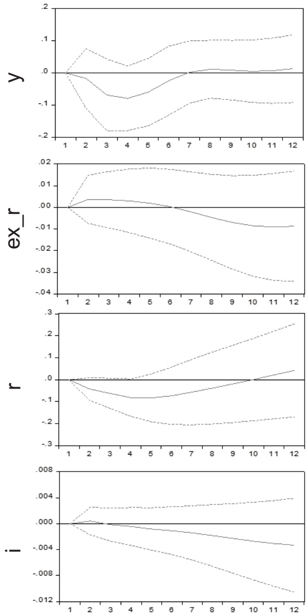


FIGURE B-8
JAPAN_USA

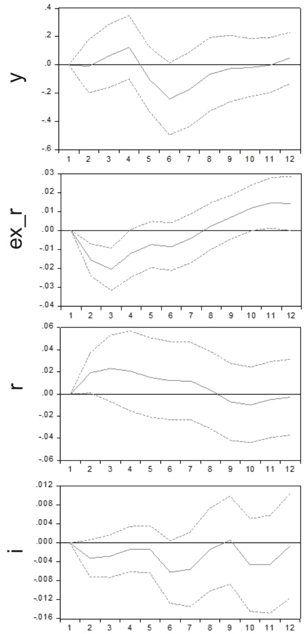


FIGURE B-9
INDIA_USA

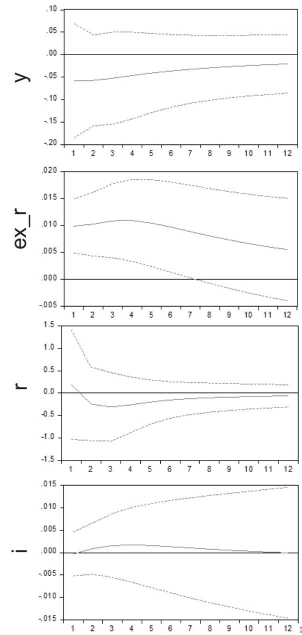


FIGURE B-10
AUSTRALIA_USA

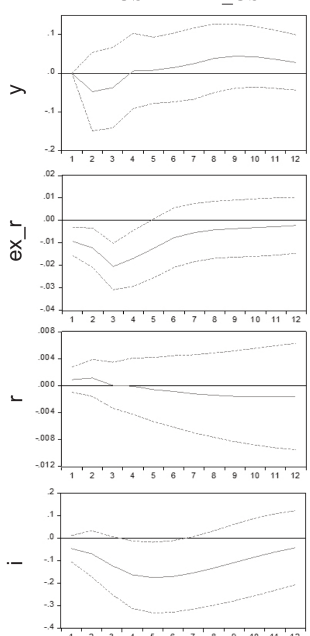
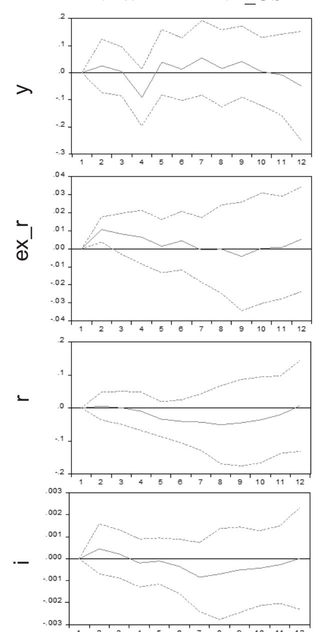


FIGURE B-11
NEW ZEALAND_USA



APPENDIX-C

FIGURE C-1
INDONESIA_USA

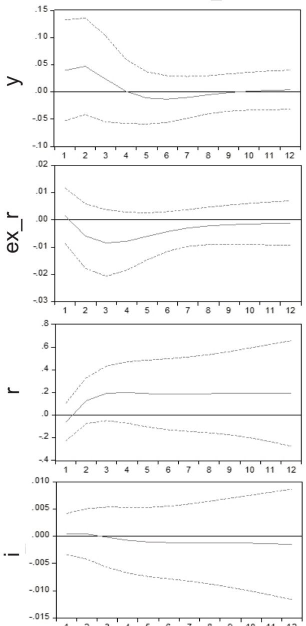


FIGURE C-2
THAILAND_USA

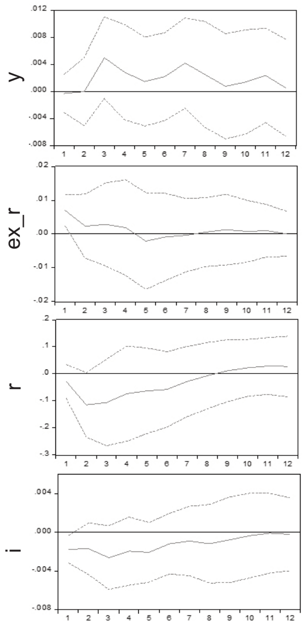


FIGURE C-3
PHILIPPINE_USA

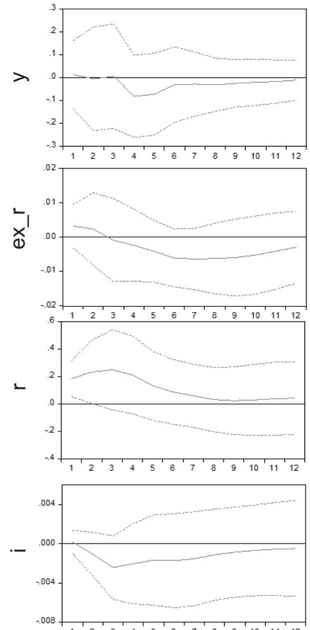


FIGURE C-4
SINGAPORE_USA

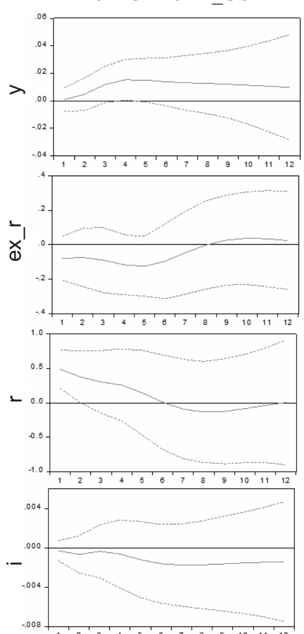


FIGURE C-5
MALAYSIA_USA

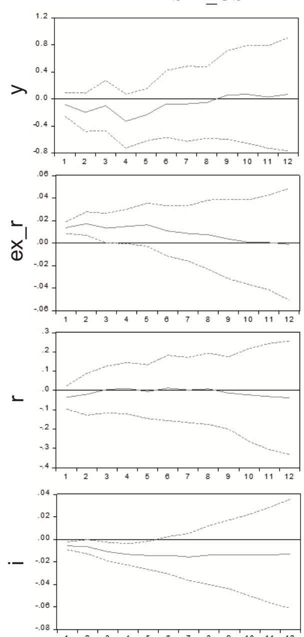


FIGURE C-6
CHINA_USA

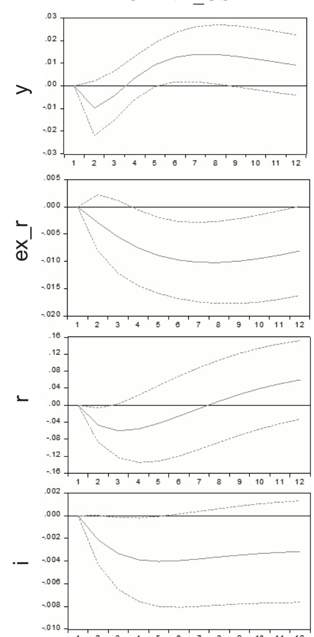


FIGURE C-7
KOREA_USA

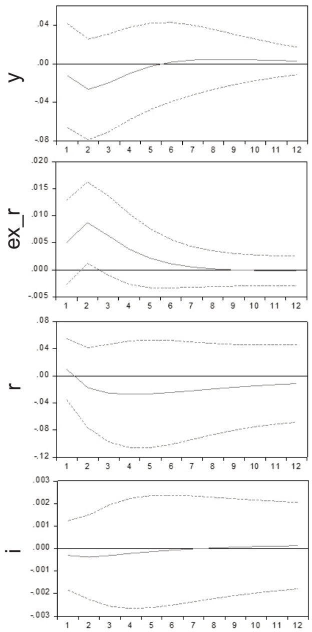


FIGURE C-8
JAPAN_USA

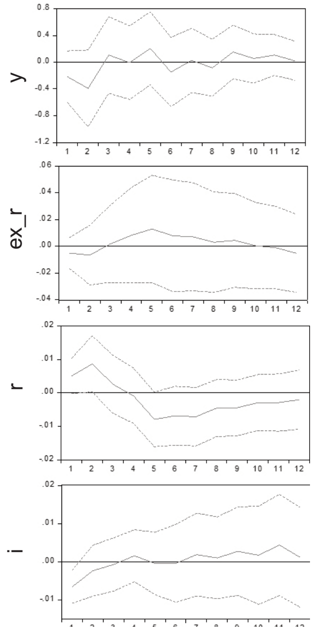


FIGURE C-9
INDIA_USA

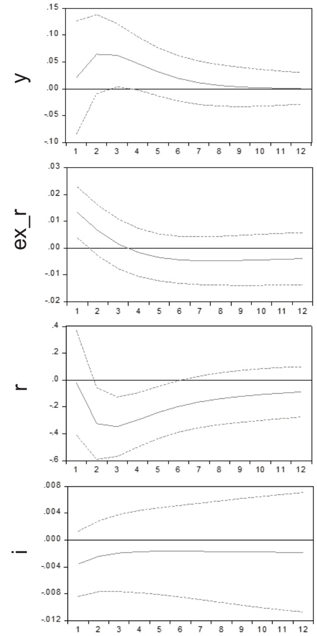


FIGURE C-10
AUSTRALIA_USA

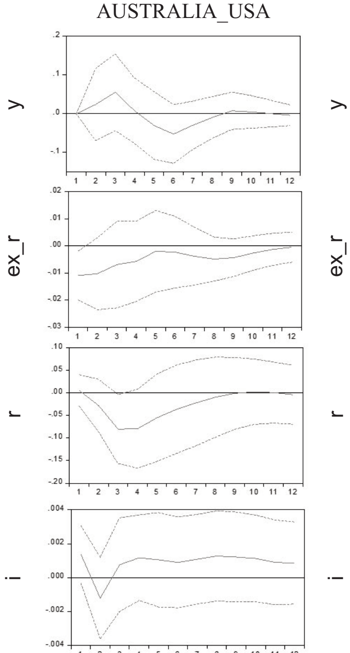
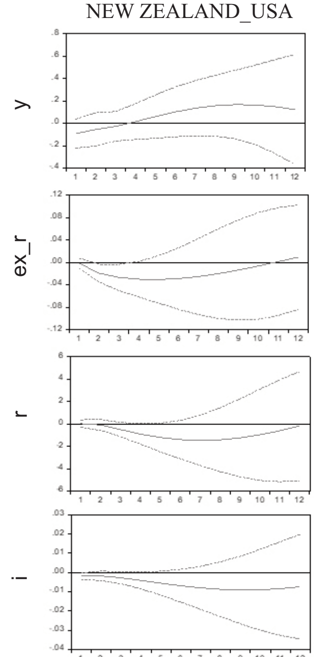


FIGURE C-11
NEW ZEALAND_USA



APPENDIX-D

FIGURE D-1
INDONESIA_CHINA

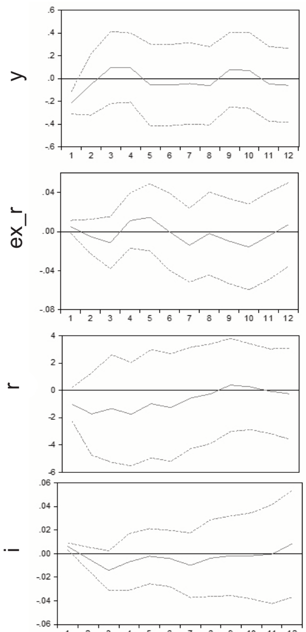


FIGURE D-2
THAILAND_CHINA

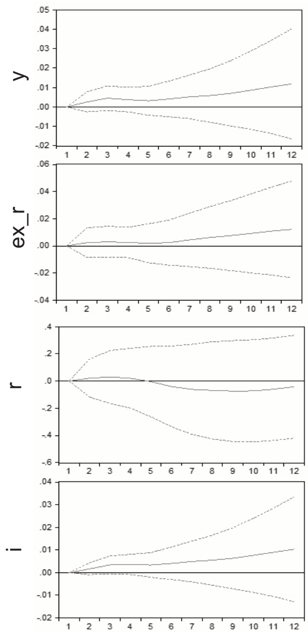


FIGURE D-3
PHILIPPINE_CHINA

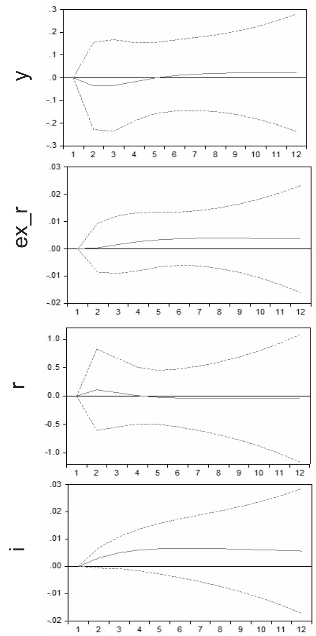


FIGURE D-4
SINGAPORE_CHINA

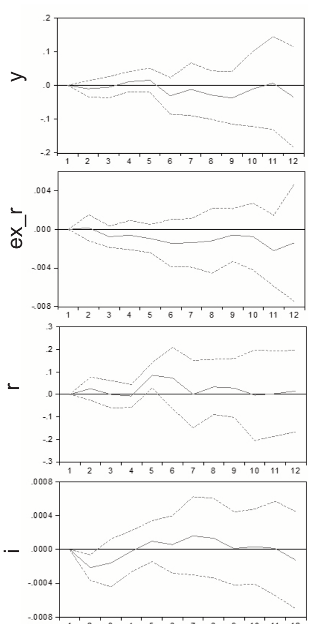


FIGURE D-5
MALAYSIA_CHINA

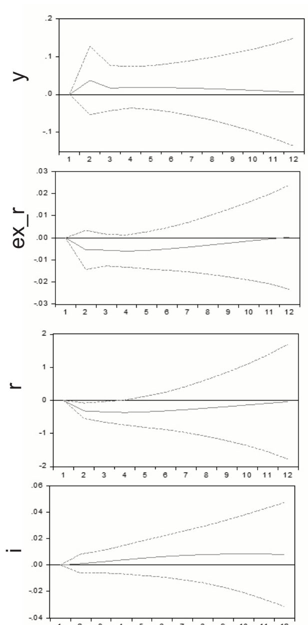


FIGURE D-6
KOREA_CHINA

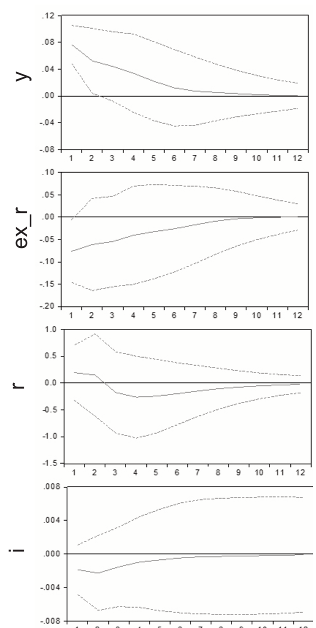


FIGURE D-7
JAPAN_CHINA

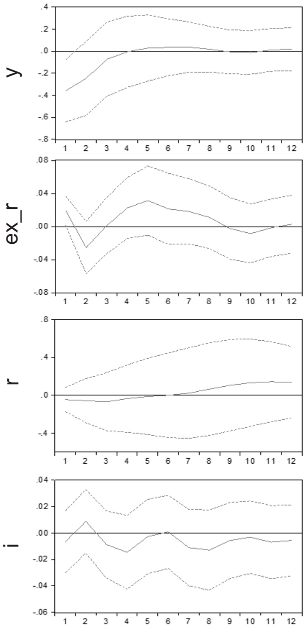


FIGURE D-8
INDIA_CHINA

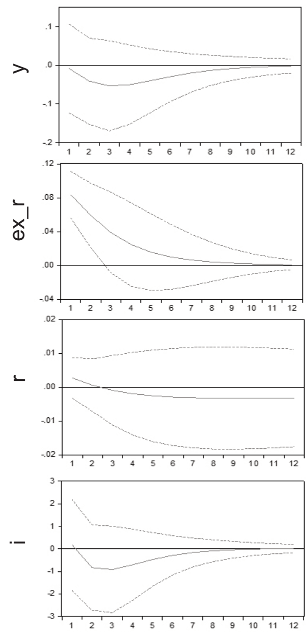


FIGURE D-9
AUSTRALIA_CHINA

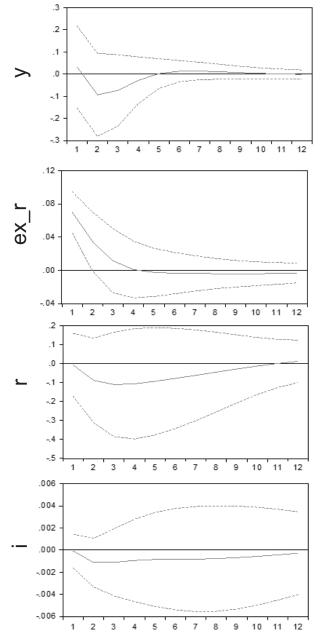
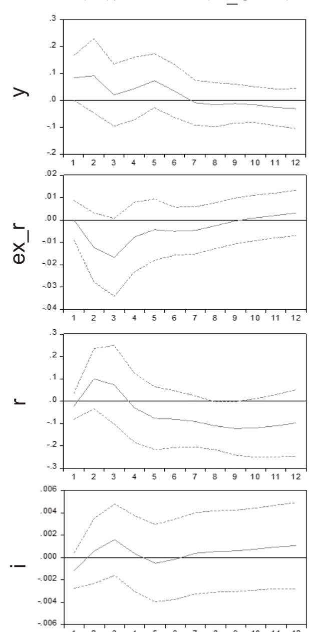


FIGURE D-10
NEW ZEALAND_CHINA



APPENDIX-E

FIGURE E-1
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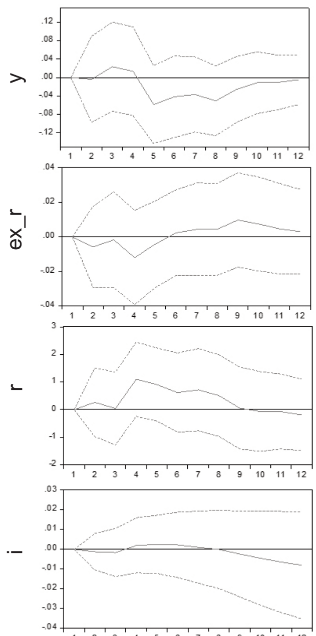


FIGURE E-2
THAILAND_CHINA

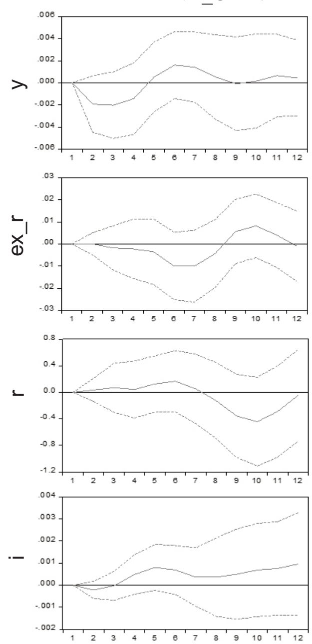


FIGURE E-3
PHILIPPINE_CHINA

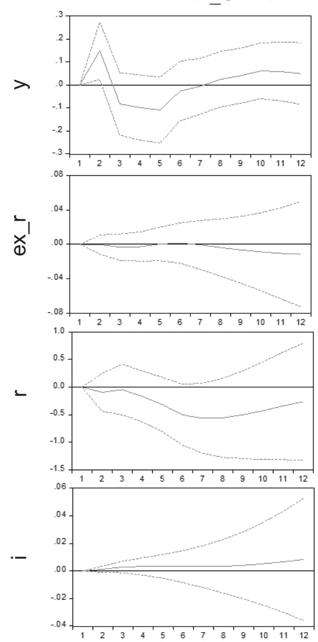


FIGURE E-4
SINGAPORE_CHINA

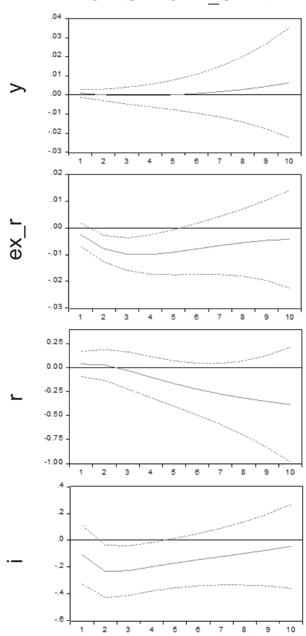


FIGURE E-5
MALAYSIA_CHINA

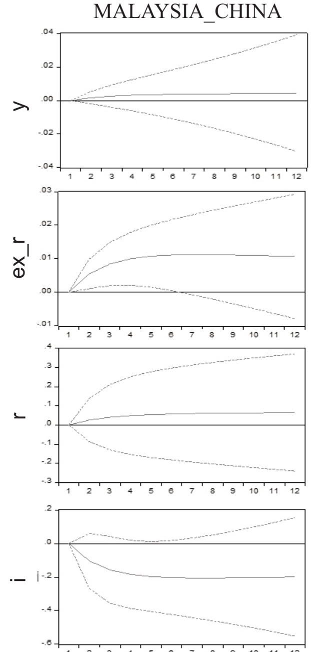


FIGURE E-6
KOREA_CHINA

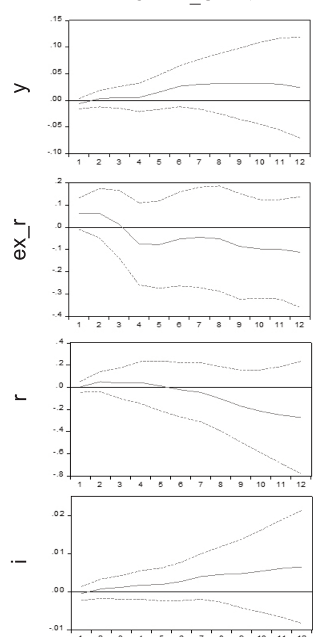


FIGURE E-7
JAPAN_CHINA

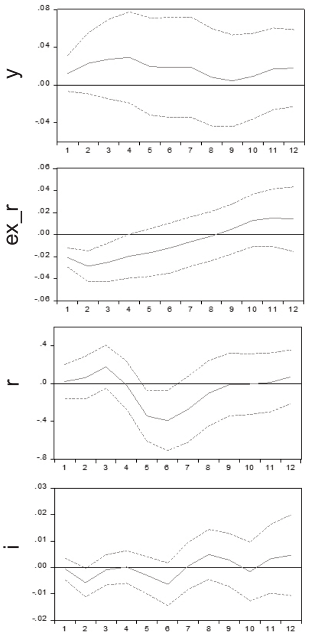


FIGURE E-8
INDIA_CHINA

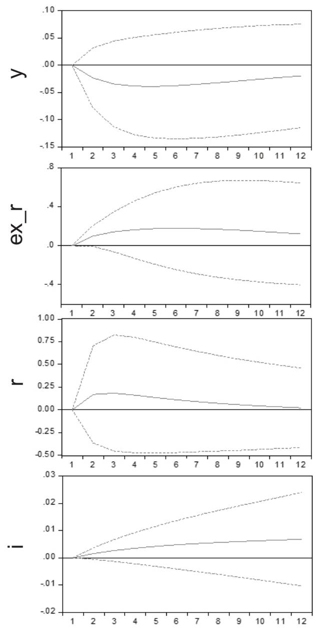


FIGURE E-9
AUSTRALIA_CHINA

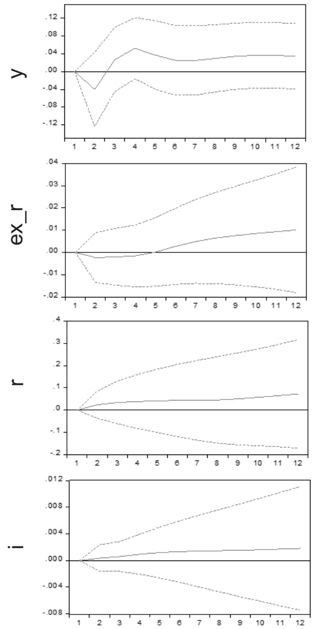
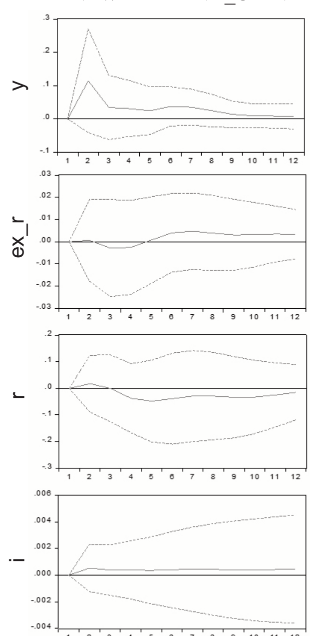


FIGURE E-10
NEW ZEALAND_CHINA



APPENDIX-F

FIGURE F-1
INDONESIA_CHINA

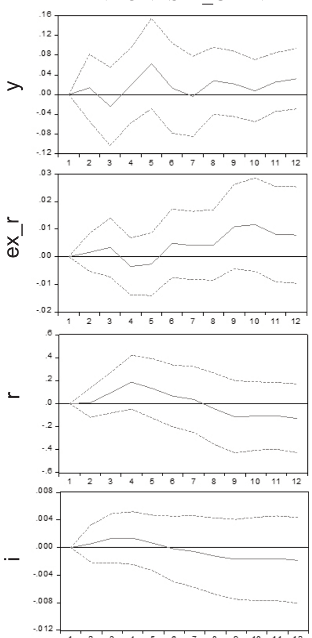


FIGURE F-2
THAILAND_CHINA

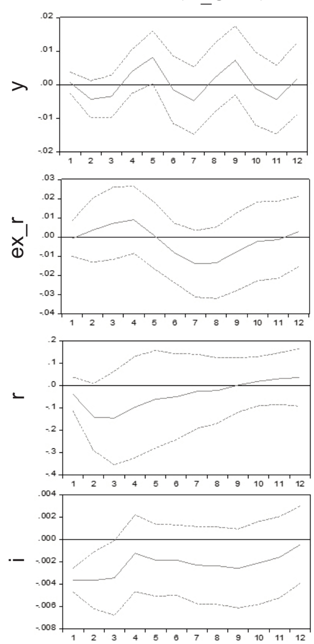


FIGURE F-3
PHILIPPINE_CHINA

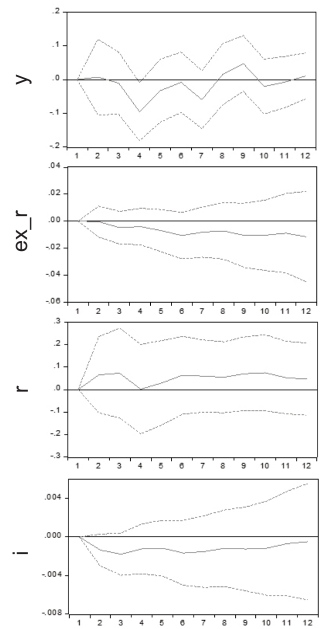


FIGURE F-4
SINGAPORE_CHINA

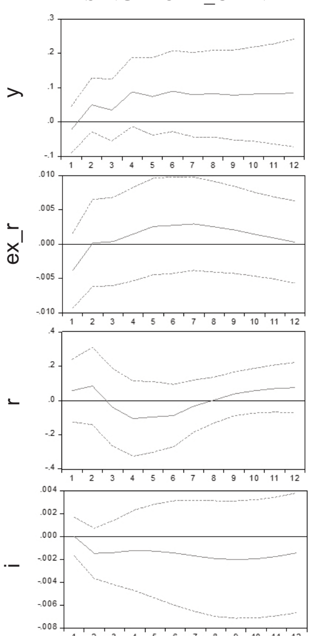


FIGURE F-5
MALAYSIA_CHINA

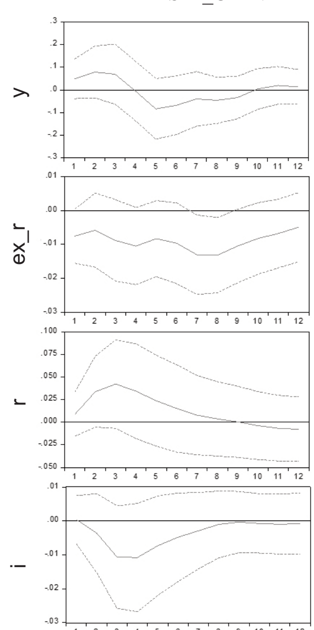


FIGURE F-6
KOREA_CHINA

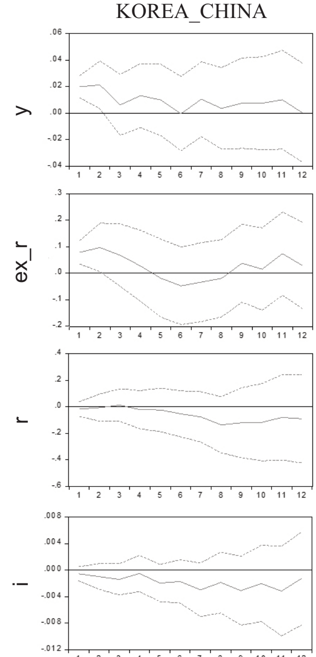


FIGURE F-7
JAPAN_CHINA

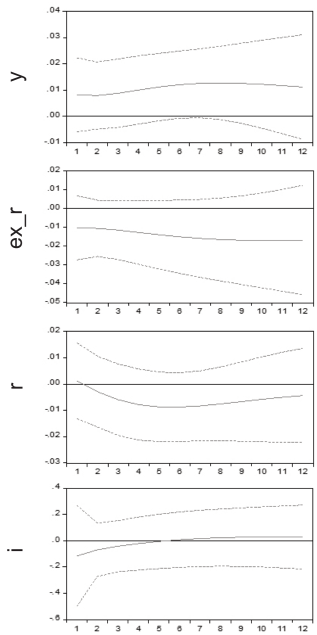


FIGURE F-8
INDIA_CHINA

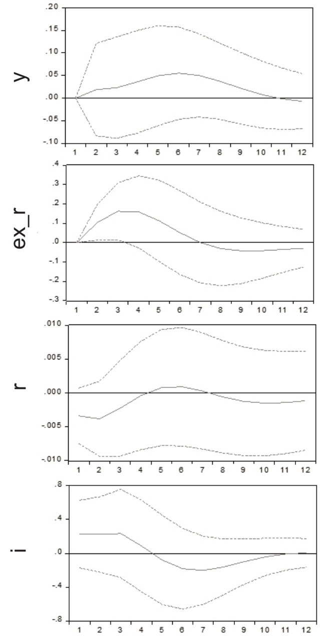


FIGURE F-9
AUSTRALIA_CHINA

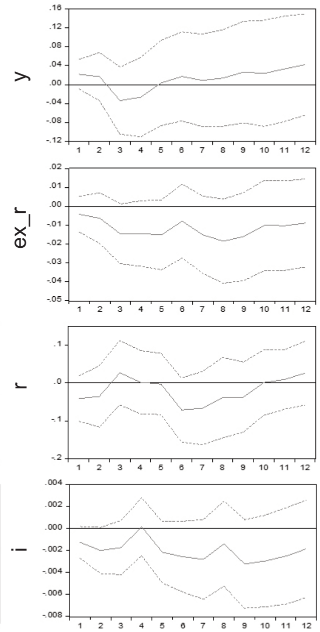
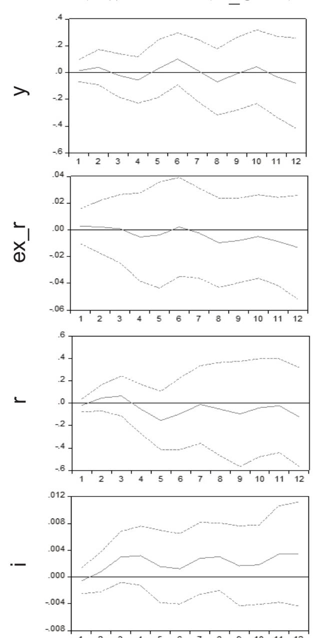


FIGURE F-10
NEW ZEALAND_CHINA



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