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Abstract

This paper investigates the optimal exchange rate regime in a group of ASEAN countries, which minimises the adverse effects of foreign demand shocks on real output, the real exchange rate, price level and between-country income gap. Using a panel structural vector autoregressive model for small open economies, we show that the extent by which foreign demand shocks influence the between-country income gap depends on the exchange rate regime and the transmission channels through output, the price level and the real exchange rate. Our results show that a fixed exchange rate is better in insulating output and real exchange rates against adverse foreign demand shocks. Nevertheless, a flexible exchange rate regime achieves lower inflation and narrows the income gap across countries. Further, foreign demand shocks explain a larger portion of the forecast error variance of macroeconomic variables under a fixed than under a flexible exchange rate regime.

Keywords: foreign demand shock, exchange rate regime, ASEAN, income gap, panel SVAR.

JEL code: D33, E30, F31, F41, F33.

1. Introduction

Economic integration has played a crucial role in driving a widespread and prolonged global expansion, and sustaining growth in the face of recent shocks such as those arising from the global financial crisis. One example of economic integration is the Association of Southeast Asian Nations (ASEAN) which is made up of ten countries in southeast Asia, namely Brunei, Cambodia, Indonesia, Lao PDR, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam. This organization established the ASEAN economic community (AEC) which came into effect in December 2015 with the aim of achieving closer regional economic integration. One of the pillars underpinning the AEC is achieving equitable economic development; that is the benefits of regional integration are distributed equitably to member countries. ASEAN countries pledged to ensure that the development gap, in particular the income gap between member countries, is to be reduced (McGillivray & Carpenter 2013)[1]. The AEC also seeks to maintain regional macroeconomic and financial stability, an open market and for the region to be fully integrated into the regional and world economy.

A salient feature of the ASEAN countries is that they are high in trade openness. High trade openness makes ASEAN economies highly vulnerable to external shocks potentially causing economic instability (Loayza and Raddatz 2007). It has been widely regarded by the International Monetary Fund (IMF), the World Bank and highlighted in the United Nations Conference on Trade and Development (UNCTAD) that external shocks impinge negatively on the economic growth of developing countries and cause macroeconomic instability (Raddatz 2007). More importantly, external shocks can lead to wider income gaps amongst ASEAN countries thus posing serious threat to the success of the AEC in attaining one of its critical pillars for success - equitable economic development. A good example is that if an

[1] The income gap in this paper refers to the difference in income per capita between countries.

external shock such as a decrease in foreign demand hits one ASEAN country then it can lead to output volatility via its impact on the real exchange rate. As consequence, output volatility affects economic growth which in turn impacts the income gap between this country and other ASEAN countries.[2] As indicated in the World Economic and Social Survey (United Nations, 2006) the long-term growth performance of an economy is strongly affected by its macroeconomic stability. Therefore, while external shocks are considered short-run macroeconomic shocks, they can destabilise economies, affect long-run growth rates and widen or narrow between-country income gaps via their impacts on macroeconomic stability.

This study aims to shed light on the possible link between the exchange rate regime and the income gap through the destabilising effect of external shocks on the economy. Specifically, we expand the literature on the choice of exchange rate regime by focusing on countries which are part of an economic zone. Unlike Chia *et al.* (2012) who include all the ten ASEAN countries in a sample of 33 small open Asian countries, this study seeks to minimize the heterogeneity of the sample by focusing only on the ten ASEAN countries, which share common economic features and policy. In addition, our study of the ten ASEAN countries casts light on issues of integration and coordination policy so as to attain the AEC objectives of narrowing the income gap and ensuring macroeconomic stability.

In theory, and in practice, the exchange rate regime is an important instrument for insulating the economy from external shocks. Previous studies document that a flexible exchange rate regime is a real shock absorber because it induces lower output volatility than under a fixed exchange rate regime. Meade (1951), Friedman (1953) and Devereux (2004) point out that under an imperfect goods market (i.e. with price and wage stickiness), the speed of adjustment of relative prices between domestic and foreign goods depends on the exchange

[2] Masron and Yusop (2008) find that with the existence of external shocks, ASEAN countries have a larger income gap between them.

rate regime. In particular, they show that under a flexible exchange rate regime relative prices will adjust constantly through adjustment of the flexible nominal exchange rate. They find that a large adjustment of relative prices changes the domestic price of export goods, which in turn makes the movement of real output smoother and thus partially offsetting the adverse effect of the shocks. In contrast, they show that under a fixed exchange rate regime the adjustment of relative prices is much slower because it can only change at the permitted speed of the nominal exchange rate stickiness. Consequently, the negative effect of real shocks becomes greater.

Be that as it may, a fixed exchange rate regime can be a nominal shock absorber. Chia and Alba (2006) point out that under a fixed exchange rate regime, if money demand increases then the monetary authorities will intervene by buying foreign currencies to avoid an appreciation of the domestic currency. As a result the money supply increases and real output remains relatively unaffected. On the other hand they show that under a flexible exchange rate regime the domestic currency appreciates, which can lead to output contraction.

A number of studies, however, have not clearly pointed out which exchange rate regime is superior when dealing with shocks, because the outcome depends on a number of factors such as the type of shock, degree of economic openness and wage indexation, amongst others. Frenkel and Aizenman (1982) argue that the nature and the origin of shocks hitting a small open economy influence the choice of the optimal exchange rate regime. Furthermore, Flood and Marion (1982) find that the relative merit of a fixed or flexible exchange rate regime in reducing the loss in real output associated with foreign shocks depends on the optimal degree of wage indexation. In addition, Pilbeam (2004) concludes that the ranking of an exchange rate regime depends on a number of factors, including the priority that the authorities put on output or price stability, structural parameters such as income elasticity of demand, the degree of openness and the elasticity of aggregate demand to fluctuations in the real exchange rate

and real interest rate.

To the best of our knowledge, although direct links between external shocks on the income gap under different exchange rate regimes has not been investigated in the literature, there is some evidence of a possible indirect link between them. Levy-Yeyati and Sturzenegger (2003) point out, for example, that lower volatility of relative prices to shocks under a fixed exchange rate regime fosters investment and trade which then increases economic growth. They also show that lower price fluctuation under a fixed exchange rate regime results in a lower real interest rate, thus increasing economic growth. The relationship between output volatility and growth across exchange rate regimes has also been considered. In particular, greater output volatility to real shocks, which is caused by a fixed exchange rate regime, may lead to a higher saving rate which then stimulates investment and then growth (Aizenman 1994; Garey Ramey & Valerie A. Ramey 1995). However, Levy-Yeyati and Sturzenegger (2003) find that developing countries with a fixed exchange rate regime have an association between greater output volatility to terms of trade shocks and slower growth rates. Schiavo (2008) shows that income convergence is related to low volatility of the real exchange rate while income divergence is associated with high instability of the real exchange rate. Krugman and Taylor (1978) show that a real exchange rate depreciation is associated with an immediate decrease in domestic economy income in terms of foreign currency. Accordingly, a real depreciation may increase the income gap between domestic and foreign economies. To conclude, external shocks may have effects on between-country income gaps via its impacts on associated macroeconomic volatilities and growth through the choice of the exchange rate regime.

To classify exchange rate regimes, previous studies apply the *de facto* exchange rate

regime of Ghosh *et al.* (1997), Reinhart and Rogoff (2004) and Ilzetzki *et al.* (2008)[3]. Using a different exchange rate regime classification may lead to different results in regard to the superiority of exchange rate regime. In this study we apply the IMF's new *de facto* classification, which has not been employed before in classifying exchange rate regimes, and in so doing this study provides additional empirical evidence on the merits of different exchange rate regimes.[4]

Last but not least, while the type of shock affects the choice of the exchange rate regime, the link between a foreign demand shock and the choice of exchange rate regime is less clear. In this study the premise of our analysis is a foreign demand shock, which is regarded as a common shock for all countries (Dollar & Kraay 2004). Moreover, it is considered as a major external shock (Lindert & Pugel 1996) in light of the Global Financial Crisis (GFC) which has caused many countries, including the ASEAN economies, to face a dramatic decrease in foreign demand.

Using structural VAR for panel data of ten ASEAN countries for the period 1999-2014, this study compares the behaviour of output, real exchange rate, price level and between-country income gap to a negative foreign demand shock under a fixed and flexible exchange rate regime.[5] In addition, it examines the contribution of foreign demand shocks to the fluctuation of these variables under fixed and flexible regimes. The main empirical results show that ASEAN economies with a fixed exchange rate regime respond to a negative foreign demand shock with a smaller output contraction and more stable real exchange rate. However, after a negative foreign demand shock the reduction in the price level and income gap is larger in the case of a flexible exchange rate regime. The variance decomposition results

[3] See the studies of Broda (2004), Chia *et al.* (2012) and Zhang *et al.* (2014)

4 The IMF's *de jure* classification was reclassified into a *de facto* classification in 1998.

[5] Due to the accession of Cambodia to ASEAN in 1999, this year is chosen for the starting year of the dataset. In addition, data relating to some variables for Cambodia, Lao PDR, Myanmar and Vietnam are not available for the time period before 1999 and after 2014.

further corroborate that foreign demand shocks explain a larger portion of the fluctuations in the macroeconomic variables of ASEAN economies with a fixed exchange rate regime relative to those of a flexible exchange rate regime.

The remainder of this paper is organised as follows. In Section 2, we present the data description and empirical model for the ASEAN countries. Section 3 discusses the empirical results. The results from robustness tests are reported in Section 4. The main conclusions are presented in Section 5.

2. Data description and empirical model

2.1. Data description

Exchange rate regime classification

This study applies a *de facto* exchange rate regime for two reasons.[6] First, under the *de jure* classification the intervention actions of monetary policy makers may be inconsistent with the policy commitment (Calvo & Reinhart 2002; Reinhart & Rogoff 2004; Levy-Yeyati & Sturzenegger 2005).[7] Second, Chia *et al.* (2012) point out that although the *de facto* classification fails to distinguish whether stability is caused by the policy commitment or the shocks' absence, it can control for the difference between the commitment and intervention by the authorities in the foreign exchange market.

Following Broda (2004) and based on the *de facto* exchange rate regime of the IMF, the exchange rate regimes of the ASEAN countries can be grouped into fixed and flexible

[6] Levy-Yeyati and Sturzenegger (2005) show that a *de jure* exchange rate regime is the legal regime that a country commits to apply

[7] Levy-Yeyati and Sturzenegger (2005) indicate that a *de facto* exchange rate regime is classified according to the actual policy rather than the announcement.

(including intermediate and floating) exchange rate regimes as shown in Table 1.[8]

[Table 1 about here]

Descriptive statistics

The econometric model considers the behaviour of output, price level, real exchange rate and between-country income gap to foreign demand shocks under different exchange rate regimes for the ten ASEAN countries from 1999 to 2014. The choice of these variables is because of the following reasons. First, an export volume shock, which reflects changes in the foreign demand for domestic goods and services, is used as a proxy for a foreign demand shock as the ASEAN countries are export-led economies and, therefore, exports play a crucial role in their economic growth.[9] The fluctuation of export demand affects the real exchange rate and export earnings which then have impacts on inflation and income. Second, the real exchange rate is chosen because any fluctuation in it arising from a foreign demand shock will be treated as a misalignment of it, which can produce macroeconomic instability. Third, Little (1993) points out that instability of the real exchange rate has negative impacts on growth as it can lead to uncertainty resulting in adverse effects on investment. Price and output volatility to foreign demand shocks will also be examined as Serra and Stiglitz (2008) indicate that economic growth and price stability are key indicators of macroeconomic stability. Finally, we examine the behaviour of the between-country income gap because it is particularly important for countries wishing to engage in more formal regional economic integration.

All data are measured in logarithm form. The data are collected from the World Bank,

8 Fixed exchange rate regimes comprise no separate legal tender, currency board and conventional fixed exchange rate regime. Intermediate exchange rate regimes include a peg with bands, crawling pegs, crawling band, stabilised arrangement and other managed arrangements. Floating exchange rate regimes comprise an independent float (or free floating) and managed float with no predetermined band.

9 Export volume shocks are changes in volume of exports

IMF and UNCTAD[10]. The real exchange rate is the nominal exchange rate against the US dollar, adjusted by the US and domestic CPI indexes. Real GDP is the nominal GDP in domestic currency, adjusted by CPI. The between-country income gap is calculated using the formula of Lim and McAleer (2004):

$$IG_{it} = lny_{it} - lny^*_t \quad (1)$$

where IG_{it} is the between-country income gap of country i at time t; y_{it} is GDP per capita based on purchasing power parity (PPP) for country i at time t; y_t^* is the average GDP per capita, based on PPP for the ten ASEAN countries such that $y_t^* = \frac{\sum_{i=1}^{10} y_{it}}{10}$

Before estimating the SVAR model the data series are tested for stationarity and cointegration. There is a plethora of tests for panel data stationarity such as Breitung (2001), Fisher-type (Choi 2001), Hadri (2000), Harris and Tzavalis (1999) (HT), Im *et al.* (2003) (IPS), and (Levin *et al.* 2002) (LLC).

Generally, the panel model for a unit root test takes the form:

$$y_{it} = \rho_i y_{i,t-1} + z'_{it}\delta_i + \varepsilon_{it} \quad (2)$$

where y_{it} is the variable to be tested for the existence of a unit root; $i = 1, \dots, N$ is cross section, $t = 1, \dots, T$ is the time index and $z'_{it}\delta_i$ is a panel fixed effect.

For most tests (LLC, HT, Breitung, IPS and Fisher - type), the null hypothesis for a panel unit root test is $H_0: \rho_i = 1$ (i.e. data have a unit root so are non-stationary) and the alternative hypothesis is $H_A: \rho_i < 1$ (i.e. data are stationary for one panel or some panels or all panels). However, in the Hadri (2000) test the null hypothesis is that all panels are stationary while the alternative hypothesis is that at least some panels are non-stationary.

[10] Details can be provided on request.

There are important differences between the various types of tests. First, unbalanced data are permitted in the IPS, Hadri, Fisher-type tests while the different remaining tests can only be applied to balanced datasets. Second, some tests such as the LLC, HT and Breitung tests assume that the autoregressive parameters (ρ) are common for all cross sections while other tests have panel-specific (fixed effect) autoregressive parameters. Finally, certain panel unit root tests are more suited for different size of panels N and time series T. In particular, the LLC test is suitable for a moderate dataset with a smaller number of cross sections relative to time periods. The HT test can be applied to a dataset with a large number of cross sections while the Breitung, Fisher and Hadri tests are appropriate for a panel with a long time series. The IPS test can be applied to any case of numbers of cross sections and time periods. The size of sample, therefore, plays an important role in deciding which test is suitable. It can be seen that the Breitung, Fisher, HT and Hadri tests are not appropriate because both the number of cross sections and time series used in this study are small. The data used in this study satisfies the sample size requirements of the LLC and IPS tests. However, Li and Liu (2005) point out that the LLC test depends on restrictions on the common autoregressive parameters which is relaxed in the IPS test. Given that this study employs data for ten ASEAN countries, the IPS test is suitable for testing a sample with heterogeneity characteristics.

Variables tested for stationarity are all in logarithmic form, except for foreign demand. The unit root tests are conducted with individual intercept, and with individual intercept and trend. The results from the unit root test are summarised in Table 2.[11] It can be seen from Table 2 that at the 5% level of significance foreign demand is stationary in the level, while real GDP, real exchange rate, CPI and the income gap are stationary in first differences.

[Table 2 about here]

[11] Detailed results of the unit root tests are available from the authors upon request.

Engle and Granger (1987) show that non-stationary variables may be linear stationary because for some non-stationary processes there may exist non-zero linear combinations of the I(1) series, which are covariance stationary. This means that these variables are co-integrated and have a long-run relationship. Therefore, we test cointegration between I(1) variables, namely real GDP, real exchange rate, CPI and income gap. There are three methods used to conduct a cointegration test for panel data, namely the Pedroni (1999), Pedroni (2004) and (Kao 1999) and Fisher (2006) methods.

The Pedroni test allows for heterogeneous intercepts and trend coefficients across cross-sections. The regression equation function is as follows:

$$y_{it} = \alpha_i + \gamma_i t + \vartheta_{1i} x_{1i,t} + \vartheta_{2i} x_{2i,t} + \cdots + \vartheta_{Mi} x_{Mi,t} + e_{i,t} \quad (3)$$

where $\alpha_i$and γ_i are intercept and trend coefficients; y, x are integrated of order one; ϑ_{mi} is the slope coefficient; t is time period with t=1,…, T; i is cross section (number of countries in the panel) with i=1,…,N; m is number of regressors with m=1, …, M; $e_{i,t}$ is a residual.

The null hypothesis of no cointegration requires $e_{i,t}$ to be integrated of order one I(1), meaning that φ_i=1 in $e_{it} = \varphi_i e_{it-1} + u_{it}$. There are two alternative hypotheses, namely the homogeneous alternative (φ_i<1) for every i and the heterogeneous alternative (φ_i<1) for some i.

Although the Kao test also follows a similar approach to that of the Pedroni test, the intercept is heterogeneous for cross sections and the parameters are homogeneous across cross sections.

Kao (1999) test:

$$y_{it} = \alpha_i + \vartheta x_{it} + e_{it} \quad (4)$$

for

$$y_{it} = y_{it-1} + \omega_{it} \quad (5)$$

$$x_{it} = x_{it-1} + \epsilon_{it} \quad (6)$$

Where t is time period with t=1,…, T; i is cross section (number of individuals in the panel) with i=1,…,N; α_i is heterogeneous; ϑ is homogeneous across cross sections. In the Fisher method the results of individual cross-section cointegration tests are combined to achieve the result for full cross-sections.

The data used in this study are for ten ASEAN countries which are at diverse stages of economic and financial development. Therefore, the Pedroni test is suitable because it allows for heterogeneous intercepts and trend coefficients across cross-sections. The results of the cointegration tests between the non-stationary variables are summarised in Table 3 as follows.[12]

[Table 3 about here]

It can be seen from Table 3 that the majority of outcomes are insignificant at the 5% significance level. This means that the null hypothesis of no cointegration cannot be rejected. Hence, there is no long-run relationship between the I(1) variables. Consequently, the VAR model will be estimated without imposing a cointegration relationship between the I(1) variables.

Exogeneity of foreign demand

Broda (2004) points out that, in theory, small countries are price takers on global markets. ASEAN countries are predominantly small economies and, hence, this study assumes that foreign demand is not affected by fluctuations of individual ASEAN economies. Therefore, in the model of the ASEAN countries, foreign demand is not affected by the output, price level, real exchange rate and between-country income gap. To test the

[12] Details of the cointegration tests are available from the authors upon request.

exogeneity of foreign demand this study applies the Granger causality test and the results from which are shown in Table 4. [13] At the 5% significance level the results suggest that none of the variables, namely real GDP, CPI, real exchange rate and income gap of the 10 ASEAN countries, Granger - cause foreign demand. This result confirms the assumption that these domestic variables of the 10 ASEAN countries have no effect on foreign demand.

[Table 4 about here]

2.2. Empirical model

For the purpose of comparison with prior studies like Chia et al. (2012) and Broda (2004), we use the panel structural VAR of Broda (2004). This model combines the traditional VAR approach, which treats the key variables of interest in the system as endogenous, with the panel-data approach, which allows for unobserved individual country heterogeneity. The SVAR model can be expressed as follows:

$$\begin{vmatrix} 1 & a_{12} & \dots & \dots & a_{1n} \\ a_{21} & 1 & \dots & \dots & a_{2n} \\ \cdot & \cdot & \cdot & \dots & \cdot \\ a_{n1} & a_{n2} & \dots & \dots & 1 \end{vmatrix} \begin{pmatrix} y_{1t} \\ y_{2t} \\ \dots \\ y_{nt} \end{pmatrix} = \begin{vmatrix} a(L)_{11} & a(L)_{12} & \dots & \dots & a(L)_{1n} \\ a(L)_{21} & a(L)_{22} & \dots & \dots & a(L)_{2n} \\ \cdot & \cdot & \cdot & \dots & \cdot \\ a(L)_{n1} & a(L)_{n2} & \dots & \dots & a(L)_{nn} \end{vmatrix} \begin{pmatrix} y_{1t} \\ y_{2t} \\ \dots \\ y_{nt} \end{pmatrix} + \begin{pmatrix} u_{1t} \\ u_{2t} \\ \cdot \\ u_{nt} \end{pmatrix} \quad (7)$$

Or more generally, in the form:

$$AY_{it} = A(L)Y_{it} + u_{it} \quad (8)$$

where the data generating process comprises a panel composed of i=1, …,M individual countries and each of which consists of an Nx1 vector of observed stationary endogenous variables, Y_{it} . Since the panel may be unbalanced, the data are assumed to be observed over t = 1,…, T, time periods. Here, A is a NxN matrix of structural parameters for the contemporaneous link between variables while A(L) is a NxN matrix of polynomial lag operators of order p. Finally, u_{it} is a Nx1 vector of structural innovation or structure errors with var(u_{it})=Ω. The panel structural vector autoregressive (SVAR) methodology is used to

[13] Detailed results are available from the authors upon request

investigate the response of output, price level, real exchange rate and income gap to a negative foreign demand shock under fixed and flexible exchange rate regimes for the ASEAN economies. The panel data comprises the ten ASEAN countries where $Y_{it} = \begin{pmatrix} FD_{it} \\ \Delta LRGDP_{it} \\ \Delta LCPI_{it} \\ \Delta LRER_{it} \\ \Delta IG_{it} \end{pmatrix}$ is a column vector of stationary endogenous variables made up of foreign demand, first differences of the logarithm of output, price level, real exchange rate and first difference of the income gap. Accordingly, A is a contemporaneous matrix, A(L) are 5x5 matrices of polynomials in the lag operator of order 3 and $u_{it} = (u_{it}^{FD}, u_{it}^{RGDP}, u_{it}^{CPI}, u_{it}^{RER}, u_{it}^{IG})$ is a vector of structural errors. Before estimating the structural VAR model the lag length of reduced VAR is determined based on the Akaike Information Criterion (AIC).[14] The lag-length results are not reported here to conserve space but the criterion points to a VAR with 3 lags. The model with 3 lags satisfies both no autocorrelation and stability requirements.[15] We estimate the SVAR model with 3 lags.

The SVAR model of equation (8) can be estimated by transforming it into a reduced form or standard VAR by pre-multiplying with A^{-1} to yield:

$$Y_{it} = A^{-1}A(L)Y_{it} + A^{-1}u_{it} \tag{9}$$

Set $D(L) = A^{-1}A(L)$; $e_{it} = A^{-1}u_{it}$, which yields the following reduced form:

$$Y_{it} = D(L)Y_{it} + e_{it} \tag{10}$$

To construct the matrix A it is necessary to impose an identification restriction. There are two issues when imposing identification restrictions. First, does the model have a recursive or non-recursive structure? Second, does the model require short run or long run

[14] In addition to the AIC, we also use the sequential modified Likelihood ratio (LR) test statistic and the final prediction error (FPE) criterion. The results are similar to the one produced by the AIC.

[15] Detailed results of lag-length, no autocorrelation and stability tests are available from the authors upon request.

restrictions to be imposed?

With respect to a recursive VAR model, Stock and Watson (2001) indicate that the error term of the subsequent equation is not correlated to the error term of the previous equation. Hence, the dependent variable of the first equation is a function of all lagged variables. The dependent variable of the second equation is a function of lagged variables of all variables plus the current value of the dependent variable of the first equation. Similarly, the dependent variable of the third equation is a function of the lagged variables of all variables plus the current value of dependent variables of the first and second equations. In the non-recursive VAR, contemporaneous relationships between variables (or restrictions) are typically built upon economic theory.

Alternatively, an identification strategy can be implemented by imposing short run and/or long run restrictions. The short-run restrictions impose some contemporaneous effects of shocks on variables. Long run restrictions are proposed by Blanchard and Quah (1988). Lütkepohl (2005) indicated that the long run response to structural innovation has the following form:

$$C=(I-\hat{A}_1-\cdots-\hat{A}_p)^{-1}A^{-1} \tag{11}$$

where $(I-\hat{A}_1-\cdots-\hat{A}_p)^{-1}$ is the forecast error accumulated responses to the reduced form shocks. The long run restrictions are imposed in the form of zero restrictions in elements of matrix C. The restriction $C_{ij}=0$ shows that the j-th structural shock has no long run accumulated impact on the response of the i-th variable. Of the two identification strategies, we apply a non-recursive VAR model, which underlines contemporaneous relationships of variables based on economic theory.

Due to the small sample size the exchange rate regime is divided into two groups, namely fixed and flexible exchange rate regimes. The flexible exchange rate regime

encompasses the intermediate and floating exchange rate regimes. To distinguish the fluctuation of variables between different exchange rate regimes, Y_{it} will be interacted with dummy variables for different exchange rate regimes (D_{peg}=0 if a fixed exchange rate regime and D_{flex}=1 if a flexible exchange rate regime). Accordingly, the model becomes the following:

$$AY_{it} = B_{peg}(L)Y_{it} * D_{peg} + B_{flex}(L)Y_{it} * D_{flex} + u_{it}. \quad (12)$$

The SVAR model for ASEAN countries with short run restrictions is based on the AB model $Ae_{it} = u_{it}$ or

$$\begin{vmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{vmatrix} \begin{pmatrix} \varepsilon_{it}^{FD} \\ \varepsilon_{it}^{RGDP} \\ \varepsilon_{it}^{CPI} \\ \varepsilon_{it}^{RER} \\ \varepsilon_{it}^{IG} \end{pmatrix} = \begin{pmatrix} u_{it}^{FD} \\ u_{it}^{RGDP} \\ u_{it}^{CPI} \\ u_{it}^{RER} \\ u_{it}^{IG} \end{pmatrix} \quad (13)$$

As indicated by Basnet and Upadhyaya (2015), most of the ASEAN countries are small economies and, hence, foreign variables are not affected instantaneously by domestic variables. Therefore, it is assumed that foreign demand has contemporaneous impacts on domestic variables whereas domestic variables have no effects on foreign demand. Hence, a_{12}=a_{13} = a_{14}=0.

The real exchange rate responds rapidly to related economic changes and, hence, it is affected contemporaneously by other variables in the economic system. In addition, the movement of the real exchange rate comes from changes in the nominal exchange rate or price. Therefore, this study assumes that the real exchange rate is affected instantaneously by foreign demand, economic growth and inflation. However, the real exchange rate has no contemporaneous effect on economic growth and inflation. Manalo *et al.* (2015) explained that this is because firms need time to adjust prices and make decisions on production in response to changes in the exchange rate. Therefore, a_{24}=a_{34}=0.

Similar to Gumata and Ndou (2017), this study assumes that growth responds slowly to inflation whereas inflation is affected instantaneously by economic growth. Hence, a_{23}=0.

Following Lim and McAleer (2004) the income gap is calculated based on GDP per capita and, hence, this study assumes that changes in output immediately affect the income gap. In addition, due to the assumption of contemporaneous effects of foreign demand on output, a foreign demand shock also has an instantaneous impact on the income gap. Based on the immediate effect of the real exchange rate on domestic and foreign income as documented in Krugman and Taylor (1978), this study assumes that the real exchange rate has a contemporaneous impact on the income gap. Moreover, because of the immediate impact of the price level on the real exchange rate, the price level also has a contemporaneous effect on the income gap. However, the income gap is assumed to have no contemporaneous effect on foreign demand, output, price level and real exchange rate because in reality the fluctuation of four of these variables are not directly affected by the income gap. Hence, a_{15}=a_{25}=a_{35} = a_{45}=0.

3. Empirical results

3.1. Dynamic response

Figure 1 to Figure 4 show the accumulated impulse response of first differences of real GDP, real exchange rate, CPI and between-country income gap under fixed and flexible exchange rate regimes to a negative one standard deviation foreign demand shock. The solid line indicates the impulse response function while the dashed lines show the confidence intervals with two standard deviations (5^{th} and 95^{th} percentile). An accumulated analytic (asymptotic) response standard error is applied to generate the impulse response of variables to foreign demand shocks over 20 periods.

[Figure 1 about here]

Figure 1.1 and Figure 1.2 display the accumulated response of output to a negative foreign demand shock under fixed and flexible regimes, respectively. It can be seen that a negative foreign demand shock leads to a contemporaneous fall in real GDP under both regimes. Under the fixed regime, after the third period, output starts to experience an expansion. However, this effect fades away after four periods, again leading to a contractionary phase for the remaining time horizon. Under a flexible exchange rate regime, a negative foreign demand shock leads to a likely output decline contemporaneously. This effect is sustained for all 20 periods of the time horizon.

In comparison to the fixed exchange rate regime the output contraction is greater under a flexible exchange rate regime. This result is inconsistent with previous studies such as Lindert and Pugel (1996), Broda (2004), Chia and Alba (2006), Hoffmann (2007), Chia *et al.* (2012) and Zhang *et al.* (2014), who find that a flexible exchange rate regime is a better shock absorber than a fixed exchange rate regime. Lindert and Pugel (1996) show that a negative foreign demand shock results in a domestic currency depreciation and, hence, under a fixed exchange rate regime the central bank will intervene by selling foreign exchange reserves and buying domestic currency. They believe that if this intervention is not supported by sterilization then the money supply will decline and real national product will further decline. Nonetheless, under a floating exchange rate regime a government does not intervene and this will improve domestic competitiveness which leads to an increase in exports and a decrease in imports. As a result, real domestic output will improve.

The inconsistency of the behaviour of output between fixed and flexible exchange rate regimes can be explained by the high degree of openness of ASEAN countries which may be a factor affecting the superiority of their flexible exchange rate regime in terms of output. As shown by Watson (2016) high openness that leads to greater firm competitiveness tends to

reduce price stickiness. Thus, under a flexible exchange rate regime the high degree of openness of ASEAN countries makes the degree of price stickiness weaker and, therefore, the depreciation of the real exchange rate is affected not only by the flexible movement of the nominal exchange rate but also by the less rigid movement of the price level. This limits the movement of the real exchange rate. As a result, a flexible exchange rate regime is not the best tool in buffering external shocks for ASEAN countries.

Moreover, the greater contraction of output under a flexible regime can be explained via the foreign-currency denominated debt. Sangaré (2016) shows that the debt of ASEAN countries is dominated mainly in foreign currency. Cook (2004) indicates that the instability of the real exchange rate makes the dominated foreign currency debts become more expensive in terms of domestic currency and hedging. As a result this leads to a decrease in investment and then output. Therefore, the higher fluctuation of the real exchange rate under a flexible than fixed exchange rate regime (See Figure 2) causes a higher accumulated output contraction.

[Figure 2 about here]

Figure 2.1 and Figure 2.2 depict the accumulated responses of the real exchange rate to a shock under fixed and flexible exchange rate regimes, respectively. Under both regimes the real exchange rate depreciates immediately. However, compared to the flexible exchange rate regime the contemporaneous effect of a foreign demand shock on the real exchange rate under a fixed exchange rate regime is negligible. A 10% (about one standard deviation) decrease in foreign demand contemporaneously leads to virtually no real depreciation under the fixed regime, which is not at all surprising, but a 0.027% real depreciation under the flexible regime. The contemporaneous real depreciation under both exchange rate regimes is associated with a decrease in the CPI (see Figures 3.1 and Figure 3.2). Also, the accumulated

response of the real exchange rate is more pronounced under a flexible regime because the fluctuation of the real exchange rate under the fixed regime is derived from the fluctuation of the price level whereas greater volatility of the real exchange rate under the flexible regime comes from fluctuations of both the price level and flexible nominal exchange rate.

As expected the real depreciation under a fixed exchange rate regime is the result of a decrease in the price level. This is because adjustment of the real exchange rate under a fixed exchange rate depends on the price level. An appreciation in the real exchange rate as a result of responding to the shock under a fixed exchange rate regime is consistent with theory. In particular, Lindert and Pugel (1996) indicate that a decline in foreign demand for exports can deteriorate the current account. Under a fixed exchange rate regime there is no change in the nominal exchange rate because of intervention by the central bank such as through buying the domestic currency. This intervention makes the money supply decrease and then lowers the price level. As a result the real exchange rate appreciates.

Under a flexible exchange rate regime the shock leads to an accumulated depreciation in the short-run, while it results in an accumulated appreciation in the long-run. These results occur because under a flexible exchange rate regime both the nominal exchange rate and price level contribute to fluctuations of the real exchange rate. Therefore, the behaviour of the real exchange rate regime to the shock (increases or decreases) under a flexible exchange rate regime depends on the relative rates of change between the nominal exchange rate and domestic price level.

[Figure 3 about here]

Figure 3.1 and Figure 3.2 illustrate the accumulated response of the price level to a foreign demand shock under a fixed and a flexible exchange rate regime, respectively. By combining the responses of the price level and output (see Figures 1 and 3) it can be seen that

the behaviour of these variables is consistent with the theory of an output - inflation trade off. In particular, under both regimes the output contraction is accompanied with deflation.

The movement of the price level to a foreign demand shock for ASEAN countries with a fixed exchange rate regime is consistent with theory as a negative foreign demand shock leads to deflation. In particular, Lindert and Pugel (1996) argue that under a fixed exchange rate regime a central bank has to buy domestic currency to prevent depreciation which is a consequence of a negative foreign demand shock. They show that this intervention results in a decline in the domestic money supply which then in turn lowers the inflation rate. Similarly, a negative foreign demand shock results in deflation under a flexible exchange rate regime. A real exchange rate appreciation lowers the imported price in terms of domestic currency and this leads to a decrease in the price level. Nevertheless, the price level declines more strongly under a flexible than under a fixed exchange rate regime.

[Figure 4 about here]

Figure 4.1 and Figure 4.2 represent the accumulated impulse responses of the income gap to one standard deviation of a negative export demand shock under a fixed and a flexible exchange rate regime, respectively. Under both exchange rate regimes, the between-country income gap narrows; however, the income gap decreases by much more under a flexible than under a fixed exchange rate regime. This can be explained by the real exchange rate appreciation which results from a negative foreign demand shock. Under a flexible exchange rate regime this makes domestic income in terms of US dollars increase and, hence, the income gap reduces more strongly under a flexible exchange rate regime. Additionally, the greater volatility of output under a flexible exchange rate regime could lead to higher saving rates and investment, and therefore higher economic growth, which in turn leads to a lower between-country income gap for ASEAN members.

3.2. Variance decomposition

This section investigates the contribution of foreign demand shocks to the fluctuation of real GDP, CPI, real exchange rate and income gap in ASEAN countries by using variance decompositions. Variance decomposition shows how much of the percentage of the fluctuation of real GDP, CPI, real exchange rate and income gap is explained by a foreign demand shock. Table 5 shows the results of variance decomposition of domestic variables which are explained by the foreign demand in the short run, medium run and long run. Following Chia *et al.* (2012), the short run refers to the first period after the shock. The medium run covers two to five years after the shock. The long run is described as five years and onwards.

[Table 5 about here]

It can be seen from Table 5 that a foreign demand shock explains more of the variation of output under the fixed exchange rate regime than under the flexible exchange rate regime. In particular, a foreign demand shock explains 26.2%, 53.4% and 54.3% of the fluctuation of output in the short run, medium run and long run, respectively. Nevertheless, the contribution of a foreign demand shock to the fluctuation of output is much less significant under the flexible regime, being 6.42%, 8.4% and 8.03% in the short run, medium run and long run, respectively. This result is consistent with Broda (2004), Chia *et al.* (2012) and Zhang *et al.* (2014), who also found that external shocks give rise to larger fluctuations of output under a fixed than under a flexible exchange rate regime.

Under both exchange rate regimes a foreign demand shock explains a small percentage of the real exchange rate fluctuation in the short run but contributes a much more significant portion of the real exchange rate fluctuation in the medium and long run. This can be explained by the fact that in the medium run and long run the rigidity of the price level is

eased and, therefore, the effect of a foreign demand shock on the price level, which is then transmitted to the fluctuation of the real exchange rate, is greater. In the medium run and long run a foreign demand shock plays a much more significant role on the fluctuation of the real exchange rate under a fixed than under a flexible regime. However, in the short run a foreign demand shock explains a greater proportion of the fluctuation of the real exchange rate under a fixed than under a flexible exchange rate regime.

With respect to the price level a foreign demand shock explains a larger portion of the variation of the price level in the medium and long run than in the short run. Greater variation of the price level is explained by a foreign shock under a fixed than under a flexible regime. Similarly, a foreign demand shock explains a remarkable percentage change in the income gap of the ASEAN economies with a fixed exchange rate regime. Nonetheless, it makes a smaller contribution to variations of the income gap under a flexible exchange rate regime. On balance, the variance decomposition results suggest that foreign demand shocks have greater impacts on the fluctuation of domestic variables in the medium run and long run.

4. Robustness tests

To examine the robustness of the main results we conduct a number of sensitivity analyses. ASEAN countries have a high degree of openness and, hence, as indicated in Hoffmann (2007) macroeconomic variables are more strongly affected and respond more quickly to external shocks. In addition, the degree of openness affects the trade balance which then impacts on the exchange rate, price level and output. For this reason we examine the robustness of our results by including trade openness as a control variable. The results of impulse responses of output, price level, real exchange rate and income gap to a negative standard deviation of a foreign demand shock under fixed and flexible exchange rate regimes are presented in Figure 5 to Figure 8, respectively.

The results from the model with degree of openness as a control variable are similar to those from the model without that control variable. In particular, the fixed exchange rate regime can minimise the negative effect of a negative foreign demand shock on real output better than the flexible exchange rate regime. By virtue of a sticky price level in the short-run, it is predicted that the real exchange rate is more stable under a fixed than under a flexible exchange rate regime when a negative foreign demand shock hits an ASEAN economy.[16] Moreover, inflation and the income gap decrease more strongly under a flexible than under a fixed exchange rate regime in response to a negative foreign demand shock.

[Figures 5 to 8 about here]

Table 6 presents the variance decomposition of domestic variables which are explained by the innovations of foreign demand for the model with the inclusion of degree of openness as a control variable. The results for the variance decomposition of this model are by and large similar to that of the model which does not include this control variable. Specifically, when compared to the flexible exchange rate regime, the negative foreign demand shock explains a larger proportion of the fluctuations of real GDP, price level, real exchange rate and income gap than under the fixed exchange rate regime. The consistent results in both models (with and without the inclusion of degree of openness) show that the empirical model for ASEAN countries is robust.

[Table 6 about here]

5. Conclusion and Policy Implications

This study seeks to expand the literature on the choice of exchange rate regime by

[16] Under a fixed exchange rate regime the nominal exchange rate is fixed, so changes in the real exchange rate under this regime are expected to come from movements in the price level. However, given that the price level is sticky in the short-run, the real exchange rate is expected to be more stable in the fixed regime than in the flexible regime.

considering the impact of external shocks on the between-country income gap of ASEAN countries. Specifically, this paper has empirically investigated differences in the response of output, price level, real exchange rate and income gap of the ASEAN economies to a negative foreign demand shock between a fixed and a flexible exchange rate regime. The results shed light for ASEAN countries on how to establish an appropriate exchange rate policy that will minimise the adverse impacts of external shocks and decrease the income gap between them.

The results of the impulse responses showed that a fixed exchange rate regime is superior in minimising the negative effects of a fall in foreign demand on output and the real exchange rate. In particular, the response of real GDP to the shock under a fixed exchange rate regime is smoother. Additionally, the real exchange rate is more stable under a fixed exchange rate regime. Although the price level is more volatile under a flexible exchange rate regime, this exchange rate regime produces greater deflation. A flexible exchange rate regime also plays a role in narrowing the income gap between ASEAN countries. On these bases, a flexible exchange rate regime is optimal in reducing the price level and income gap for ASEAN countries.

The results of variance decomposition indicate that under the fixed exchange rate regime the fluctuation of key variables is strongly driven by foreign demand shocks. In contrast, a foreign demand shock does not induce much of the variation of variables under the flexible regime. In addition, the variance decomposition results of both exchange rate regimes suggest that foreign demand shocks become more important to the fluctuation of domestic variables in the medium run and long run.

The findings provide some policy implications for ASEAN countries. First of all, the optimal exchange rate regime depends on the criteria that each ASEAN country prefers. For example, if an ASEAN country desires high economic growth or real exchange rate stability then it should choose a fixed regime. In contrast, the flexible regime should be applied if the

country needs low inflation or seeks to narrow its income gap. It can be seen that if an ASEAN country chooses a flexible exchange rate regime, it has to trade - off targets, namely economic growth and inflation targeting. Conversely, an ASEAN country has to sacrifice low inflation and cope with a widening income gap if a fixed exchange rate regime is chosen. The weighting, or relative priorities, of these targets to identify the most suitable exchange rate regime for ASEAN countries are left for future research. Second, the findings suggest that a foreign demand shock makes a significant contribution to fluctuations of macroeconomic variables under a fixed exchange rate regime. In addition, it becomes more important in the medium run and long run. Therefore, a country with a fixed exchange rate regime should pay more attention to coping with unanticipated foreign demand shocks. Given that the ASEAN countries have high trade openness it is likely that any negative foreign demand shock will cause large fluctuations in the nominal exchange rate, which imply that central banks need to intervene heavily in the foreign exchange market to maintain a fixed exchange rate regime with direct implications on the country's foreign reserves.

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Table 1: ASEAN Countries and their exchange rate regimes, 1999-2014

Countries	Fixed years	Floating years
Brunei	1999-2014	
Cambodia		1999-2014
Indonesia		1999-2014
Lao PDR		1999-2014
Malaysia	1999-2004	2005-2014
Myanmar	1999-2000	2001-2014
Philippines		1999-2014
Singapore		1999-2014
Thailand		1999-2014
Vietnam	2005-2007	1999-2004, 2008-2014

Source: Annual Report on Exchange Rate Arrangements and Exchange Restrictions (AREAER, 1999-2014) and reclassified following Broda (2004).

Table 2: Im-Peresan-Shin (2003) unit root test results

Individual intercept			
Level	**Significance level**	**Difference**	**Significance level**
Foreign demand	0.0000		
Log of real GDP	0.3024	ΔLog of real GDP	0.0000
Log real exchange rate	0.9945	Δlog real exchange rate	0.0000
Log CPI	0.9953	Δlog CPI	0.0000
Income gap	1.0000	ΔIncome gap	0.0000
Individual intercept with trend			
Level	**Significance level**	**Difference**	**Significance level**
Foreign demand	0.0000		
Log of real GDP	0.5713	ΔLog of real GDP	0.0000
Log real exchange rate	0.1220	Δlog real exchange rate	0.0385
Log CPI	0.7220	Δlog CPI	0.0000
Income gap	0.5790	ΔIncome gap	0.0000

Table 3: A summary of the cointegration tests

Dependent variable	Panel rho-Statistic	Prob.
Real GDP	2.20	0.9859
Real exchange rate	2.40	0.9918
Consumer price index	2.52	0.9941
Between-countries income gap	2.78	0.9974

Table 4: Panel Granger causality test

Foreign demand	Chi-sq	Prob.
Real GDP does not Granger - cause foreign demand	2.15	0.54
CPI does not Granger - cause foreign demand	7.06	0.07
Real exchange rate does not Granger - cause foreign demand	3.14	0.37
Income gap does not Granger- cause foreign demand	3.41	0.33

Table 5: Variance decomposition (%) of innovations in foreign demand based on a baseline model

	Fixed exchange rate regime				Flexible exchange rate regime			
	Real GDP	CPI	Real exchange rate	Income gap	Real GDP	CPI	Real exchange rate	Income gap
Short run	26.2	2.3	0.1	27.1	6.4	0.1	0.4	4.6
Medium run	53.4	9.4	21.7	34.5	8.4	5.0	1.4	11.5
Long run	54.3	11.2	24.6	30.2	8.0	4.9	1.5	11.3

Table 6: Variance decomposition (%) of innovations in foreign demand based on a model which controls for trade openness

	Fixed exchange rate regime				Flexible exchange rate regime			
	Real GDP	CPI	Real exchange rate	Income gap	Real GDP	CPI	Real exchange rate	Income gap
Short run	32.0	4.68	0.63	27.4	5.22	0.17	0.18	4.7
Medium run	52.7	5.6	8.38	25.95	6.93	5.40	1.74	13.22
Long run	49.38	5.75	15.25	18.74	6.38	5.18	1.95	12.57

Figure 1: Accumulated response of real GDP to a foreign demand shock under fixed and flexible exchange rate regimes

Fig.1.1: Response of real GDP under a fixed ERR

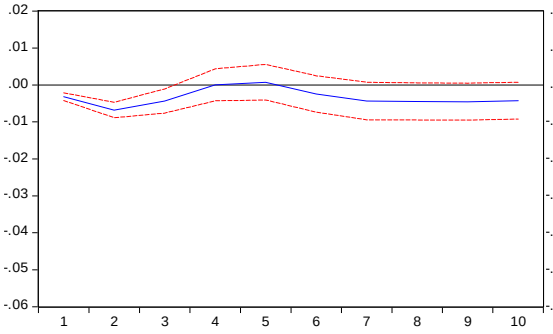

Fig.1.2: Response of real GDP under a flexible ERR

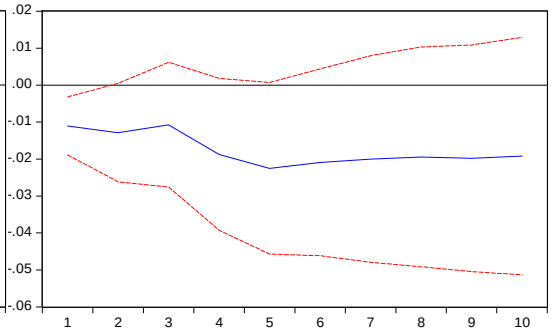

Figure 2: Accumulated response of the real exchange rate to a foreign demand shock under fixed and flexible exchange rate regimes

Fig. 2.1: Response of real exchange rate under a fixed ERR

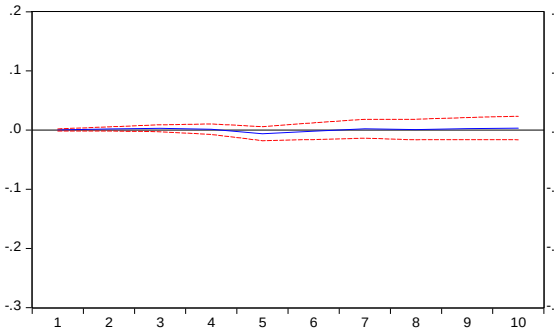

Fig. 2.2: Response of real exchange rate under a flexible ERRR

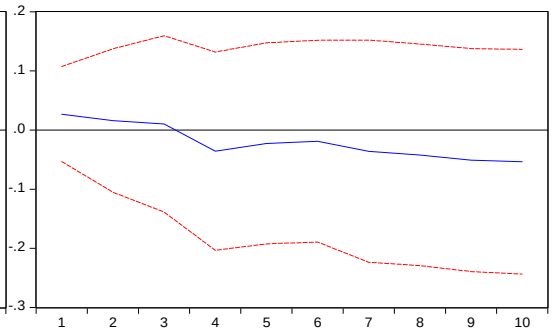

Figure 3: Accumulated response of the CPI to a foreign demand shock under fixed and flexible exchange rate regimes

Fig. 3.1: Response of CPI under a fixed ERR

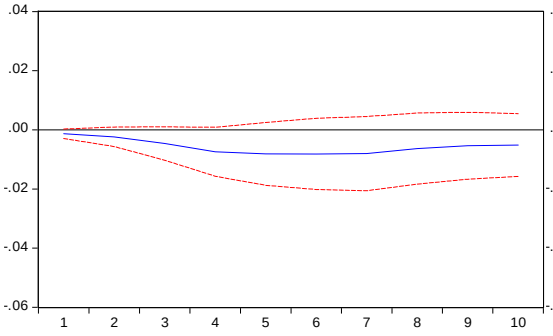

Fig. 3.2: Response of CPI under a flexible ERR

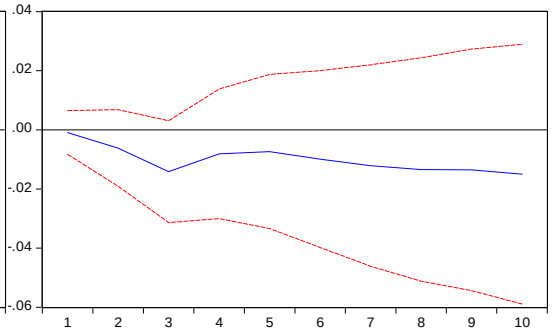

Figure 4: Accumulated response of between-country income gap to a foreign demand shock under fixed and flexible exchange rate regimes

Fig. 4.1: Response of income gap under a fixed ERR

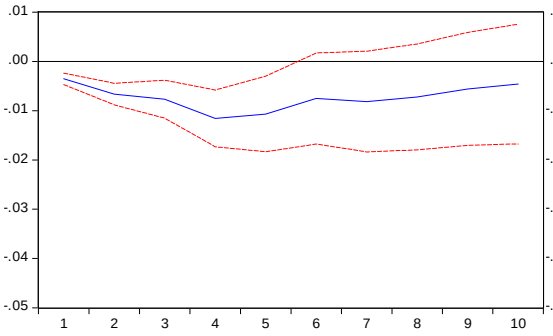

Fig. 4.2: Response of income gap under a flexible ERR

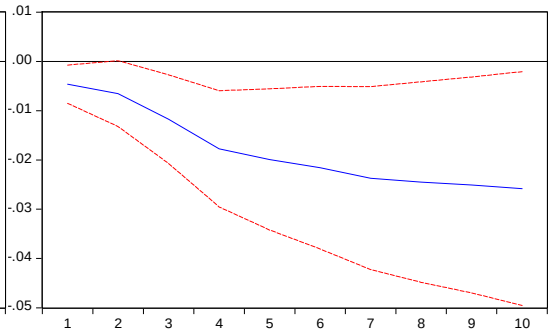

Figure 5: Accumulated response of real GDP to a foreign demand shock under fixed and flexible exchange rate regimes with openness as a control variable

Fig. 5.1: Response of real GDP under a fixed ERR

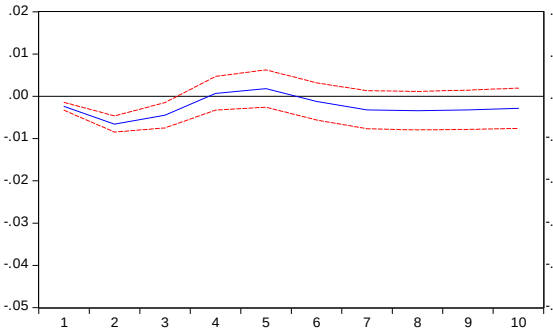

Fig. 5.2: Response of real GDP under a flexible ERR

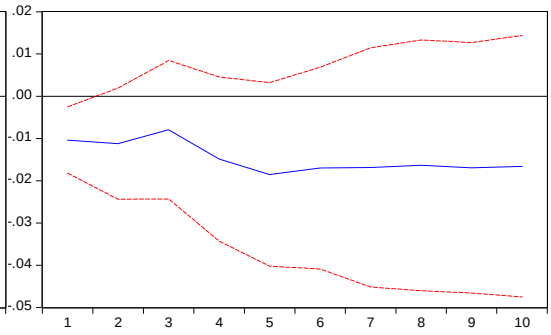

Figure 6: Accumulated response of consumer price to a foreign demand shock under fixed and flexible exchange rate regimes with openness as a control variable

Fig. 6.1: Response of CPI under a fixed ERR

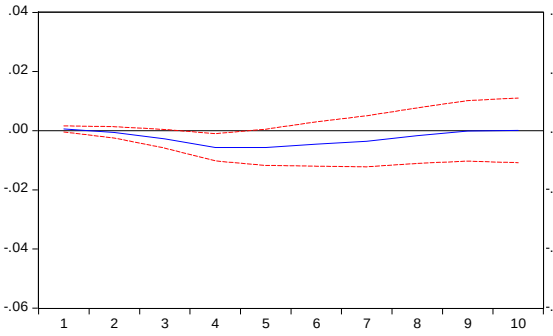

Fig. 6.2: Response of CPI under flexible ERR

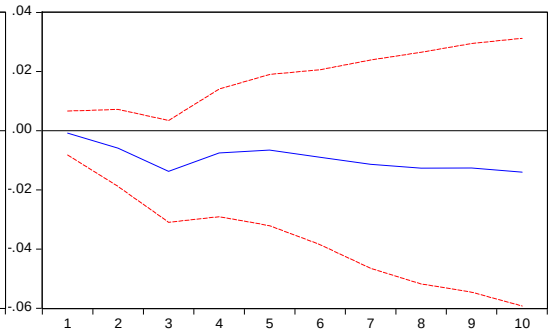

Figure 7: Accumulated response of the real exchange rate to a foreign demand shock under fixed and flexible exchange rate regimes with openness as a control variable

Fig. 7.1: Response of real exchange rate under a fixed ERR

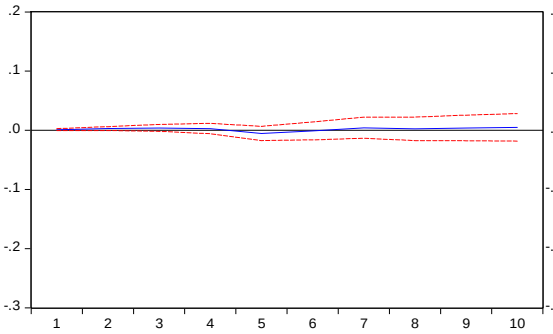

Fig. 7.2: Response of real exchange rate under a flexible ERR1

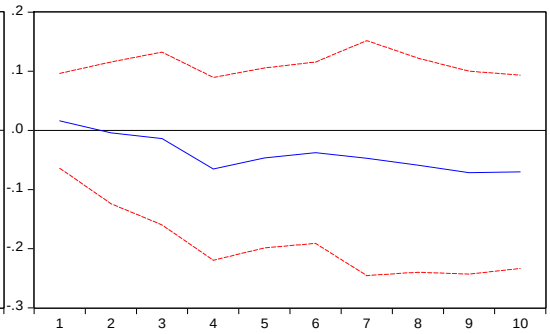

Figure 8: Accumulated response of the income gap to a foreign demand shock under fixed and flexible exchange rate regimes with openness as a control variable

Fig. 8.1: Response of income gap under a fixed ERR

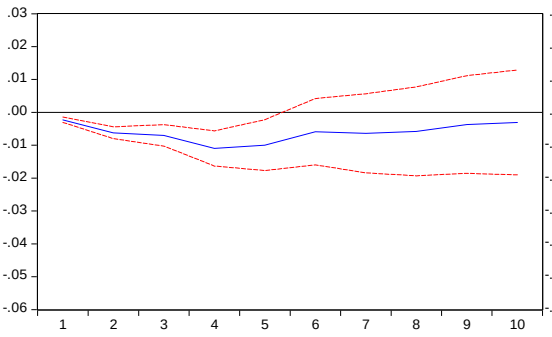

Fig. 8.2: Response of income gap under a flexible ERR