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Policy coordination among the ASEAN-5: A global VAR analysis

Madeleine Sui-Lay Tan

Level 5, FBE Building, University of Melbourne, 111 Barry St, Parkville 3010, Victoria, Australia

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ABSTRACT

This paper aims to analyse the feasibility of policy coordination among the ASEAN-5 economies. This is done by determining whether they experience symmetric responses to common shocks. Given that the problem of dimensionality plagues large-scale macroeconomic modelling, a Global VAR model by Pesaran, Schuermann, and Weiner (2004) and Dees, Mauro, Pesaran, and Smith (2007) is used. The results in this paper provide some weak evidence of symmetric responses to the common (global) shocks of interest: a US monetary policy shock, a US output shock, a Chinese output shock; an oil price shock. Shocks from the US produced the most symmetric responses. The lack of symmetry in some cases has implications for further policy coordination. Since migrant remittances could provide an adjustment mechanism, further labour market integration is needed as it currently lags behind trade and financial integration in the region.

1. Introduction

1.1. Background

The Asian Financial Crisis (AFC) in 1997 was a defining event for the East Asian economies, particularly the ASEAN[1] economies. It highlighted the increasing interdependence among them in the period leading up to this crisis created through trade and financial linkages. The regional experience of the AFC is consistent with Eichengreen and Bayoumi (1996) and Glick and Rose (1999) who find that the pattern of crises is often regional. As such, managing these linkages needs to be a regional effort. Some of the suggestions put forth post-AFC were influenced by the successful launch of the Euro. However, the ASEAN members lack the political commitment to follow through with a common currency such as the Euro. Coupled with the Greek crisis that has unfolded through the Global Financial Crisis (GFC), these nations are wary of such an arrangement especially if their fundamentals are starkly different from the economy of the anchor currency. Unlike the path taken by the European Monetary Union (EMU), the nature of the ASEAN economic integration and the way they arrived at the present levels of integration differ. The regional integration process in the ASEAN-5 group is driven by market forces rather than by political ones. Large firms, particularly multinational corporations (MNCs), rather than governments instigated trade and financial flows in this region and continue to drive their movements now, even though this is now also reinforced by formal arrangements at the governmental levels (Brennan & Manning, 2015).

E-mail address: suit@unimelb.edu.au.

[1] Association of Southeast Asian Nations (ASEAN) includes Brunei, Cambodia, Lao PDR, Myanmar, Vietnam and the founding five countries also known as the ASEAN-5: Indonesia, Malaysia, the Philippines, Singapore and Thailand.

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1.2. Exchange rate stability

Instead of managing the economic linkages through a common currency, the creation of an ASEAN Economic Community (AEC) by 2015 was planned as part of the member countries' efforts towards a more holistic approach to integration known as the ASEAN Community. The other two pillars of this community are cooperation among member states focused on socio-cultural development (ASEAN Socio-Cultural Community) and political security (ASEAN Political-Security Community). According to the ASEAN Secretariat, the AEC would be the goal of regional economic integration and will exhibit four main characteristics: it will be a single market and production base, a highly competitive economic region, a region of equitable economic development, and a region fully integrated into the global economy. It was therefore a milestone for the ASEAN economies when the AEC was launched in 2015. The creation of such an economic entity allows these small open economies to compete at the global level with larger economies such as China and India.

Exchange rate stability, whether through policy dialogue and surveillance, or through formal arrangements regarding exchange rate movements, is not only necessary to prevent crises similar to the AFC in the future, but will be needed to maintain a stable production base underpinned by bilateral trade flows and to encourage inclusive growth among these economies. While the majority of recent literature is consistent with Tenreyro (2007) and does not find strong evidence showing that nominal exchange rate volatility dampens the volume of trade, there is evidence that real exchange rate volatility has a negative effect on trade – particularly when financial markets are not well developed as was found in Héricourt and Poncet (2013). Exchange rate uncertainty could also lead to increased bilateral trade volatility that then impacts on aggregate trade flows, and eventually macroeconomic volatility as well, according to Baum and Caglayan (2010).

1.3. Policy coordination

The ADBI (2014) study was conducted in consultation with ASEAN governments on the future of ASEAN towards the year 2030. In this report, it was suggested that rather than being complacent with the achievement of successfully launching the AEC, this milestone should be a stepping stone to deeper regional integration. Policy cooperation and coordination appears to be the way forward for these countries. Monetary and exchange rate policy coordination was first suggested by Branson and Healy (2009) and ASEAN (2005). They occur in tandem because according to the Mundell–Fleming model, fixed or rigid exchange rates under a high degree of capital mobility implies that there is only one effective monetary policy instrument.

Truman (2011) helpfully points out that there is a spectrum when it comes to the manner of policy coordination. The first level of policy coordination involves occasional exchanges of views while the second level of policy coordination involves surveillance or reviews of the economic and financial policies in the respective economies. The ASEAN group already has such an arrangement in place with a research group known as the ASEAN Macroeconomic Research Office (AMRO) and the ASEAN Bond Market Initiative (ABMI) which is a bond market surveillance team. Beyond these two initial means of policy coordination are two further approaches which are now under consideration. The third level of policy coordination involves an agreement upon joint policy actions towards a common agreed objective. Such objectives are specifically targeted to a particular issue or is conducted on an ad hoc basis. As Truman (2011) elaborates, joint action may target anti-money laundering or represent a coordinated effort to deal with a financial crisis. The fourth and highest level of policy coordination according to Truman (2011) involves a continuous adjustment of policies towards a common objective. In this paper, policy coordination refers to this fourth level of economic commitment. More specifically, macroeconomic policy coordination (both in monetary and exchange rate policy coordination) would firstly enable economies to conduct domestic macroeconomic stabilisation policies but has the added benefit of forcing member countries to internalise policy externalities that spills over into other member economies owing to the increasingly strong trade and financial linkages (Kawai & Motonishi, 2005).

1.4. Optimum currency area literature

The optimum currency area (OCA) literature stemming from Mundell (1961) is valuable in this discussion as it elaborates on the conditions for feasible monetary and exchange rate policy coordination. An OCA is optimal if it enables participating economies to achieve full domestic employment and maintain stable domestic prices. The literature recognizes that the criterion of common and symmetric shocks is important. Domestic policies would previously have been used autonomously to help the domestic economy adjust to shocks. However, under an OCA arrangement, national interests will have to be ceded in place of regional interests whenever differences in domestic and regional needs arise. The direction of a coordinated policy response to asymmetric shocks is less certain, whereas with symmetric responses these economies have the option of agreeing to do nothing or make a concerted adjustment depending on the type of shock that occurs. Therefore, the presence of asymmetric shocks creates significant costs for member economies of the OCA. In addition to this, symmetric responses to a common source of shocks indicate that their economic structures or policy preferences (that is, inflation-output trade-off preferences), are similar (Fleming, 1971; Haberler, 1970). As such, the presence of symmetric responses to common shocks suggests that macroeconomic policy coordination in the form of monetary and exchange rate policy coordination is feasible.

1.5. Macroeconometric modelling

Modelling for such analysis can be problematic because it requires specifying these interconnected economies using fully endogenous domestic variables. Such attempts would quickly face the "curse of dimensionality" described by Bellman (1957) because a substantial number of parameters will need to be estimated in order to incorporate the different ways that their economies are linked. Exacerbating this further, the available time-series data for the ASEAN-5 economies is also limited. The Global VAR (GVAR) model by Pesaran et al. (2004) and Dees et al. (2007) provide a way around this dimensionality problem by allowing for the estimation to occur at the country-specific level with weakly exogenous (non-domestic) foreign factors constructed as a weighted average, based on the relative importance of a country's bilateral trade and financial flows. The results are then unpacked at the second stage into the global model since the trade and financial flow weights used to construct the foreign variables are known. The GVAR model by Pesaran et al. (2004) and Dees et al. (2007) is used as it is highly suitable to the tightly interconnected ASEAN-5 economies.

In fact, the study by Han and Ng (2011) shows that there is benefit in using the GVAR model over country-specific models alone for this group of countries. In forecasting the macroeconomic variables for the ASEAN-5 economies, Han and Ng (2011) finds that out-of-sample forecast estimates using the GVAR model significantly outperformed forecasts based on country-specific models alone. In Pesaran et al. (2004), the authors produced a set of mean squared forecast errors for several variables across different regions and countries. They found that out of all the regions and variables analyzed, the forecasts of the Southeast Asian variables saw the most improvement from using the GVAR model compared to modelling them as a random walk.

1.6. Shocks common to the ASEAN-5 region

The responses in each of the ASEAN-5 domestic variables to four global sources of shocks are analyzed. The sources of shocks were selected because they dominate the world economy. The US economy has often been found to be a major influence for this region. However, during the GFC, the influence of China's demand for global exports was noted as it helped to buoy several countries, particularly the ASEAN-5 economies through a crisis that originated in the US. Studies such as Dungey and Vehbi (2011) and Cesa-Bianchi, Pesaran, Rebucci, and Xu (2011) have looked at the possible move away from the US as the only dominant influence for these countries, to China also being a significant economic force affecting them. As such, both shocks from China and the US on the ASEAN-5 economies are examined. There is some evidence, such as in Roache (2012), that China has an indirect impact on the ASEAN-5 economies through commodities and oil prices in addition to a more direct relationship through trade. As determined in Osorio and Unsal (2013), since the ASEAN-5 economies are driven directly by commodities and oil prices in addition to the US and Chinese economies, their responses to an oil price increase are also analyzed.

1.7. Overview

This paper aims to determine if the ASEAN-5 economies experience symmetric responses to common shocks, and thereby determine if policy coordination is feasible among them. The results in this paper provide some evidence of symmetric responses to the common (global) shocks selected: a US monetary policy shock, a US output shock, a Chinese output shock, and an oil price shock. Although this evidence helps to show that policy coordination is feasible, the result is weak since it depends on the type of shock and in some cases, such as with an oil price shock, it is only limited to the short-run. Therefore, the conclusion that there is no symmetry is just as important for future policy coordination efforts as it is the conclusion that there is some evidence of symmetry in their responses to common shocks. This paper is organised into five sections. Section 2 describes the Global VAR approach, Section 3 specifies the estimated model, Section 4 describes the results while Section 5 discusses the findings. Finally, Section 6 concludes.

2. The global VAR (GVAR) approach

The GVAR estimation procedure makes a distinction between the global model and country-specific models. Unless explicitly restricted to be strictly exogenous, all variables for all countries of interest in the global model are endogenous. This global model is segmented into country-specific models for estimation in order to circumvent the dimensionality problem previously noted. The domestic variables in the country-specific models are endogenous while foreign variables are included as weakly exogenous regressors. These variables are different for each country because they are constructed as weighted averages of the other non-domestic variables in the global model. In the country-specific models, these foreign variables are weakly exogenous but when the estimates from all the country-specific models are unpacked to construct the global model, these foreign variables are no longer exogenous.

Estimating the GVAR model requires a two-step approach. First, the country-specific models are estimated separately. In the second stage, the estimates are stacked to build the full global model. The weights used in the construction of these aggregate foreign variables for each country-specific model estimation are pre-determined which makes this estimation strategy possible.

2.1. The global model

There are $(N+1)$ countries in the model, indexed $i = 0, \ldots, N$ and t time observations. Country $i = 0$ is assumed to be strictly exogenous in that it influences the other $i = 1, \ldots, N$ countries but is not influenced by them. There are m_y endogenous variables in each country $i = 1, \ldots, N$ and m_x exogenous variables in country $i = 0$. This means that there are Nm_y endogenous variables and m_x exogenous variables contained in the global vector of variables, y_t. $m = m_x + Nm_y$ is the total number of variables in the global model. This $m \times 1$ global vector of variables, y_t is formed by stacking each of the country-specific vectors, $y_{i,t}$:

$$y_t = \begin{bmatrix} y_{0,t} \\ y_{1,t} \\ \vdots \\ y_{N,t} \end{bmatrix}$$

where

- $y_{i,t}$ is an $m_y \times 1$ vector of endogenous variables for each country $i \; \forall \; i = 1, \ldots, N$.
- $y_{0,t}$ contains the m_x exogenous variables in the model which are allowed to influence each other but none of the variables in country $i \; \forall \; i = 1, \ldots, N$ can influence the variables in this vector.

The global model is:

$$Fy_t = h_0 + h_1 t + Gy_{t-1} + Hy_{t-2} + \eta_t \tag{1}$$

where

- y_t is an $m \times 1$ vector of all the variables included in the model.
- t represents the time trend included in the regression.
- F is the $m \times m$ contemporaneous matrix.
- G is an $m \times m$ matrix that describes the effect of the first lag of y_t, y_{t-1}.
- H is an $m \times m$ matrix that describes the effect of the second lag of y_t, y_{t-2}.
- h_0 is the intercept and is $m \times 1$.
- h_1 is the coefficient describing the effect of the trend, t.
- η_t is an $m \times 1$ vector that contains the error terms in the global system.

Ideally, F, G and H can be estimated directly. However, due to the dimensionality problem, this is not possible. Therefore, these coefficients, F, G and H which represent the contemporaneous, first and second lag effects are defined as the weighted coefficients from each country-specific model. Each equation for country $i = 1, \ldots, N$ will contain the contemporaneous, first and second lag values of the endogenous variables and the contemporaneous, first and second lag values of the m^* weakly exogenous foreign variables which are aggregated based on a set of pre-determined weights, w_i. Let $k = m_y + m^*$ be the number of variables in the country-specific models in country $i = 1, \ldots, N$. The weighting matrix, w_i is a $k \times m$ matrix.

Owing to this set up, the coefficients across the countries are linked to each other through the weighting matrices, w_i at the global level. Since country $i = 0$ is a special case in that it is treated as exogenous, its weight matrix, $w_{i=0}$ is merely a selection matrix, $w_{i=0} = s_{m_x \times m}$. It does not have any foreign variables in its country-specific model. These global coefficients therefore, look as follows:

$$F = \begin{pmatrix} P_0 \\ P_1 w_{i=1} \\ \vdots \\ P_N w_{i=N} \end{pmatrix}, \quad G = \begin{pmatrix} Q_0 \\ Q_1 w_{i=1} \\ \vdots \\ Q_N w_{i=N} \end{pmatrix}, \quad H = \begin{pmatrix} R_0 \\ R_1 w_{i=1} \\ \vdots \\ R_N w_{i=N} \end{pmatrix}$$

where P_i, Q_i, and R_i are the contemporaneous, first lag and second lag coefficients from each country-specific model, described in the next section.

2.2. The country-specific models

With the exception of the exogenous country $i = 0$, all other country-specific models have a set of endogenous (domestic) variables included in an $m_y \times 1$ vector, $y_{i,t}$ and a set of foreign variables which are aggregated based on a set of pre-determined weights. These foreign variables are included in an $m^* \times 1$ vector, $Y^*_{i,t}$ such that $y^*_{i,t} = \tilde{w}_i y_t$. The weight matrix $\tilde{w}_i$ is

informed by the respective bilateral trade and financial flows. $\tilde{w}_i \ \forall \ i = 1, \ldots, N$ is set up so that flows to itself are equal to zero, $\tilde{w}_{ii} = 0$, and are normalised, $\sum_{j=0}^{N} \tilde{w}_{ij} = 1 \ \forall \ i = 1, \ldots, N$.

Let $z_{i,t}$ be a $k \times 1$ vector containing both these vectors, $z_{i,t} = \begin{bmatrix} y_{i,t} \\ y^*_{i,t} \end{bmatrix}$. The weighting matrix can be modified so that $w_i = \begin{bmatrix} s_i \\ \tilde{w}_i \end{bmatrix}$ where s_i is a selection matrix for domestic variables in country i, $z_{i,t} = w_i y_t$. Here, w_i is a $k \times m$ matrix $\forall\, i = 1, \ldots, N$.

The country-specific model with these weakly exogenous foreign variables is based on a VARX(2,2)[2] where both domestic and foreign variables are of lag order 2. These weakly exogenous foreign variables affect the domestic variables in the country-specific model contemporaneously but they are not strictly exogenous in the sense that the lagged changes of both the domestic and foreign variables are still able to affect them. However, these weakly exogenous foreign variables are "long-run forcing" because they are not affected by disequilibria in the country-specific model. Weak exogeneity in these foreign variables allows the other variables in the global model to influence the domestic variables based on the weights used to construct these foreign variables which vary across countries. At the same time, the lagged effects, or feedback of these domestic variables on the foreign variables facilitates the endogeneity at the global level, with the exception of country $i = 0$.

Garratt, Lee, Pesaran, and Shin (2006) describes how the country-specific model can be separated into a conditional and a marginal model, required for efficient estimation. The model used in this paper is expressed in error-correction form, consistent with the one described in Garratt et al. (2006). The VARX(2,2) is re-parameterized into a VECMX(1,1). While the GVAR methodology can be applied to both stationary and integrated variables, the estimation was done in error-correction form in order to take into account the integration properties of the series.

There may be a structural break in the long-run relationship and a dummy variable may need to be included to account for it. Dees et al. (2007) demonstrates that partitioning the cointegrating relations matrix β_i to include a constant, trend and dummy is possible.[3] Partitioning $\tilde{\beta}'_i$ this way allows for cointegration to be present among the endogenous variables, $y_{i,t}$ and also between $y_{i,t}$ and the weakly exogenous foreign variables, $Y^*_{i,t}$ in the model (Dees et al., 2007). Notice also that the country-specific intercept shift dummy, $d_{i,t}$ is assumed to be subject to the same lag order as $y_{i,t}$ which is how Greenwood-Nimmo, Nguyen, and Shin (2012) and Shin (2009) have handled the dummy variable included in their model.

Therefore, the marginal model is expressed as follows:

$$\Delta y^*_{i,t} = h_{i0,y^*} + a_{i1,y^*} t + \psi_{i1,y^*} \Delta z_{i,t-1} + \delta_{i0,y^*} \Delta d_{i,t} + \delta_{i1,y^*} \Delta d_{i,t-1} + u_{i,y^* t} \tag{2}$$

While the conditional model is:

$$\Delta y_{i,t} = c_{i0} + \tilde{c}_{i0,y} \Delta d_{i,t} + \tilde{c}_{i1,y} \Delta d_{i,t-1} + \Lambda_i \Delta y^*_{i,t} + \psi_i \Delta z_{i,t-1} + \alpha_{i,y} \beta'_i (z_{i,t-1} - \mu_i d_{i,t-1} - \gamma_i (t-1)) + \eta_{i,t} \tag{3}$$

The estimation strategy is employed in two stages. Once the long-run β_is have been identified, Dees et al. (2007) states that it is possible to estimate the short-run parameters in the conditional model α_i, c_{i0}, $\tilde{c}_{i0,y}$, $\tilde{c}_{i1,y}$, Λ_i and ψ_i directly by OLS regression.

Let:

- $P_i = [I_{m_y \times m_y} - \Lambda_i]$ is the contemporaneous matrix with dimension $m_y \times k$.
- $\Pi_{i,y} = -\alpha_{i,y} \beta'_i$ is the long-run matrix which is $m_y \times k$ in size.
- $Q_i = P_i + \Pi_{i,y} + \psi_i$ is an $m_y \times k$ coefficient matrix for the first lag.
- $R_i = -\psi_i$ is an $m_y \times k$ coefficient matrix for the second lag.
- $h_{i0} = c_{i0} + \tilde{c}_{i0} \Delta d_{i,t} + \tilde{c}_{i1} \Delta d_{i,t-1} + (-\Pi_{i,y} \mu_i) d_{i,t-1}$ is $m_y \times 1$ contains the deterministic terms.
- $h_{i1} = -\Pi_{i,y} \gamma_i$ is $m_y \times 1$ that captures the effect of the time trend.

Recall also that $z_{i,t} = \begin{bmatrix} y_{i,t} \\ y^*_{i,t} \end{bmatrix} = w_i y_t$. This estimated country-specific model appears as follows:

$$P_i z_{i,t} = h_{i0} + h_{i1} t + Q_i z_{i,t-1} + R_i z_{i,t-2} + \eta_{i,t} \quad \forall \ i = 1, \ldots, N \tag{4}$$

As can be seen in the following equation, this gives the coefficients from each country i needed to construct the global model's coefficients, F, G and H in Eq. (1):

$$(P_i w_i) y_t = h_{i0} + h_{i1} t + (Q_i w_i) y_{t-1} + (R_i w_i) y_{t-2} + \eta_{i,t} \quad \forall \ i = 1, \ldots, N \tag{5}$$

[2] While the GVAR circumvents the issue of dimensionality, the estimation of each country-specific model is still constrained by the available degrees of freedom. In this case, the data span is a limiting factor. The number of lags was restricted to a maximum of 2 for this reason in each of the country-specific models estimated. Autocorrelation and partial correlation of the residuals were checked and it does not appear that this is a problem at the 5% significance level.

[3] Let the following matrices be modified to include a trend and dummy: $\tilde{\beta}'_i = \left[\beta'_{i,y} \ \ \beta'_{i,y^*} \ \ (\beta'_{i,trend}\gamma) \ \ (\beta'_{i,d}\mu_i)\right]$ and $\tilde{z}_{i,t-1} = \left[y_{i,t-1} \ \ y^*_{i,t-1} \ \ (t-1) \ \ D_{i,t-1}\right]$. If $b_{i,1} = \beta'_{i,trend}\gamma_i$ and $b_{i,2} = \beta'_{i,d}\mu_i$, $\tilde{\beta}'_i \tilde{z}_{i,t-1} = \beta'_{i,y} y_{i,t-1} + \beta'_{i,y^*} y^*_{i,t-1} + b_{i,1}(t-1) + b_{i,2} d_{i,t-1}$.

While Eqs. (3) and (4) are employed for countries $i = 1, \ldots, N$ the country-specific model for country $i = 0$ is different since it is treated as exogenous and does not receive any influence from countries $i = 1, \ldots, N$. Country $i = 0$ is modelled as a simple VECM(1):

$$\Delta y_{0,t} = c_{00} + \alpha_{0,y}\beta_0' y_{0,t-1} + \psi_{01}\Delta y_{0,t-1} + \eta_{0,t} \tag{6}$$

To allow for dynamic analyses using a GVAR, Generalized Impulse Response Functions (GIRFs) by Pesaran and Smith (1998) and Generalized Forecast Error Variance Decompositions (GFEVDs) are generated. These GIRFs can be used to show the response of each variable to a shock[4] GFEVDs complement the analysis of GIRFs because they help to determine the main drivers of variables in the model.

3. The GVAR model

Data for the ASEAN-5 is retrieved from the EIU database and is limited to 74 quarterly observations (1993Q1–2011Q2). The trade data also retrieved from this database shows that the ASEAN-5 economies are small but relatively open economies that are export-driven. The statistics found in Table 1 show that these economies' trade (exports and imports) account for at least half to almost three times its domestic output in real terms. The five countries included are: Indonesia, Malaysia, the Philippines, Singapore and Thailand and are indexed from $i = 1, \ldots, 5$, respectively.

Economies outside the ASEAN-5 region are modelled as a "rest-of-world" economy. These countries, especially China and the US, have an influence on the global economy and so this model essentially represents the global forces that affect the ASEAN-5 countries. This "rest-of-world" model is treated as exogenous to the ASEAN-5 economies to reflect the real-world scenario; this is country $i = 0$ in the Global VAR. There are only $m_x = 5$ variables in vector $y_{0,t} = x_t = \{R_t^{US}, P_t^{US}, Y_t^{US}, Y_t^{CN}, P_t^{oil}\}$ where R_t^{US}, P_t^{US} and Y_t^{US} refers to the short-term nominal interest rate, consumer price index and the real output per capita for the US economy, Y_t^{CN} is the real output per capita for China and P_t^{oil} is the world crude oil price. All these five variables interact at the global level and influence economic conditions in the ASEAN-5 group even though economic conditions in the ASEAN-5 group do not influence these "rest-of-world" variables. Therefore, these five variables are modelled in the "rest-of-world" economy and incorporated into the global model as exogenous drivers for the ASEAN-5 economies.

Countries $i = 1, \ldots, 5$ each have $m_y = 6$ domestic variables in $y_{i,t}$ and $m^* = 4$ weakly exogenous foreign variables in $Y_{i,t}^*$. $y_{i,t} = \{Y_{i,t}, P_{i,t}, EX_{i,t}, IM_{i,t}, E_{i,t}, R_{i,t}\}$ and $y_{i,t}^* = \{Y_{i,t}^*, P_t^*, R_{i,t}^*, P_t^{oil}\}$. $Y_{i,t}$ refers to the real output per capita, $P_{i,t}$ the consumer price level, $EX_{i,t}$ the real per capita exports, $IM_{i,t}$ the real per capita imports, $E_{i,t}$ the real exchange rate (local currency units per US dollar), $R_{i,t}$ the short-term nominal interest rate, and P_t^{oil} the world crude oil price. All variables are used in logarithmic form for an easier interpretation of the estimates.

The foreign variables in $Y_{i,t}^*$ are constructed using three different weighting schemes. The $Y_{i,t}^*$ variables are constructed using weights $w_{1,ij}$, based on trade and foreign direct investment (FDI) flows to all 7 countries: the individual ASEAN-5 countries, the US and China.

$$Y_{i,t}^* = \sum_{j=0}^{7} w_{1,ij} Y_{j,t}$$

The $P_{i,t}^*$ variables are a weighted average of prices in the ASEAN-5 economies only and so uses the second weighting scheme, $w_{2,ij}$ as follows:

$$P_{i,t}^* = \sum_{j=0}^{5} w_{2,ij} P_{j,t}$$

The $R_{i,t}^*$ variables are constructed using information on trade and financial flows for the ASEAN-5 economies and the US only since China's interest rate was not included in the model. This is the third weighting scheme, $w_{3,ij}$:

$$R_{i,t}^* = \sum_{j=0}^{6} w_{3,ij} R_{j,t}$$

Oil prices, P_t^{oil} are used as is without weights from any other variables. Therefore, the weight matrix component associated with oil prices can be thought of as a selection matrix. Although each country $i = 1, \ldots, 5$ has the same variables in its foreign vector $y_{i,t}^* = \{Y_{i,t}^*, P_t^*, R_{i,t}^*, P_t^{oil}\}$, these aggregate foreign factors are different since they vary according to the relative importance of bilateral trade and FDI flows for that country compared with other economies in the model, with the exception of oil prices.

[4] Unlike Orthogonalized Impulse Response functions (OIRFs) by Sims (1980), these GIRFs are particularly useful because they are invariant to the ordering of variables. Since there is no meaningful way for each of these variables to be stacked in the GVAR, the GIRFs provide a way to analyze the effect of a unit shock to the the ith structural error. The impact of the system-wide shock is scaled. GIRFs use the observed distribution of all the shocks and integrates out the effects of the other shocks (di Mauro & Pesaran, 2013, p. 26).

Table 1
Trade (exports and imports) as a share of output, 1993Q1–2011Q2 ($t = 74$).

	Indonesia	Malaysia	Philippines	Singapore	Thailand
Mean	0.4558	1.6864	0.7431	2.8952	1.0164
Median	0.4417	1.7052	0.7511	2.8200	1.0769
Maximum	0.8289	2.0290	1.1689	3.6427	1.4600
Minimum	0.3348	1.2985	0.4555	2.3447	0.6438
Std. Dev.	0.0993	0.1666	0.1727	0.3176	0.2243

Source: EIU database.

The weight matrix for each country i, $\tilde{w}_i$ combines the different weighting schemes to construct $y^*_{i,t} = \tilde{w}_i y_t$ where y_t is an $m \times 1$ vector of all the variables included in the global model. These weights $\tilde{w}_i$ are calculated based on the average of the bilateral trade and financial flows for the full sample period, 1993Q1–2011Q2.[5]

$$w_{ij} = \frac{1}{2}\left[\left(\frac{imports_{ij} + exports_{ij}}{\sum_{j=1}^{n}(imports_{ij} + exports_{ij})}\right) + \left(\frac{inflows_{ij} + outflows_{ij}}{\sum_{j=1}^{n}(inflows_{ij} + outflows_{ij})}\right)\right] \quad \forall \; i, j \neq i$$

- $imports_{ij}$ = imports of i from country j.
- $exports_{ij}$ = exports of i to country j.
- $inflows_{ij}$ = FDI inflows of i from country j.
- $outflows_{ij}$ = FDI outflows of i to country j.
- $\sum_{j=1}^{n}(imports_{ij} + exports_{ij})$ = sum of all exports and imports of country i to and from all other countries in the global model.

The values of the different weight schemes are reported in Table 2. These bilateral trade and financial flows are retrieved from the IMF Direction of Trade Statistics database. From the values seen in this table, Singapore and the US are focal points of trade and financial flows for the ASEAN-5 countries across the three different weighting schemes. Interestingly, while it is expected that the US economy is an important economic partner for the ASEAN-5 economies, Singapore outweighs China as a combined trade and financial partner for the ASEAN-5 countries.

Each of the variables used in the GVAR model was tested for unit roots. The results of the Augmented Dickey–Fuller, Philips–Perron and KPSS tests show that these variables each contain a unit root; they are all $I(1)$ variables. Therefore, there may be cointegrating relationships present among them in the system. This is explored in the next section.

3.1. Structural and preliminary test considerations

3.1.1. Cointegration test

Since the unit root test results find that all variables are integrated of order 1, there may be cointegrating relationships that will need to be modelled. The cointegrating VAR with weakly exogenous regressors (CVARX) used in the country-specific models is able to distinguish between short-run and long-run dynamics. Consequently, it is possible to further exploit the long-run dynamics by identifying what these long-run relationships might be in each of the country-specific models. Macroeconomic theory provides possible long-run relationships present in the data and if they are found, these long-run theoretical relationships would provide a structural interpretation of the dynamics in these models. Based on the variables included for each country, three long-run relationships from theory are considered:

1. PPP: Productivity-biased purchasing power parity (Harrod–Balassa–Samuelson).
2. GAP: Conditional output convergence.
3. UIP: Uncovered interest parity condition.

The way in which these three long-run theories are tested for can be summarized as follows:

$$PPP: \quad P_{i,t} - P^*_{i,t} - E_{i,t} = b_{i0,1} + b_{i1,1}t + b_{i2,1}d_{i,t} + \varepsilon_{i1,t+1}$$
$$GAP: \quad Y_{i,t} - Y^*_{i,t} = b_{i0,2} + b_{i2,2}d_{i,t} + \varepsilon_{i2,t+1}$$
$$UIP: \quad R_{i,t} - R^*_{i,t} - E_{i,t} = b_{i0,3} + b_{i2,3}d_{i,t} + \varepsilon_{i3,t+1}$$

[5] Other weighting schemes were also tested. Specifically, equal weights and bilateral trade flows only as weights were explored. Compared to the weights used in this paper (the average of both their bilateral trade and financial flows), the impulse responses generated were not significantly different. The responses differ mainly due to differences in scaling. There were a few instances in the exports, imports, exchange rate and interest rate responses that exceeded a difference in scale, however, this is to be expected. Compared to equal weights, adding trade weights affected the responses of exports, imports and exchange rate variables while adding on financial flows to the weights, as was used in this paper, changed the interest rate responses.

Table 2
Weights for constructing the weakly exogenous foreign variables.

j = partner\ i = main	Indonesia	Malaysia	Philippines	Singapore	Thailand
Weight Scheme 1 (ASEAN-5, China and US), $w_{1,ij}$ to construct $Y^*_{i,t}$					
Indonesia	0.000	0.040	0.024	0.120	0.040
Malaysia	0.112	0.000	0.055	0.247	0.084
Philippines	0.016	0.020	0.000	0.025	0.032
Singapore	0.347	0.375	0.208	0.000	0.352
Thailand	0.062	0.056	0.043	0.055	0.000
China	0.182	0.088	0.102	0.103	0.119
US	0.281	0.421	0.569	0.450	0.373
Total	1.000	1.000	1.000	1.000	1.000
Weight Scheme 2 (ASEAN-5 only), $w_{2,ij}$ to construct $P^*_{i,t}$					
Indonesia	0.000	0.081	0.067	0.297	0.090
Malaysia	0.210	0.000	0.150	0.545	0.187
Philippines	0.031	0.041	0.000	0.048	0.068
Singapore	0.643	0.767	0.671	0.000	0.655
Thailand	0.117	0.112	0.112	0.110	0.000
Total	1.000	1.000	1.000	1.000	1.000
Weight Scheme 3 (ASEAN-5 and US only), $w_{3,ij}$ to construct $R^*_{i,t}$					
Indonesia	0.000	0.047	0.028	0.132	0.051
Malaysia	0.138	0.000	0.063	0.283	0.106
Philippines	0.021	0.024	0.000	0.030	0.039
Singapore	0.421	0.407	0.230	0.000	0.379
Thailand	0.077	0.066	0.049	0.065	0.000
US	0.344	0.456	0.630	0.489	0.425
Total	1.000	1.000	1.000	1.000	1.000

Source: IMF Direction of Trade Statistics database.

The analysis considers the theoretical long-run relationships in sub-samples using a single-equation autoregressive distributed lag (ARDL) bounds test by Pesaran, Shin, and Smith (2001).[6] This test attempts to determine if cointegration is present among the variables that would align with the PPP, GAP and UIP relationships considered. This finding would suggest that the data matches the theory.

The critical values for the *F*-statistic used in this test comes from Pesaran et al. (2001). The results are summarized in Table 3 and show that at least one of the three steady-state relationships described from theory is present in each domestic economy.[7] All three long-run relationships from theory hold true in Indonesia while both the GAP and UIP relationships are present in Malaysia and Thailand. The Philippines and Singapore have only one long-run relationship in their domestic economies. The PPP relationship holds in the Philippines while the GAP relationships is found for Singapore.

3.1.2. Structural break test

The global VAR approach hinges on the assumption of weak exogeneity of the y^* variables. Formal testing indicated that there was sufficient evidence of weak exogeneity. Testing for structural breaks is another consideration that needs to be made especially for the ASEAN-5 context. A CUSUM squared test was run and the following structural breaks were identified and accounted for in each CVARX model by including a dummy variable.

The Chow test and CUSUM test results reported varying break dates. From the historical economic context and by consulting the graphs of the data series, the following break dates in Table 4 were used. They are broadly consistent with the break dates used in other studies.[8]

3.1.3. Weak exogeneity test

The estimated model requires the assumption of weak exogeneity. The test was run for each estimated country *i* model according to Johansen (1992) and Harbo, Johansen, Nielson, and Rahbek (1998). This procedure involves testing for joint significance in the error-correction terms, $\varepsilon_{i,t-1}$ using an *F*-test for all the foreign variables marked by * and world oil prices which are included in vector *x*.

[6] The Johansen cointegration test also identified the presence of cointegration among these variables but from a structural interpretation perspective, these ARDL cointegration test results are more meaningful.

[7] Persistence profiles developed by Pesaran and Shin (1996) were checked. They show that the impact of a system-wide shock to each of these long-run relationships dies away, suggesting that they are stable.

[8] Greenwood-Nimmo et al. (2012) choose the following breaks: Indonesia (1997Q3), Malaysia (1997Q3), Philippines (1997Q4), Singapore (none), Thailand (1997Q3).

Table 3
ARDL bounds test results.

	F-statistic	95% lower bound	95% upper bound	ARDL(*p*, *q*, *r*)
Indonesia				
GAP	9.99**	3.23	4.35	ARDL(1,1)
PPP	4.96**	2.81	3.76	ARDL(2,1,2)
UIP	4.43**	2.86	4.01	ARDL(2,1)
Malaysia				
GAP	8.94**	3.23	4.35	ARDL(2,1)
PPP	1.79	2.81	3.76	ARDL(1,1,1)
UIP	6.38**	2.86	4.01	ARDL(1,1)
Philippines				
GAP	1.16	3.23	4.35	ARDL(2,1)
PPP	3.20*	2.81	3.76	ARDL(1,1,1)
UIP	2.48	2.86	4.01	ARDL(2,1)
Singapore				
GAP	3.74*	3.23	4.35	ARDL(1,1)
PPP	2.04	2.81	3.76	ARDL(1,2,1)
UIP	2.82	2.86	4.01	ARDL(1,1)
Thailand				
GAP	7.10**	3.23	4.35	ARDL(1,2)
PPP	2.30	2.81	3.76	ARDL(1,1,1)
UIP	4.46**	2.86	4.01	ARDL(1,1)

Table 4
Structural break dates.

Indonesia	1998Q1
Malaysia	1997Q4
Philippines	1998Q1
Singapore	1998Q1
Thailand	1997Q3

For each element l in vector x, the following regression is run:

$$\Delta x_{it,l} = \mu_{i,l} + \sum_{j=1}^{r_i} \gamma_{ij,l} \varepsilon^{j}_{it-1,l} + \sum_{k=1}^{s_i} \varphi_{ik,l} \Delta y_{it-k,l} + \upsilon_{i1,l} \Delta x_{it-1,l} + \zeta_{it,l}$$

The idea behind this test is that the weakly exogenous variables in vector x are long-run forcing but are not affected by the disequilibrium in the system. Table 5 summarizes the results for this test. There were a few isolated cases where weak exogeneity did not hold but for the most part, this assumption was supported by the data.

4. Results

Before constructing the global model, the estimates from each of the country-specific models were examined. Specifically, the contemporaneous effects of the foreign variables on the respective set of domestic variables were checked. These estimates are reasonable. For example, foreign output has a positive and significant impact on all domestic output for all countries except for Indonesia, where the result was found to not be significant. It also significantly affects trade variables such as exports and imports contemporaneously which suggests that there may be a link between foreign output and domestic output through trade. This understanding is consistent with the extensive literature on the emerging regional production network among these countries. In addition to this, the impact elasticity of the world oil price is significant for most variables in each of the ASEAN-5 economies, with the exception of the Philippines for which the effect is not significant. This is expected since the statistics in Table 6 show that the Philippines has the lowest oil usage intensity and is the least reliant on the trade of oil out of all the ASEAN-5 economies.

The next section uses Generalized Impulse Response Functions (GIRFs) to examine the relationships between the global variables and each of the domestic variables. Following which, the Generalized Forecast Error Variance Decompositions (GFEVDs) will identify the main drivers of variation in two key variables – output and prices.

4.1. Generalized impulse response functions (GIRFs)

Figs. 1–4 summarize the GIRFs for the ASEAN-5 domestic variables over 40 quarters (10 years). It was verified that these responses to shocks settle at an equilibrium value.

Table 5
Test for weak exogeneity.

	Y^*	P^*	R^*	Oil
Indonesia, $F(3,63)$	0.9956	4.4819*	5.1125*	0.4296
Malaysia, $F(4,62)$	3.8299*	0.3864	1.7565	0.9512
Philippines, $F(3,63)$	1.0628	2.8457	1.5353	1.2194
Singapore, $F(3,63)$	2.6523	2.9972	6.3099*	2.7756
Thailand, $F(5,61)$	1.7452	2.8505*	1.1198	3.7712**

* Significance at the 95% level.
** At the 99% level.
$F(r, T-k)$: r is the number of cointegrating relationships, k is the number of regressors in the unrestricted model and T is the number of observations.

Table 6
Oil usage statistics for ASEAN-5.

	Oil intensity[a]	Oil production[b]	Oil imports	Oil exports	Net imports/exports
Indonesia	4.45	1,030,000	767,400	404,100	363,300
Malaysia	3.52	716,000	355,300	644,900	−289,600
Philippines	3.31	33,110	338,400	60,460	277,940
Singapore	6.76	10,910	2,052,000	1,374,000	678,000
Thailand	5.40	406,800	807,100	269,100	538,000

[a] Million barrels of oil equivalent per GDP in billions of 2005 U.S. dollars.
[b] Barrels of oil per day.
Source: Oil intensity statistics from IMF's WEO Oct 2010 report.
Oil Imports and Exports from CIA World Factbook, 2009 figures.

Since the GIRFs settle down eventually, these graphs suggest that the system is stable.[9] There is no clear ordering specified by economic theory. Hence, the impulse response function describes the net effect of a system-wide shock that increases the level of a specific variable in the system, on each of the other variables, after all the interactions and spillovers have taken place. The following subsections describe the pattern of responses to each global shock explored: a US monetary policy shock, a US output shock, a Chinese output shock and a world oil price shock. The responses for each of the variables (output, prices, exports, imports, exchange rates, interest rates) are examined across the countries. If the GIRFs from a common shock are observed to increase or decrease together, this is interpreted as evidence of symmetry. Since policy stabilisation is employed to address the short-run trade-off between inflation and output, policy coordination would target the short-run effects rather than the long-run effects of a shock. Therefore, a distinction is made between short-run and long-run asymmetries experienced in the responses to a common shock.

4.1.1. Shock to US interest rate

A system-wide shock that displaces any of these variables in the system by one standard error produces GIRFs that are invariant to the ordering of the variables in the system, unlike their Orthogonalized Impulse Response Function (OIRF) counterpart. With the GIRFs, examining a shock that increases US interest rates is not the same as examining a US monetary policy shock which would be the case with OIRFs, since there is a particular ordering as to when each variable is affected by the shock. Pesaran and Shin (1998) shows, however, that this is possible as there exists a relationship between the GIRFs and OIRFs. The set of GIRFs generated for a shock to the first variable in the system is equivalent to the OIRFs generated for a shock to this same variable (Pesaran & Shin, 1998). Therefore, since the US interest rate variable is the very first variable in the GVAR, these GIRFs are equivalent to its OIRFs. A shock to the US interest rate can equivalently be understood as a US monetary policy shock since this variable is affected by the shock before the other variables in the global model. Fig. 1 shows how a shock that increases the US interest rate by one standard error affects the ASEAN-5 economies. A one standard error shock causes US interest rates to increase by 0.45 percentage points.

The effect of an increase in the US interest rate for the purposes of monetary policy immediately raises US output which continues into the long run and permanently raises the level of output in each of the ASEAN-5 economies. The result of symmetry is similarly replicated in the exports and interest rate responses where these variables experience a short-run and long-run increase due to a rise in US interest rates. The GIRFs allow for responses to spillover effects as well, and so they describe the net effect after all of these interactions have occurred. This result, while initially counterintuitive, is not unlikely since contractionary monetary policy has the effect of reducing the US price level but upon inspection, US output still

[9] The stability condition related to the eigenvalue of the companion matrix was also checked, as was done in di Mauro and Pesaran (2013, pp. 26–27).

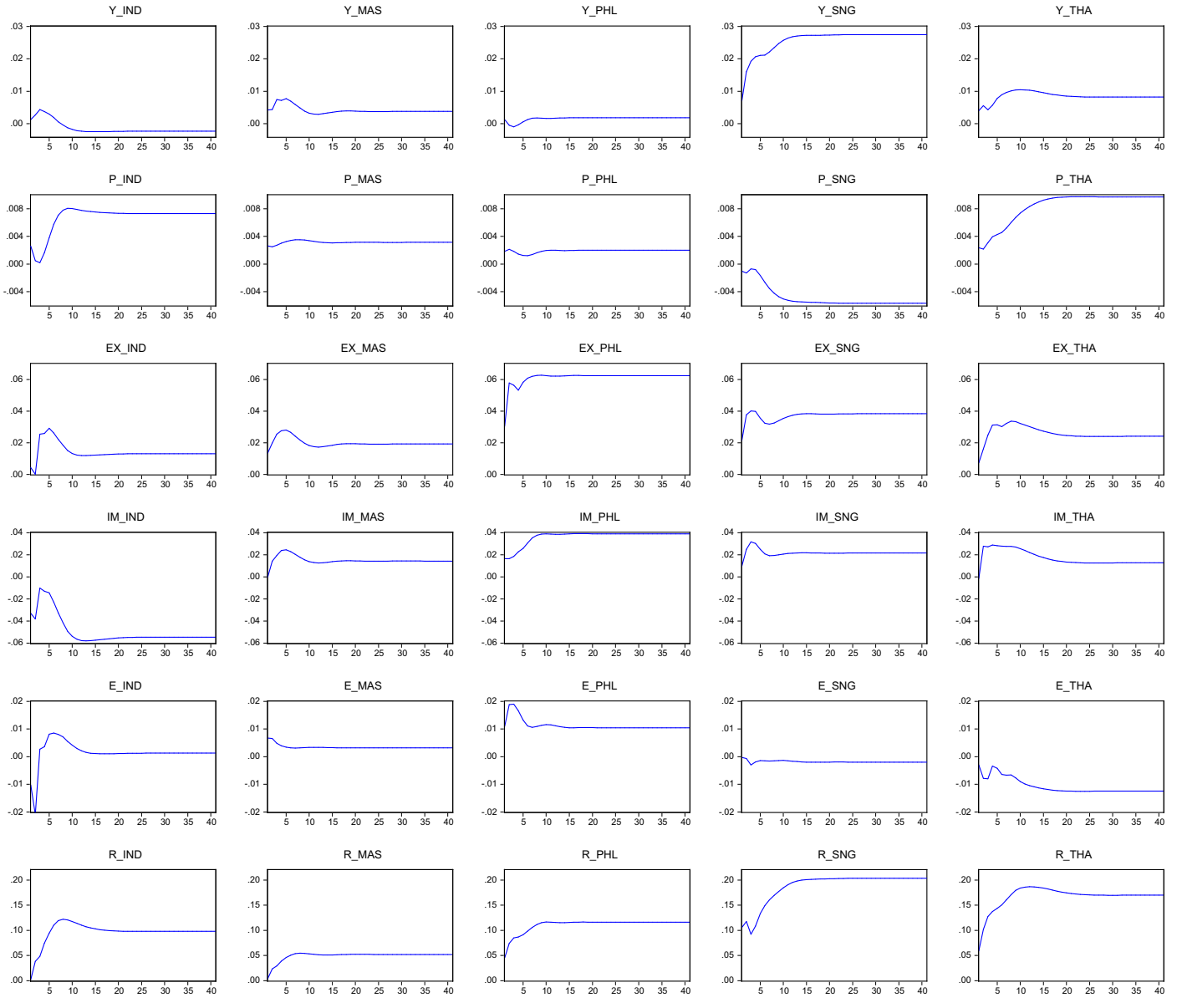

Fig. 1. Generalised impulse responses from a 1 s.e. shock to US interest rates.

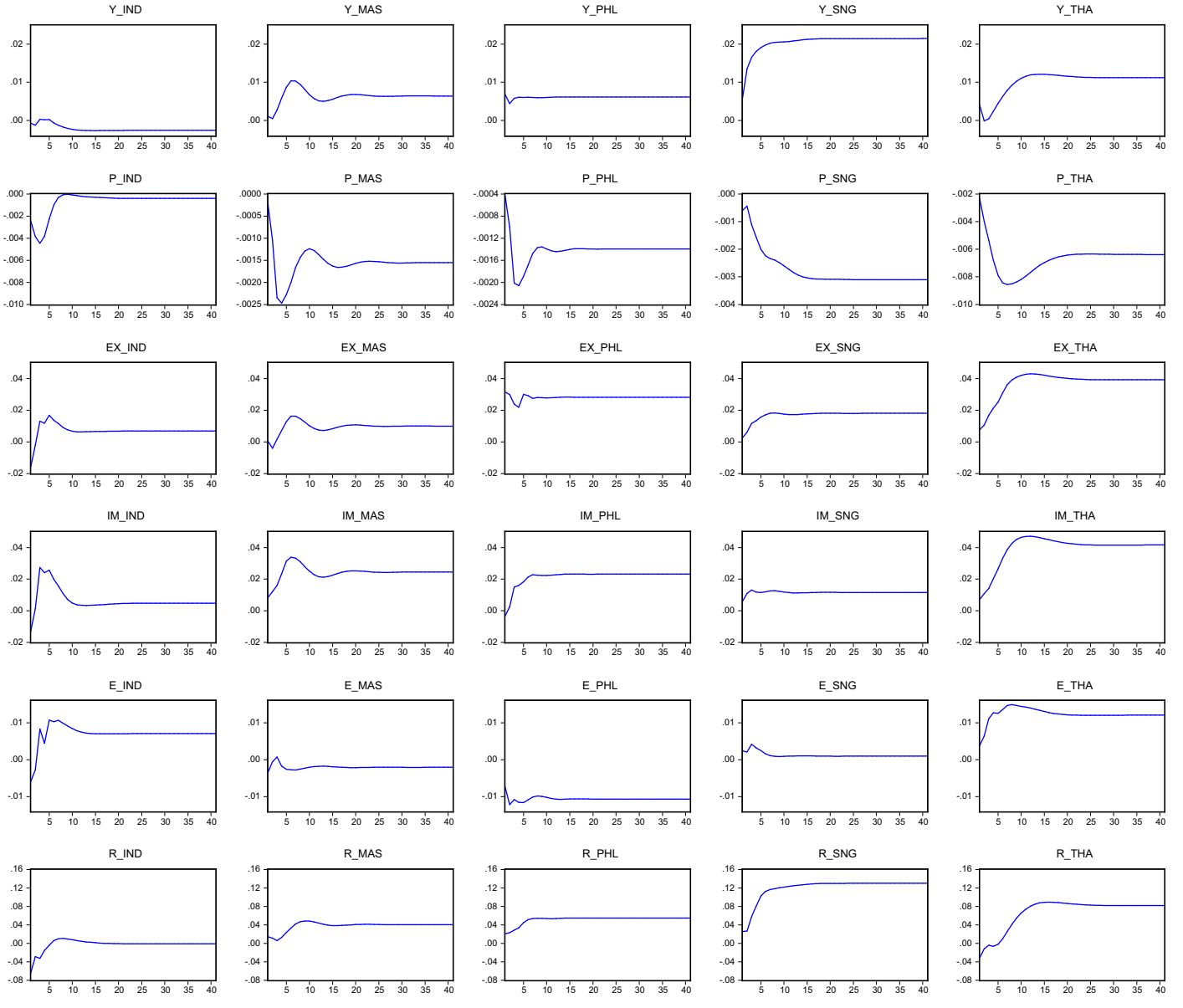

Fig. 2. Generalised impulse responses from a 1 s.e. shock to US output.

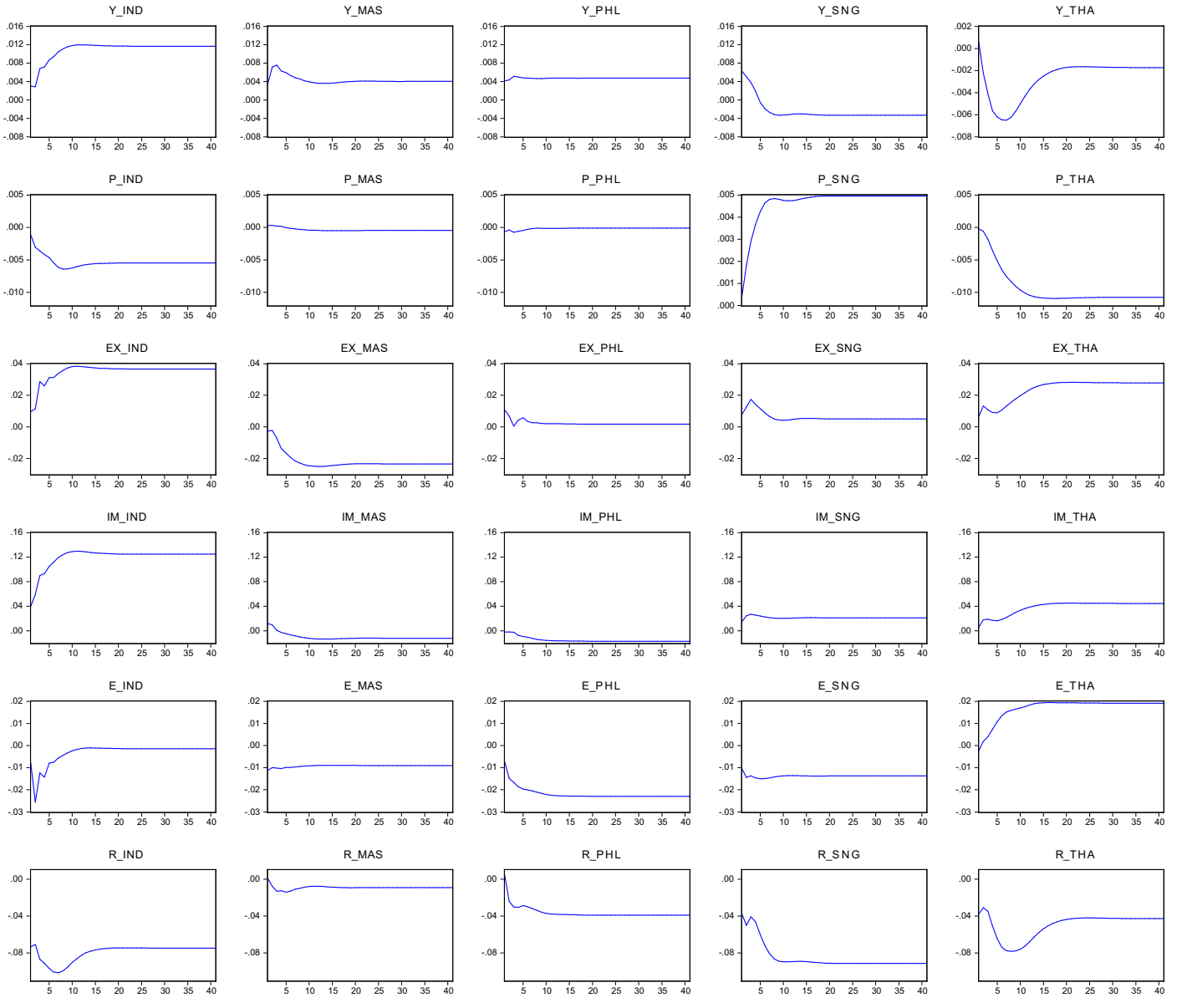

Fig. 3. Generalised impulse responses from a 1 s.e. shock to China's output.

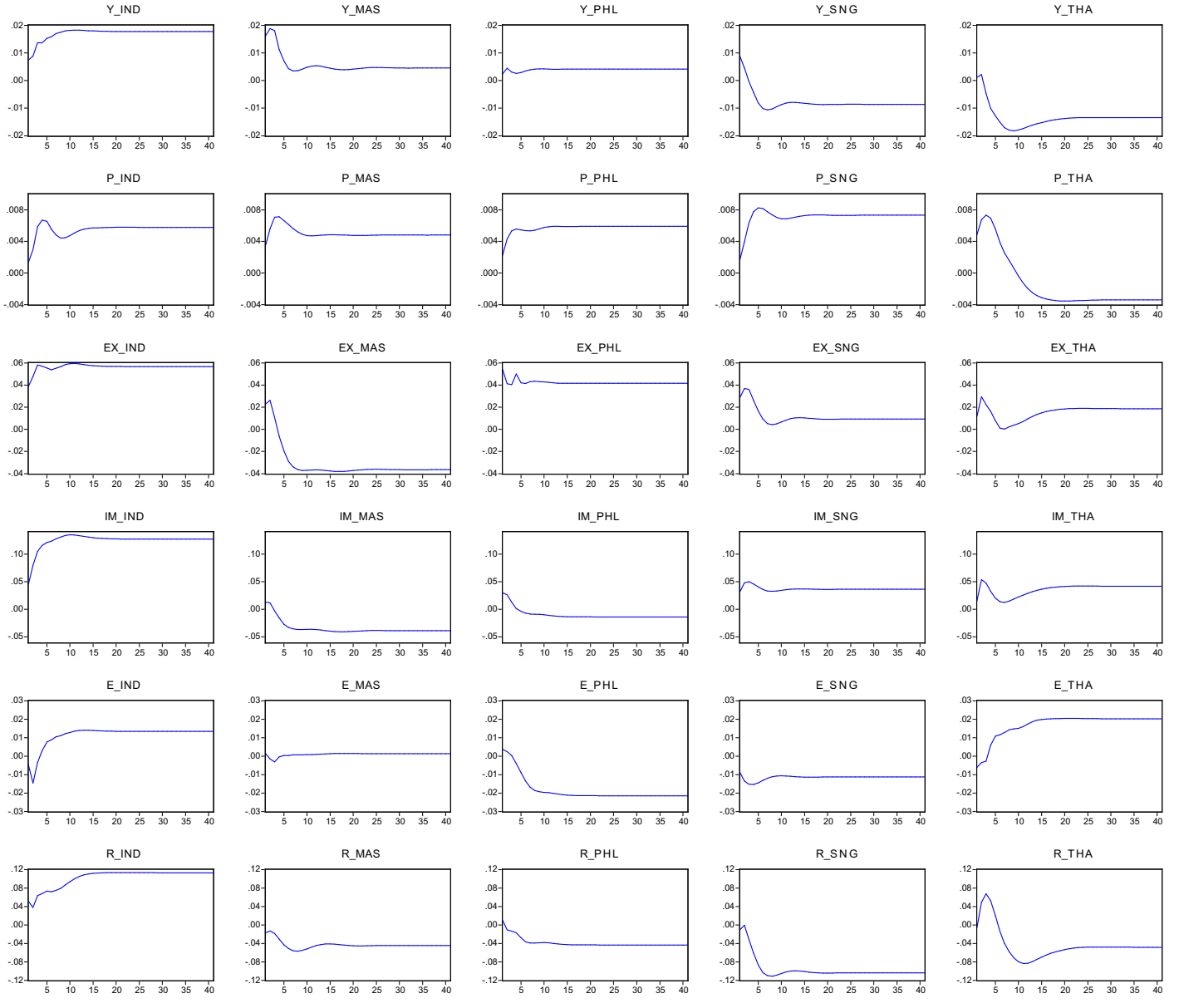

Fig. 4. Generalised impulse responses from a 1 s.e. shock to oil prices.

continues to rise, albeit at a slower pace. Therefore, this rise in US output could potentially increase output in the ASEAN-5 economies as well.

The price responses for the ASEAN-5 economies to a US interest rate increase are symmetric, with the exception of Singapore's response. Singapore experiences a permanent fall in its price level while the other four economies see an increase in their price levels in both the short and long run.

The imports responses suggest weak evidence of symmetry. While the imports of the ASEAN-5 rise as a result of the increase in US interest rates, Indonesia's imports decrease to a lower level than before the shock, creating some asymmetry in the longer run. The five countries' exchange rate responses are the most diverse of all the variables' responses to a shock to US interest rates. Singapore's exchange rate variable is the least responsive but this is expected since Singapore is the only country among them that engages in exchange-rate targeting as described in MAS (2010). In the long run, the GIRFs show that Thailand's baht and Singapore's dollar depreciate while the currencies of all other countries appreciate. However, the long-run change in Indonesia and Singapore is small.

It is an interesting result that an increase in the US interest rate, which can be interpreted as a tightening of monetary policy, would also increase the interest rates in each of the ASEAN-5 economies. One explanation of this result might be that the US economy functions as a common lender. This credit channel creates financial linkages between the ASEAN-5 countries and the US. As the cost of borrowing increases with a rise in the US interest rate from the shock, so too does the cost of credit in each of the ASEAN-5 economies. This is reflected in the interest rate responses for each of the five economies to a US monetary policy tightening in the form of an interest rate increase. This outcome is consistent with the results from the study by Mackowiak (2007). Here, the author finds that the interest rate in emerging economies such as the ASEAN-5 increase as a result of tighter monetary policy in the US (Mackowiak, 2007).

4.1.2. Shock to US output

The responses in the ASEAN-5 economies to a system-wide shock that increases US output by one standard error, or approximately 0.9% is summarized in Fig. 2. Compared to their output and trade variables' responses to a shock to US interest rates, the responses of the ASEAN-5 macroeconomic variables are less symmetric. There are, nevertheless, still many instances when they do respond in a similar manner to this shock, particularly in the long run.

The price level responses in the ASEAN-5 are symmetric; they all see a decrease in their price levels. The long-run responses to the trade variables, exports and imports, are also symmetric. All countries see their exports and imports increase as a result of a system-wide shock that increases US output by one standard error. While there was some symmetry in the ASEAN-5 economies' output responses, Indonesia's output response differed from the rest of the group in both the short run and long run.

Of particular interest in Fig. 2 is Singapore's exchange rate GIRF that is found to be relatively unresponsive once again. This is similar to what was found in its exchange rate response to a shock to US interest rates and is likely due to the same reason; Singapore uses an exchange rate target rather than an inflation target to maintain domestic price stability (MAS, 2010). This lack of response is made up for in Singapore's interest rate variable that sees a large increase due to the same shock. Overall, the interest rate responses in the ASEAN-5 economies are symmetric in the long run. In the short run, Indonesia's interest rate response creates some asymmetry as it decreases before increasing to its long-run equilibrium level.

4.1.3. Shock to China's output

Fig. 3 shows the responses of the ASEAN-5 economies to a system-wide shock which increases China's output by one standard error, or approximately 1.6%.

Overall, the variables were less sensitive to an increase in China's output. This can be seen particularly for the Philippines; its output, price, exports and imports responses are relatively muted compared to the other countries' responses for these same domestic variables. Any evidence of symmetry among the responses of the ASEAN-5 economies to this shock is found mainly in their interest rate responses and to a limited extent, their exchange rate responses. Their interest rate responses are clearly symmetric as they all experience a fall in their domestic interest rates in both the short run and long run, owing to this shock. The evidence of symmetry in their exchange rate responses is weak; all the local currencies experience an appreciation with the exception of the Thai baht, following an increase in China's output.

4.1.4. Shock to oil prices

Fig. 4 summarizes the responses in the ASEAN-5 economies from a system-wide shock that increases world crude oil prices by one standard error, which is approximately 14%.

According to Osorio and Unsal (2013), domestic prices in the ASEAN-5 are significantly affected by oil prices. The GIRFs provide some evidence consistent with their finding. An increase in world crude oil prices raises the price levels in all their economies except for Thailand, where there is an increase in the short run but this eventually leads to a reduction in their price level to a point that is below the original level before the shock. One might suspect that monetary policy might be at play as there is also an equivalent increase in their domestic interest rate in the short run. This too, eases off in the long run to a level that is below the rate prior to the shock.

The short-run response to an oil price increase was symmetric in the ASEAN-5 economies' output and trade variables. The output responses were all positive in the short run but in the long run the output levels in Singapore and Thailand eventually fall to a level below the original pre-shock levels. Similarly, exports and imports see an increase in response to this shock but

in the longer run, Malaysia's trade variables fall to a value that is lower than the original level prior to the shock. Meanwhile, the other countries maintain the gain in exports and imports into the long run.

4.2. Generalized forecast error variance decomposition

One of the main aims of macroeconomic policy is to achieve full employment while also stabilising domestic prices. Therefore, it would be useful to determine whether the output and prices in the ASEAN-5 economies are driven by the same factors since successfully implementing and coordinating macroeconomic policies would mean that their needs for full employment and stable domestic prices can be met. To determine what the main drivers of output and prices are, Generalized Forecast Error Variance Decompositions (GFEVDs) were computed. Table 8 summarizes the contribution of regional prices and global factors to each of their domestic price levels.

4.2.1. Price variance decomposition

Domestic factors drive price variation in Indonesia and the Philippines. Specifically, imports account for 11% of price variation in Indonesia by the 5th year, and the domestic exchange rate is the main driver of prices in the Philippines explaining 10% of its variation in the longer run. These results are not surprising since household consumption takes up a large proportion of output in Indonesia and the Philippines, as can be seen in Table 7. The measure of household consumption as a share of total output shows the importance of consumption in each economy. The average household consumption share of output was largest in the Philippines, accounting for 73% of output over the period of the data span, 1993–2011. Indonesia's share of household consumption was the second largest, taking up 60.75% of its total output. These ratios are large compared to the same measures for consumption in Malaysia, Singapore and Thailand that take up only 40–55% of their total output.

Furthermore, according to IMF (2012) and ADB (2013), the domestic consumption in Indonesia fuels its economic growth. Imports drive domestic prices because imported goods sustain and add variety to Indonesia's domestic consumption. Ito, Sasaki, and Sato (2005) finds that there is a large and significant degree of exchange rate pass-through to both inflation and import prices in this region. It is therefore unsurprising that imports, exports and Indonesia's own exchange rate form the top drivers of price variation in its economy. In the case of the Philippines, the price variance decomposition in Table 8 is consistent with the findings in Cortinhas (2009). Cortinhas (2009) finds that out of all the ASEAN-5 economies, the Philippines experiences the largest exchange rate pass-through to domestic inflation. Unsurprisingly, the domestic exchange rate for the Philippines is the top contributor to domestic price variation.

The price variations in Malaysia and Thailand are best explained by economic variables in Singapore. Since trade dominates Singapore's economy, particularly its imports of consumables from Malaysia, it is not surprising that the price level in Singapore heavily drives the price variation in Malaysia (CIA, 2012). The contribution is notably large; up to 77% of Malaysia's price variation is accounted for by Singapore's price movements in the 2nd year and this value drops to 30% in the 5th year. The trade linkage between Singapore and Thailand, however, is not as strong as that between Singapore and Malaysia. Even so, the results indicate that output in Singapore is a main driver of price fluctuations in Thailand. This may also be due to global factors. US output movements are a close second when it comes to factors that contribute to Thailand's price variation. Even though the size of the US output contribution is not as large, it is close to the proportion by which Singapore's output drives price variation in Thailand.

Singapore targets its exchange rate rather than inflation. Therefore, shocks that change its terms of trade and have an impact on its exchange rate would affect domestic prices as well. Oil prices may be such a factor since oil plays a key role in the Singapore economy. According to BP (2008), Singapore is one of top three export refining centres in the world and therefore, the result that its domestic prices are driven largely by oil prices is not unexpected.

4.2.2. Output variance decomposition

Table 9 highlights results from the output variance decomposition for the ASEAN-5. Once again, Indonesia and the Philippines are largely driven by domestic factors; interest rates drive output in Indonesia while exchange rates explain output movements in the Philippines. The size of the contributions are approximately equal. These domestic factors contribute the most to output variation in the 2nd year. Interest rate movements in Indonesia account for up to 25% of its output variation while the exchange rate in thePhilippines explains up to 28.6% of its output variation in the second year. While domestic factors are the primary drivers of the price level in Indonesia and the Philippines, migrant remittances are a likely contributor to this result as well.

These GFEVDs show that domestic imports are the largest driver of Malaysia's output variation. Imports form an important source of inputs into its production process especially for the production of exports within the regional production network and therefore, would feature heavily in the dynamics of its economy. Since Singapore and Thailand are also part of this regional production network, the main drivers of their output fluctuation can be understood based on this economic characteristic. The regional production network caters for external demand from economies such as the US. According to Abonyi (2012), approximately 71% of final manufactured goods exported from this region are bound for developed economies like the US. Therefore, movements in factors affecting this demand such as US monetary policy (reflected in its interest rate) would significantly affect the ASEAN-5 domestic output levels as well. Table 9 shows that the US interest rate is the most important driver of output fluctuations in Singapore.

Table 7
Household consumption as a share of GDP (%).

	Indonesia	Malaysia	Philippines	Singapore	Thailand
1993	53.04	48.29	72.93	44.23	54.67
1994	54.10	48.14	71.41	43.64	53.97
1995	55.82	47.92	71.31	41.39	53.17
1996	56.53	46.03	70.64	40.90	53.78
1997	55.91	45.35	69.99	40.13	54.66
1998	61.44	41.56	72.47	39.43	54.15
1999	69.08	41.58	72.75	42.01	55.96
2000	61.65	43.75	72.20	41.94	56.13
2001	63.15	46.12	73.63	45.66	57.29
2002	67.62	45.01	73.90	46.31	57.24
2003	68.14	44.58	74.35	45.45	57.22
2004	66.77	44.00	74.50	42.11	57.19
2005	64.36	44.19	75.01	40.13	57.25
2006	62.67	44.34	74.59	38.77	55.82
2007	63.54	45.15	73.48	37.27	53.43
2008	60.62	44.71	74.34	40.24	55.06
2009	58.70	48.84	74.67	40.15	55.23
2010	56.61	47.50	71.55	38.39	53.73
2011	54.58	47.50	73.72	39.37	54.49
Average	60.75	45.50	73.02	41.45	55.29

Source: EIU database.

Table 8
Generalised forecast error variances: ASEAN-5 prices.

Year	P_{IND}	P_{MAS}	P_{PHL}	P_{SNG}	P_{THA}	Y_{CHN}	Y_{US}	P_{OIL}	P_{US}	Max (%)	Source
Indonesia											
0	30.5262	2.9060	3.6032	5.9864	2.7727	0.0758	0.0236	0.0072	0.0003	30.5262	P_{IND}
1	2.8046	2.1114	2.1362	3.1255	2.6488	0.2772	0.1686	0.7621	0.0769	8.3994	Y_{IND}
2	2.4016	2.8539	2.5319	5.9136	4.1546	0.2528	0.2204	4.5143	0.7909	8.4254	IM_{IND}
3	2.1902	2.8478	2.5965	6.9644	4.5157	0.2290	0.4178	4.7304	0.8176	9.8528	IM_{IND}
4	2.1765	2.7608	2.6242	7.9075	4.7282	0.1457	0.7302	4.1954	0.7278	10.6581	IM_{IND}
5	2.2253	2.6702	2.6358	8.7846	4.8717	0.0974	1.0601	3.6640	0.6450	11.1607	IM_{IND}
Malaysia											
0	0.6425	22.5141	5.0767	0.0019	4.8284	0.8663	0.8814	15.8482	10.6983	22.5141	P_{MAS}
1	1.4255	0.2784	0.3738	77.3920	0.4392	0.5149	0.2614	0.4262	0.3319	77.3920	P_{SNG}
2	3.2270	0.2810	0.5065	53.9747	0.6856	1.6674	0.5529	0.9164	0.5929	53.9747	P_{SNG}
3	3.7539	0.3229	0.6425	42.3913	0.8459	2.5017	0.9331	1.3693	0.8649	42.3913	P_{SNG}
4	3.9710	0.3482	0.7304	35.2740	0.9617	3.0356	1.3157	1.7656	1.0998	35.2740	P_{SNG}
5	4.0179	0.3628	0.7915	30.4492	1.0486	3.3904	1.7103	2.1382	1.3178	30.4492	P_{SNG}
Philippines											
0	3.9783	8.5678	30.8307	4.6891	11.2453	0.0067	0.5548	4.6774	1.9466	30.8307	P_{PHL}
1	1.8586	1.4456	1.3118	2.2762	1.3658	11.3471	0.6269	1.7219	1.4213	18.9813	E_{PHL}
2	2.2299	1.2814	0.9747	3.4186	1.1819	8.3473	0.4248	1.9758	1.4109	15.8811	E_{PHL}
3	2.3893	1.3434	0.9839	4.0245	1.2387	9.2549	0.5012	2.1769	1.5672	11.9191	E_{PHL}
4	2.4051	1.3439	0.9678	4.2478	1.2391	9.6967	0.5184	2.2167	1.6053	10.8688	E_{PHL}
5	2.3990	1.3328	0.9491	4.3753	1.2288	9.9748	0.5169	2.2260	1.6164	10.4228	E_{PHL}
Singapore											
0	1.3640	0.1128	0.8936	43.1685	0.6580	0.4174	0.1174	0.1462	0.1626	43.1685	P_{SNG}
1	1.4304	3.9056	2.1228	1.6312	2.1028	5.0941	3.8061	17.4562	0.6657	17.4562	P_{OIL}
2	0.2932	1.5982	1.0366	0.9038	0.8355	7.1547	4.2911	24.3843	1.3287	24.3843	P_{OIL}
3	0.1713	0.9998	0.8391	0.8713	0.5731	7.4297	5.3812	21.6079	1.0894	21.6079	P_{OIL}
4	0.1299	0.7686	0.7775	0.9108	0.4847	7.4409	5.6084	19.7341	0.9491	19.7341	P_{OIL}
5	0.1083	0.6317	0.7494	0.9689	0.4393	7.4141	5.4762	18.3558	0.8583	18.3558	P_{OIL}
Thailand											
0	2.5810	6.2498	8.7803	3.1003	26.5566	0.1747	3.3844	16.5398	7.1303	26.5566	P_{THA}
1	2.3759	3.1558	3.1082	1.9204	3.2584	3.2676	3.4986	3.2351	3.2328	8.0416	IM_{THA}
2	1.3443	3.4657	3.6419	0.7117	4.4742	1.7452	6.2199	4.5774	4.8501	11.9569	Y_{SNG}
3	1.1918	3.6640	3.9890	0.4910	5.1248	1.1043	7.4361	5.1645	5.5636	12.5169	Y_{SNG}
4	1.1542	3.9334	4.3631	0.3803	5.7332	0.8704	8.3481	5.7372	6.1807	11.2106	Y_{SNG}
5	1.1321	4.1577	4.6729	0.3134	6.2471	0.7392	9.0022	6.2222	6.6715	10.5794	Y_{SNG}

Table 9
Generalised forecast error variances: ASEAN-5 output.

Year	Y_{IND}	Y_{MAS}	Y_{PHL}	Y_{SNG}	Y_{THA}	Y_{CHN}	Y_{US}	P_{OIL}	Max (%)	Source
Indonesia										
0	59.9815	0.4754	1.2908	0.0652	0.9228	0.0084	0.1741	2.6041	59.9815	Y_{IND}
1	0.2884	1.0874	0.2273	9.0582	0.2319	1.4883	0.3072	0.2627	29.1639	EX_{SNG}
2	0.2996	0.3555	0.2760	1.1868	2.7493	1.4971	2.3577	0.3449	25.8670	R_{IND}
3	0.2067	0.1837	0.4483	0.6768	4.4405	1.5642	5.4412	0.2170	20.8724	R_{IND}
4	0.1634	0.3396	0.8019	1.3861	5.6635	1.8549	7.6107	0.1849	16.4207	R_{IND}
5	0.1491	0.6201	1.1731	2.1763	6.3840	2.0854	8.7784	0.2086	13.4053	R_{IND}
Malaysia										
0	0.2320	16.9397	4.2208	9.2638	2.1512	1.5622	0.1522	15.3721	16.9397	Y_{MAS}
1	0.8016	2.9127	3.0627	3.1612	3.2853	4.9408	1.2596	3.2304	8.0299	E_{MAS}
2	0.1318	3.0707	3.1950	4.2313	5.1117	5.3594	2.3225	3.0772	7.6178	R_{MAS}
3	0.0746	3.4178	3.6806	5.2501	6.1168	5.3419	4.2698	3.0330	7.8441	IM_{MAS}
4	0.0575	3.7609	4.1653	6.0590	6.6385	5.3769	5.7532	3.0903	8.5692	IM_{MAS}
5	0.0473	3.9867	4.4882	6.6803	6.9491	5.2919	6.9055	3.0687	8.9827	IM_{MAS}
Philippines										
0	0.6315	8.9761	23.6391	11.4919	3.5298	3.5413	8.0938	1.5533	23.6391	Y_{PHL}
1	1.0105	1.2692	1.1943	1.2897	1.4594	1.2793	1.2391	1.4520	24.6533	E_{IND}
2	0.4338	1.1432	1.2077	1.2876	1.8645	1.2250	1.4205	0.8056	28.6183	E_{PHL}
3	0.3699	1.4457	1.5911	1.6855	2.5373	1.5237	1.9283	0.7790	26.5544	E_{PHL}
4	0.3350	1.7183	1.9391	2.0393	3.0804	1.7789	2.3690	0.7775	24.6512	E_{PHL}
5	0.3092	1.9546	2.2494	2.3474	3.5208	1.9880	2.7498	0.7748	23.1120	E_{PHL}
Singapore										
0	0.4883	11.6258	5.4565	19.6281	4.0224	2.8408	2.2186	4.3829	19.6281	P_{SNG}
1	2.1077	3.3721	3.1693	2.9896	3.3413	3.2384	4.1923	4.1008	9.1091	R_{US}
2	1.1263	3.6313	3.3812	2.9842	3.6208	2.8490	6.4643	4.8696	19.9029	R_{US}
3	1.0926	3.6228	3.3330	2.8637	3.5524	2.7128	7.0358	5.1254	21.4765	R_{US}
4	1.1707	3.6204	3.2992	2.8157	3.5097	2.7406	7.0883	5.4351	20.9144	R_{US}
5	1.2532	3.6194	3.2690	2.7808	3.4720	2.8068	7.0409	5.7415	20.2570	R_{US}
Thailand										
0	0.6314	6.4935	4.4820	11.9634	30.8937	3.1273	2.7691	1.5182	30.8937	Y_{THA}
1	2.0973	2.8668	2.5442	2.6616	2.2821	3.0021	2.9712	4.3969	9.6045	P_{SNG}
2	0.7410	2.6904	2.7020	2.5445	1.6431	2.7318	6.4399	2.9688	12.7877	P_{IND}
3	0.3977	3.0309	3.3337	2.9115	1.5096	2.5582	10.4470	2.1023	11.3141	R_{US}
4	0.2568	3.3324	3.7607	3.2107	1.4661	2.4036	13.0517	1.6990	15.1438	R_{US}
5	0.1852	3.5700	4.0606	3.4656	1.4672	2.2877	14.7095	1.4595	17.5616	R_{US}

5. Discussion

In this paper, symmetric responses are defined as the observation of GIRFs responding in the same direction. Overall, the GIRFs present some evidence of symmetric responses to a common shock. However, this result is weak as it depends on the type of common shock. A shock from the US produces the greatest number of symmetric responses, followed by a shock to China's output or the world crude oil price. These results are summarized in Table 10.

Do these results suggest that policy coordination is feasible for the ASEAN-5 economies? The results do not support an unequivocal answer. On the one hand, the results indicating symmetry in the ASEAN-5 economies' responses to common shocks, though limited, suggests that policy coordination is feasible. Given that macroeconomic stabilisation policies are concerned particularly with managing the effects of shocks in the short run, the symmetry observed in the short run supports the feasibility of policy coordination among these five economies. On the other hand, the reasons for the lack of symmetry in particular responses will need to be addressed in order to feasibly pursue policy coordination, and achieve the aims of the AEC.

The lack of symmetry observed could be due to one of two causes especially since their domestic macroeconomic policy responses in the past are manifested in the GIRFs generated. It could be due to differences in their economic structures, or differences in the ways that they have addressed shocks to their domestic economies in the past. It would be useful to analyse this result further to determine what else needs to be discussed or changed among the the ASEAN-5 economies as they work together towards deeper economic integration.

The GFEVDs elucidate this matter by identifying that the output and price variables for the ASEAN-5 economies are driven by different factors, making them structurally different. Consistent with what was found by Osorio and Unsal (2013), domestic factors drive output and price variation in Indonesia and the Philippines. According to the GFEVDs, domestic factors also drive output fluctuations in Malaysia. Foreign factors however, drive Malaysia's price variation and both Singapore and Thailand's output and price movements. More specifically, Malaysia's price and Thailand's output and price variations are dominated by regional factors centered on Singapore, while Singapore's output and price fluctuations are driven by global variables such as US output or world crude oil prices. Therefore, consistent with the conclusions in Majuca and Pagaduan

Table 10
Summary of the GIRF results.

	R^{US} shock		Y^{US} shock		Y^{CN} shock		P^{oil} shock	
	Short run	Long run	Short run	Long run	Short run	Long run	Short run	Long run
Y^{IND}	+	–	–	–	+	+	+	+
Y^{MAS}	+	+	+	+	+	+	+	+
Y^{PHL}	+	+	+	+	+	+	+	+
Y^{SNG}	+	+	+	+	+	–	+	–
Y^{THA}	+	+	+	+	–	–	–	–
P^{IND}	+	+	–	–	–	–	+	+
P^{MAS}	+	+	–	–	=	=	+	+
P^{PHL}	+	+	–	–	=	=	+	+
P^{SNG}	–	–	–	–	+	+	+	+
P^{THA}	+	+	–	–	–	–	+	–
EX^{IND}	+	+	+	+	+	+	+	+
EX^{MAS}	+	+	+	+	–	–	+	–
EX^{PHL}	+	+	+	+	+	=	+	+
EX^{SNG}	+	+	+	+	+	+	+	+
EX^{THA}	+	+	+	+	+	+	+	+
IM^{IND}	–	–	+	+	+	+	+	+
IM^{MAS}	+	+	+	+	–	–	–	–
IM^{PHL}	+	+	+	+	–	–	–	–
IM^{SNG}	+	+	+	+	+	+	+	+
IM^{THA}	+	+	+	+	+	+	+	+
E^{IND}	–	+	–	+	–	–	+	+
E^{MAS}	+	+	–	–	–	–	=	=
E^{PHL}	+	+	–	–	–	–	–	–
E^{SNG}	=	=	+	=	–	–	–	–
E^{THA}	+	–	+	+	+	+	–	+
R^{IND}	+	+	–	+	–	–	+	+
R^{MAS}	+	+	+	+	–	–	+	–
R^{PHL}	+	+	+	+	–	–	–	–
R^{SNG}	+	+	+	+	–	–	–	–
R^{THA}	+	+	–	+	–	–	+	–

+ indicates an increase, – indicates a decrease; = indicates a lack of response.
SR = short run, LR = long run.

(2015), the GFEVDs suggest that the ASEAN-5 economies are prone to different types of shocks, which subsequently create differing policy response needs.

Complicating matters is the fact that these economies have approached stabilising their domestic economies differently in the past. Indonesia, the Philippines, and Thailand have committed to an explicit inflation target (Mishkin & Schmidt-Hebbel, 2002; Rose, 2007). However, Singapore maintains internal price stability through the use of an exchange rate target while Malaysia does so through an interest rate target coupled with a floating exchange rate regime (Poon & Lee, 2014). This suggests a potential problem in that Malaysia currently relies on the exchange rate mechanism to absorb and adjust to shocks while Singapore manages its exchange rates more rigidly. Whether these policy approaches are able to achieve both internal aims and still support regional interests needs to be further examined, but is beyond the scope of this paper.

While there are significant trade and financial linkages among the ASEAN-5 economies, the regional production network that defines their economic relationship is also heavily dependent on global economies like the US and China. The GIRFs suggest that while economies respond most symmetrically to shocks from the US, there is a lack of symmetry in their responses to a shock from China. From the trade perspective, the US economy continues to be an important source of demand for final goods produced in the region. However, the trade relationship between China and the ASEAN-5 economies is less clear. This is reflected in the lack of symmetry in their trade variables' responses even though these same variables respond symmetrically to the other shocks considered. The ASEAN-5 economies and China compete or complement each other depending on the labour-skill and technology intensity required in the production of a good according to Holst and Weiss (2004). The competitive nature of their economic relationship is evident in light of the rationale for creating the AEC to form a single market and stable production base so that the ASEAN economies can compete with larger emerging economies like India and China. Holst and Weiss (2004) states that although the ASEAN-5 countries appear to have an advantage in high-technology intensity goods which complement production in China, there is increased competitiveness in high labour-skill intensity products between China and the ASEAN-5 economies for market share in third-party markets. There are signs that China's economy will have to move away from being a low-cost workshop globally in the future as it continues to lose competitiveness. Between 2004 and 2014, its productivity-adjusted manufacturing wages increased by 187% (Sirkin, Zinser,

& Rose, 2014). As China rebalances its domestic economy and moves into the production of less labour-intensive goods, their currently complementary relationships will become increasingly competitive. As such, establishing a single market and production base within the ASEAN group will become even more crucial to the vitality of their regional economy.

Putting all of this together, the lack of symmetry due to differences in economic structures, coupled with differences in domestic policy approaches, do not bode well for further economic integration in the form of policy coordination. Where monetary and exchange rate policy coordination fails, one possible strategy to alleviate the asymmetries is to allow factors of production to move freely within the group as it has the potential to aid in the adjustment. This is consistent with the second wave of the OCA literature stemming from Mundell (1973) which is his lesser-known work. Adopting such an approach would enable the ASEAN-5 economies to handle the asymmetries that would otherwise crop up and persist into the long run.

Beyond the movement of goods and capital only, it is possible that the movement of labour could also be pivotal in the adjustment mechanism. Specifically, migrant remittances already play a very important role in the economies that are structurally different according to GFEVDs. These two economies, Indonesia and the Philippines, are two of the world's largest receivers of migrant remittances according to Migration (2011). Much has been written about the important role that these remittances play in economic development since it is largely used for household consumption (Migration, 2011). Since both Indonesia and the Philippines are driven by domestic factors, particularly private consumption according to IMF (2012) and ADB (2013), as opposed to foreign factors, these migrant remittances may have the potential to smooth out asymmetries that arise due to differences in economic structures. Yang (2008) finds that in the case of the Philippines, an adverse shock such as an exchange rate appreciation sees an increase in household remittances from overseas where the estimated elasticity of the remittances in pesos with respect to the exchange rate is 0.60. There are long-term benefits associated with these remittances as well in the form of enhancing human capital accumulation and entrepreneurship, while also increasing child educational expenditures (Yang, 2008). These benefits could facilitate inclusive growth in the region in line with the goals of the AEC.

Migrant remittances are possible only with labour mobility within the region. Although labour in the ASEAN region is as, if not more mobile than labour in some countries of the EU (Bayoumi & Eichengreen, 1994; Goto & Hamada, 1994); labour market integration still lags significantly behind financial and monetary integration efforts being pursued by ASEAN as a group. This is an area that the ASEAN economies should be developing, in tandem with all their other trade and financial integration efforts.

6. Conclusion

Using a GVAR model, this paper has analyzed whether the ASEAN-5 economies respond symmetrically to a common shock. This was done to determine if there is evidence to support further economic integration in the form of monetary and exchange rate policy coordination. While the results do present some evidence of symmetry in their responses which suggests that coordination efforts towards the AEC goals are possible, this result is weak. The result depends on the type of common shock. Shocks from the US economy produce the most symmetric responses followed by shocks to China's output and the oil price, where evidence of symmetric responses were limited in both cases. This result has significant implications for the areas in which the ASEAN-5 economies will need further policy dialogue and prioritization as they work towards establishing deeper regional integration. Specifically, attention should be given to the choice and use of policy adjustment tools and also regional labour market integration. Migrant remittances not only play an adjustment role in their macroeconomies but are also able to help with inclusive growth for the region as a whole.

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