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Sources of Macroeconomic Fluctuations in Thailand

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Abstract: This paper analyses the sources of macroeconomic fluctuations in Thailand. In particular, imposing long run restrictions implied by economic theory on two structural vector autoregression model. The first model analyses the role of external and domestic shocks. The second model analyses the role of aggregate supply and aggregate demand shocks. We use open economy model for identified shocks and their impulse responses function. The evidence in the first model suggests that the main source of real output fluctuations is technology shock. The real exchange rate is driven mostly by demand shocks. The terms of trade shocks are important for real exchange rate fluctuations. The price level is mainly due to nominal shock. In the second model found that both aggregate supply and aggregate demand shocks have the role play on output fluctuations but the labor supply shock is important than the productivity shock in long run.

1. INTRODUCTION

Real GDP of Thailand has increased 25 times from 1960 to 2015. There fluctuate between periods of high and low activity, revealing in Figure 1. The period of economic expansions and contractions have unstable frequency by intensity and duration from time to time. Figure 1 exhibits the basic features of the Thai business cycle. The growth has come in gradually increase. On average, real GDP growth has grown by only 6.09% per year (Indicated by the dotted line in figure 1. However, the growth path of the Thai economy is not AS smooth. A year to year real GDP growth has revealed some significant fluctuations. It failed to attain stable growth every year. An important fact about fluctuations in Thai economy is that do not exhibit any simple regular or cyclical pattern. The table 1 summarizes the behavior of real GDP in the recessions.

The table show that output declines vary different in size and spacing. The fall in real GDP range from 1.1 per cent in 1999–2001 to 6.4 per cent in the recent recession. The times between the end of one recession and the beginning of the next range from 1 year in 1973–1974 to almost 10 years in 1988–1998.

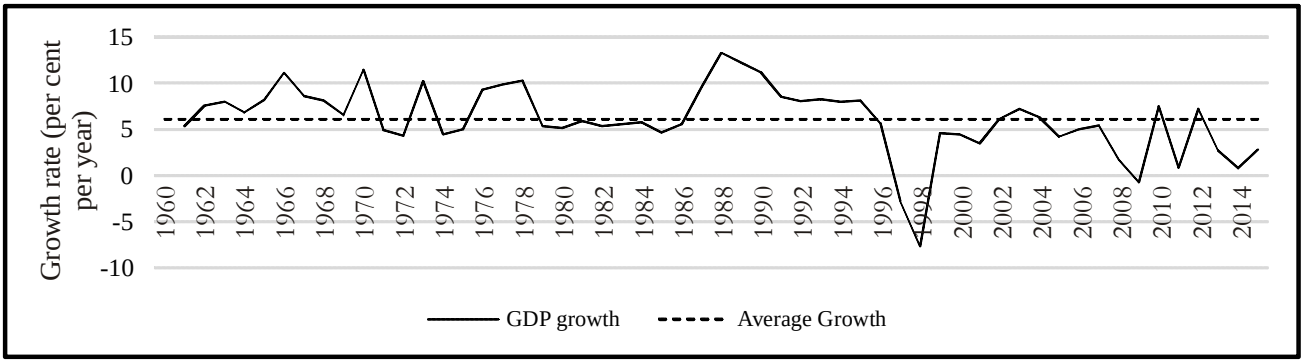

Figure 1: The business cycle in Thailand 1960-2015

The patterns of the output declines also vary greatly. In the 2009 recession, the real GDP decline of 6.2 per cent took place in a single year; in the 1974 recession, output fell for a quarter, then slightly increased.

Considering the economic fluctuations in the Thai economy over two decades. With the real GDP during the years 1993-2015. To understand business cycle fluctuations in economic activity. Hodrick and Prescott (1997) employed time series tools to examine the empirical regularities and detrended their variables from cyclical component. Using a procedure now widely known as the Hodrick Prescott (HP) filter.

To compare the amplitude of fluctuations between Thailand and developed countries. It can demonstrate by the percentage of standard deviation of the cyclical component of real GDP. In table 2, for all series, Thailand real GDP is much higher than the fluctuations of output in the developed countries. And also, showed that imports of Thailand have been highly volatile than investment and exports.

The output has fluctuated lowest compared to all series and rather consistent with the study of Backus and Kehoe (1992). This study the stylized fact of business in 10 countries, including Australia, Canada, Denmark, Germany, Italy, Japan, Norway, Sweden, UK and US. Fiorito and Kollintzas (1994) studied a group of seven leading industrial countries, including the US, Canada, Japan, Germany, France, Britain and Italy. From these studies showed that the cycle of consumption has been cyclical fluctuations as well as the gross domestic product. While the cyclical fluctuations of about three times in investment. The cycle of exports and imports are highly fluctuations by comparison to the gross domestic product.

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The Figures and tables suggests the evidence that consistent the economic growth, full employment, and a stable price level are difficult to achieve. An important fact about fluctuations in Thai economy is that do not exhibit any simple regular or cyclical pattern. It is known that the economy is perturbed by disturbances of various types and sizes of shocks. At more or less random intervals those shocks then propagate through the economy. The fluctuations in growth rate creates economic uncertainty impacting future growth rates negatively. Identification of the source of macroeconomic fluctuations is a critical issue. It should be serious attention in designing effective macroeconomic policy to maintain economic stability. Therefore, to control the fluctuations in the economy. It's becoming a major challenge for policy maker. An understanding of economic fluctuations is important for both the evaluation of economic developments and the application of effective economic policies.

Table 1[3]
The Thai economy behavior of real GDP in the eleven recessions.

Year of peak in real GDP	*Number of years until trough in real GDP*	*Change in real GDP, peak to trough (%)*
1966	3	–4.6
1970	2	–7.1
1973	1	–5.8
1978	2	–5.1
1981	4	–1.3
1988	10	–20.9
1999	2	–1.1
2003	2	–3.0
2007	2	–6.2
2010	1	–6.7
2012	2	–6.4

Source: Authors' Calculation.

Table 2
Fluctuations in economic activity, Thailand and developed countries.

		Developed countries		
Series	*Thailand*	*USA*	*EU*	*Japan*
Output	2.45	1.21	0.69	1.74
Consumption	2.78	1.35	0.78	1.26
Investment	7.89	3.78	1.65	2.54
Government spending	2.23	1.05	0.48	1.21
Export	4.67	3.22	1.83	3.81
Import	7.54	4.87	2.51	4.79

Note: The amplitude of fluctuations measured by the percentage of standard deviation of the cyclical component of each series. To be consistent, all data are obtained only from one source, the World Bank. The range of data starts from 1991 and ends at 2015 by decomposing a time series into a trend and cyclical movement.

Source: Authors' Calculation.

The thoughts and theories for economic fluctuations those are Real Business Cycle (RBC) and Keynesian. The RBC economists such as Kydland and Prescott 1982, Long and Plosser (1983), Hansen (1985) and King and rebelo (2000) conclude that aggregate supply is the driving force behind the output fluctuation. Whereas the Keynesian economists such as Blanchard 1997, Blinder 1997, Eichenbaum 1997 and Taylor 1997, these economists would say aggregate demand have short run movement in economic activity. Ahmed *et al.* (1993), Ahmed and Murthy, (1994) Canova and Marrinan (1998), Kwark (1999), Hoffmasiter and Roldos (2001), Chang, Filer and Ying (2002) and Genberg (2003) Concluded that fluctuations of the several variables economy as a result of various shocks. These shocks are caused by domestic shocks such as output, money, prices, exchange rate, government expenditure and interest. And external or worldwide shocks such as the terms of trade, foreign output, oil price, and the world interest rate.

Based on previous studies. Suggests that a major source of economic volatility is the aggregate supply shock, commonly referred to economically as technology shock. But from the study of Bjornland (2000) has investigated the dynamic effects of shocks to analyses the role of aggregate demand shocks and aggregate supply shocks in explaining business cycles in a small open economy of Norway. Where the aggregate supply shock can be separated into labor productivity shock and labor supply shock. The results indicate that in the long run, labor supply shock is the dominant cause of economic fluctuations. Also, we develop a small open economy version of the structural vector autoregression (VAR) model and adds economic restrictions to identify the sources of macroeconomic fluctuations in Thai economy. This paper differs from previous work in two respects. First, we analyze the source of macroeconomic fluctuation as external shocks and domestic shocks. Second, for domestic shocks, we analyze the aggregate supply shock as labor productivity and labor supply shocks for movement of output.

This research can be device in five parts. In section two we propose an open economy model that satisfies the identifying restrictions discussed here. Section three identifies the SVAR model, and in section four we trace out the impulse response and the variance decomposition to the identified shocks. In section five, summarizes and concludes.

2. MODEL

1. Open Economy Model Base on External and Domestic Shocks

Mendoza (1991), Ahmed et al (1993), Ahmed and Park (1994), Stockman and Tesar (1995) and Hoffmaister and Roldos (1996, 2001) applied open economy Real Business Cycle model for developed and developing country to explain the sources of macroeconomic fluctuations. By using these theoretical framework, this paper considers Thailand as a developing country with characteristics of small open-economy. Hence, this section presents a theoretical model as priori assumptions for restriction in VAR model in next section.

Output

Hoffmaister and Roldos (1996, 2001) set a small open economy that produces both exportable and nontradable goods. The sector which produces exportable goods uses imported intermediate goods (*m*), Capital (*K*) and Labor (*L*). Under these assumptions of output can be represented by the following production function:

$$Y_t = \varnothing + \left(\frac{1}{\mu}\right) A_{x_t} - \left(\frac{(1-\mu)}{\mu}\right) P_{m_t} + \left(1 - \frac{s_n}{\lambda_n}\right) \log K_t + \left(\alpha - \frac{s_n}{\lambda_n}\right) \log l_x \qquad (1)$$

Denote $l_x = L_x / K$ is the inverse of capital/labor ratio in the tradable sector. Y_t, an equation for real output in logarithm. $\varnothing = \left[\mu(1-\mu)^{1-\mu/\mu}\right]$ is the constant term, $\mu < 1$, s_n is the ratio of non-tradable goods in total production, λ_n λ_n is the ratio of labor working in nontradable sector in total labor force. P_m is the world price of the imported intermediate good.

World interest rate

Individuals in this economy have access to international capital markets, where they borrow an amount D at the world interest rate i^* implying tradable output less interest payments equal consumption of tradable goods, C_x as $C_x = Y_x - i^* D$. Finally, the fourth term in equation (1) captures the effect of world interest rate shocks because in the long run the marginal productivity of capital equals the world interest rate under perfect capital mobility. Also, model define world interest rate as:

$$i^* = \mu A_{x_t}^{1/\mu} \left[(1-\mu) P_m^{-1} \right]^{(1-\mu)/\mu} (1-\alpha) l_x^{\alpha} \tag{2}$$

Real exchange rate

The long-run response of the (log) real exchange rate, q_t, to the different shocks is as follows:

$$q_t = \varnothing + \left(\frac{1}{\mu}\right) A_{x_t} - a_{n_t} - \left(\frac{(1-\mu)}{\mu}\right) P_{m_t} + (1-\beta)\left(\frac{1-\lambda_n}{\lambda_n}\right) \log K_t - \left[(1-\alpha) + (1-\beta)\left(\frac{1-\lambda_n}{\lambda_n}\right)\right] \log l_{x_t} \tag{3}$$

Nominal variables

In the study of business cycle fluctuations, Blanchard and Quah (1989) emphasize the nominal shocks as zero in long run effects. When compared to real shocks, nominal shocks have little effects in the long run. To verify the role of nominal variables in the short run, the structural model should be including unspecified equation for the price level. The price level in the theory of monetary economic is determined by money supply and nominal exchange rate.

2. Open Economy Model Base on *AD – AS* Shocks

Bjornland (2000) developed open *AD* (aggregate demand) – *AS* (aggregate supply) model from Keynesian theory as presented by Blanchard and Quah (1989), and consists of equations as follow:

$$\Delta y_t = (1+\beta)\Delta\varepsilon_t^{VEL} + (1+\pi)\Delta\varepsilon_t^{FI} + (1+\gamma)\varepsilon_t^{PR} + (\alpha - \gamma + \beta\delta)\Delta\varepsilon_t^{PR} + \varepsilon_t^{LS} + \beta\sigma\Delta\varepsilon_t^{LS} \tag{4}$$

$$u_t = -(1+\beta)\varepsilon_t^{VEL} - (1+\beta\pi)\varepsilon_t^{FI} + (\alpha - \gamma + \beta\delta)\varepsilon_t^{PR} + (1+\beta\sigma)\varepsilon_t^{LS} \tag{5}$$

$$\Delta p_t = \varepsilon_{t-1}^{VEL} + (1+\beta\pi)\varepsilon_{t-1}^{FI} - \varepsilon_t^{PR} + (\alpha - \gamma + \beta\delta)\varepsilon_{t-1}^{PR} - (1-\beta\sigma)\varepsilon_{t-1}^{LS} \tag{6}$$

$$(w - p)_t = \varepsilon_t^{PR} \tag{7}$$

$$\Delta(e + p^* - p)_t = \Delta\varepsilon_t^{VEL} + \pi\varepsilon_t^{FI} + \delta\varepsilon_t^{PR} + \sigma\varepsilon_t^{LS} \tag{8}$$

where y_t is the log of real output, u_t is the rate of unemployment, p_t is the log of price level, w is the log of nominal wage, e is the log of nominal exchange rate, p^* is the log of foreign price level. α, β, γ, δ, π and σ are coefficients. Δ is the difference operator, $(1\text{-}L)$.

In (4), all disturbances can influence on output but the productivity and labor supply shocks have affect the level of output y_t in the long run. The monetary and fiscal shocks have affect in the short run. In (5), unemployment has short run effect of all disturbances and consistence in Blanchard and Quah (1989). In (6), all shocks have affect the price level in long run. In (7), the productivity shock is only have affect the real wage in the long run. Finally, real exchange rate has a long run effect from all shocks except the monetary shock in (8).

In the next section, the research will be specified and identified empirically. as the model, above, let the interpretation of long-run paths of equations (1)-(3) in open economy base on external and domestic shocks and the interpretation of long-run paths of equation (4)-(8) in open economy model base on *AD – AS* shocks can apply for long run restriction in SVAR model as describe in next section.

3. DATA AND METHODELOGY

1. Data

The two VAR models used of seven macroeconomic variables; world interest rate, term of trade, domestic output, Unemployment rate, real wage, real exchange rate and price level. The selection of these variables based on the international real business cycle model and open *AD*-AS model from discussion above. Quarterly data are used covering the period from 1993: Q1 to 2016: Q4. The data come from several sources, International Financial Statistics (IFS), Office of the National Economic and Social Development Board (NESDB) of Thailand, The Bank of Thailand and Bureau of Trade and Economic Indices (BTEI) of Thailand.

2. Methodology

In this section, I will discuss about the empirical methodology. The reduced form of VAR model is expressed as following:

$$Y_t = A_0 + \sum_{i=1}^{k} A(i)Y_{t-1} + e_t = A_0 + A_L Y_{t-1} + e_t \tag{9}$$

AS mentioned in the study of Sims's (1980) which trace out the time path of various shocks: $Y_t = \mu + B_L e_t$ where $\mu = (I - A_L L)_{-1} A_0$, $B_L = (I - A_L L)^{-1}$ is the matrix of lag polynomials where $B_L = \sum_{i=0}^{\infty} b(i)L^i$. $b(i)$ is a matrix of coefficients for $i = 0, 1, 2, ..., K$ and $b(0) = I$. There exists a non-singular matrix $c(0)$ such that $e_t = c(0)\varepsilon_t$ then (9) can be rearranged AS follows:

$$Y_t = \mu + \sum_{i=1}^{\infty} b(i)c(0)\varepsilon_{t-i} = \mu + \sum_{i=0}^{\infty} c(i)\varepsilon_{t-i} \tag{10}$$

Where $c(i) = b(i)c(0)$, $E(\varepsilon) = 0$ and $E[\varepsilon\varepsilon'] = \Omega$. In order to use the Blanchard and Quah identification, at least one of the variables must be nonstationary when stationary variables $I(0)$ do not have a permanent component. In additional, all variables must be in a stationary from. Since is $I(1)$, uses the first difference of the series.

2.1. Identifying the SVAR models

Model 1

In model 1, assume that $Y_t^1 = [\Delta i_t^*, \Delta p_t^m, \Delta y_t, \Delta s_t, \Delta p_t]'$ is a covariance stationary process where i^*_1, p^*_1, y_t, s_t and p_t represent the world interest rate, terms of trade, real GDP, real exchange rate and price level. In this study, is a (5 × 1) vector of constant. is (5 × 1) vector of serially uncorrelated structural disturbances and there exists a (5 × 5) non-singular matrix $c(0)$ such that $et = c(0)\varepsilon_t^1$ (where the asterisk is used to denote number of model) implying that the reduced form residuals are a linear transformation of the structural shocks. $\varepsilon_t^1 = (\varepsilon_t^{i*}, \varepsilon_t^{tot}, \varepsilon_t^s, \varepsilon_t^d, \varepsilon_t^n)'$. The vector of ε_t^{i*} is the external shocks for world interest rate shock, ε_t^{tot} is the external shocks for term of trade shock, ε_t^s is the internal domestic supply (technology) shock, ε_t^d is the demand shock and ε_t^n is the nominal shock, respectively A_L is a (5 × 5) matrix of lag polynomials.

Model 2

The four variables; real GDP, unemployment, real wage and the real exchange rate, the four structural shocks; monetary, fiscal, productivity and labor supply shocks, can be identified. Denoting the real wage as ($rw = w - p$) and the real exchange rate as ($s = e + p^* - p$), and ordering the vector of stationary variables as $Y_t^2 = (\Delta rw_t, \Delta y_t, \Delta s_t, u_t)'$ as same as model 1, A_0 is a (4 × 1) vector of constant. ε_t is (4 × 1) vector of serially uncorrelated structural disturbances and there exists a (4 × 4) non-singular matrix $c(0)$ such that $e_t = c(0)\varepsilon_t^2$ and the four serially uncorrelated orthogonal structural shocks defined as: $\varepsilon_t^2 = (\varepsilon_t^{PR}, \varepsilon_t^{LS}, \varepsilon_t^{FI}, \varepsilon_t^{VEL})'$. Assume productivity (or labor demand) shocks (ε_t^{PR}), labor supply shocks (ε_t^{LS}), fiscal shocks (ε_t^{FO}) and monetary shocks (ε_t^{VEL}),

2.2. Restrictions in SVAR models

This paper utilizes some main restrictions under the assumption of Thailand as of small open economy model and the model discussion in section II. The restrictions are similar to Blanchard and Quah (1989) for the long-run impact matrix can be expressed in the formula: (less constant term). Our structural decomposition can be implemented using a Choleski decomposition.

1. *Restrictions in SVAR model 1:* In the model 1, the long run path can be restricted from small open economy model AS describe above. These are:

   (a) World interest rates are given. The shocks in Thai economy can't affects world interest rates. World interest rates are determined with their own stochastic process and the domestic variables do not have any effect on them. Therefore:

$$\Delta i_t^* = \sum_{k=0}^{\infty} c_{11}(k)\varepsilon_{t-k}^{i*} \tag{11}$$

   (b) The first shock that determines terms of trade is world interest rate shock. The second shock is the terms of trade that changes in export and import prices. The determination of terms of trade by these two shocks can be seen in equation below:

$$\Delta p_t^m = \sum_{k=0}^{\infty} c_{21}(k)\varepsilon_{t-k}^{i*} + \sum_{k=0}^{\infty} c_{22}(k)\varepsilon_{t-k}^{tot} \tag{12}$$

   (c) The first factor that affects the growth of real GDP is the world interest rate shock. The labor/capital ratio is the most important indicators of production. And this is determined by world

interest rates. Under the assumption of perfect capital mobility, the marginal product of capital will be equal to world interest rates. The second factor is the terms of trade shock. It has influence on the growth rate of real GDP by deterioration. The last impact on real GDP is technology shocks. A positive technology shock will increase the growth rates. There for:

$$\Delta y_t = \sum_{k=0}^{\infty} c_{31}(k)\varepsilon_{t-k}^{i*} + \sum_{k=0}^{\infty} c_{32}(k)\varepsilon_{t-k}^{tot} + \sum_{k=0}^{\infty} c_{33}(k)\varepsilon_{t-k}^{s} \tag{13}$$

(d) Real exchange rate fluctuation result from change in world interest rate and the price of import. The technology shocks generate fluctuations in the real exchange rate. If technology shock affects in the tradable sectors, real exchange rate appreciates. But if the technology shock affects in non-tradable sectors, real exchange rate depreciates. Finally, demand shock as a result of applied fiscal policies, labor force can move between tradable and non-tradable sectors. It creates fluctuations in the real exchange rate. There for:

$$\Delta s_t = \sum_{k=0}^{\infty} c_{41}(k)\varepsilon_{t-k}^{i*} + \sum_{k=0}^{\infty} c_{42}(k)\varepsilon_{t-k}^{tot} + \sum_{k=0}^{\infty} c_{43}(k)\varepsilon_{t-k}^{s} + \sum_{k=0}^{\infty} c_{44}(k)\varepsilon_{t-k}^{d} \tag{14}$$

(e) The fluctuations in the price level can result from all shocks in long run. Here represents nominal shocks. This equation represents the real and nominal shocks are effective on the price level. Hence:

$$\Delta p_t = \sum_{k=0}^{\infty} c_{51}(k)\varepsilon_{t-k}^{i*} + \sum_{k=0}^{\infty} c_{52}(k)\varepsilon_{t-k}^{tot} + \sum_{k=0}^{\infty} c_{53}(k)\varepsilon_{t-k}^{s} + \sum_{k=0}^{\infty} c_{54}(k)\varepsilon_{t-k}^{d} + \sum_{k=0}^{\infty} c_{55}(k)\varepsilon_{t-k}^{s} \tag{15}$$

According to the long-run restrictions, the SVAR model can be represented compactly AS the Choleski decomposition, the matrix in Eq. (16) is lower triangular as follow:

$$\begin{bmatrix} \Delta i^* \\ \Delta p^m \\ \Delta y \\ \Delta s \\ \Delta p \end{bmatrix} = \begin{bmatrix} C_{11}(L) & 0 & 0 & 0 & 0 \\ C_{21}(L) & C_{22}(L) & 0 & 0 & 0 \\ C_{31}(L) & C_{32}(L) & C_{33}(L) & 0 & 0 \\ C_{41}(L) & C_{42}(L) & C_{43}(L) & C_{44}(L) & 0 \\ C_{51}(L) & C_{52}(L) & C_{53}(L) & C_{54}(L) & C_{55}(L) \end{bmatrix} \begin{bmatrix} \varepsilon^{i*} \\ \varepsilon^{tt} \\ \varepsilon^{s} \\ \varepsilon^{d} \\ \varepsilon^{n} \end{bmatrix} \tag{16}$$

2. *Restrictions in SVAR model 2:* In the model 2, the restriction from long run path in equation (4)-(8) as follow:

(a) Interpretation of long-run paths from model 2 describe above, I found that only productivity shocks can create the real wages fluctuations in the long run, there for:

$$\Delta rw = \sum_{k=0}^{\infty} c_{11}(k)\varepsilon_{t-k}^{PR} \tag{17}$$

(b) The growth rate of output fluctuation result from productivity and supply shocks:

$$\Delta y_t = \sum_{k=0}^{\infty} c_{21}(k)\varepsilon_{t-k}^{PR} + \sum_{k=0}^{\infty} c_{22}(k)\varepsilon_{t-k}^{LS} \tag{18}$$

(c) The productivity, supply and fiscal shocks can affect the real exchange rate in the long run:

$$\Delta s_t = \sum_{k=0}^{\infty} c_{31}(k)\varepsilon_{t-k}^{PR} + \sum_{k=0}^{\infty} c_{32}(k)\varepsilon_{t-k}^{LS} + \sum_{k=0}^{\infty} c_{33}(k)\varepsilon_{t-k}^{FI} \tag{19}$$

(d) Unemployment doesn't affect from all shocks in long run. There for, no restrictions are placed on unemployment. However, with these six long run restrictions, it represents by matrix in will be lower triangular AS follow:

$$\begin{bmatrix} \Delta rw \\ \Delta y \\ \Delta s \\ u \end{bmatrix} = \begin{bmatrix} C_{11}(L) & 0 & 0 & 0 \\ C_{21}(L) & C_{22}(L) & 0 & 0 \\ C_{31}(L) & C_{32}(L) & C_{33}(L) & 0 \\ C_{41}(L) & C_{42}(L) & C_{43}(L) & C_{44}(L) \end{bmatrix} \begin{bmatrix} \varepsilon^{PR} \\ \varepsilon^{LS} \\ \varepsilon^{FI} \\ \varepsilon^{VEL} \end{bmatrix} \tag{20}$$

4. THE EMPIRICAL RESULTS

The study of fluctuations of the Thai economy is based on four models of economic fluctuations. The results from the first models is Open economy model base on external and domestic shocks and the second model is Open economy model base on $AD - AS$ shocks.

The first working on preliminary data analyses and verify (see Table 3), We have specified the variables with their time series properties. We test for stationary of the series AS the familiar Augmented Dickey-Fuller (ADF) test, the Phillips-Perron (PP) and The Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests suggest that their first differences ($I(1)$) are stationary. of a unit root against the alternative hypothesis of stationarity around a deterministic time trend. We can reject the hypothesis of $I(1)$ for all variables. In fact, We can reject the hypothesis that unemployment and real exchange rate are $I(0)$. However, the ADF and PP tests suggest that real exchange rate contains a unit root, the KPSS and DF-GLS test indicate that it is stationary in levels. Thus, the non-stationary variables in the VAR model are specified in first differences.

Table 4 show the optimum lag length of the VAR models. The Likelihood Ratio test (LR) test suggested four and three lags in the first and the second VAR model respectively. But the Schwartz (SIC) information suggest one lag in model 1 and the Akaike (AIC) suggest 8 lags. We present the VAR results using lag length by LR because it can be test by statistic significant at 5% level. At four and three lags in first and second model, we couldn't accept the hypothesis of no serial correlation. Thus, we use six and four lags applies for accept the hypothesis of no serial correlation at 5% level. Finally, the cointegration test using the Johansen (1991) procedure, we can conclude that all variables are no cointegrate and implies that the variables in VAR are not driven by common stochastic trends. But by independent stochastic trends.

1. Open Economy Model Base on External and Domestic Shocks (Model 1)

The empirical evidence about the impacts of external (world interest rate and term of trade) and domestic (supply, demand and nominal) shocks on Thai economy that represent by real GDP. The results of these effects summarized by the variance composition. We also illustrate the dynamic of adjustment through the impulse response functions.

Table 3
Testing for stationarity.

	Test statistic							
	ADF[a]		*DF–GLS*[a]		*PP*[a]		*KPSS*[b]	
Variables	*Level*	*Difference*	*Level*	*Difference*	*Level*	*Difference*	*Level*	*Difference*
	–1.306	–6.966**	–1.306	–6.953**	–1.397	–7.229**	0.839^	0.085^^
	–2.672	–11.211**	–0.846	–9.537**	–2.578	–11.466**	0.540^	0.246^^
	0.410	–9.581**	1.412	–9.397**	0.852	–9.657**	0.956^	0.326^^
	0.316	–4.152**	1.558	–2.073*	–0.536	–14.146**	1.270^	0.111^^
	–2.382	–7.819**	–1.971*	–7.855**	–1.884	–7.735**	0.287^^	0.178^^
	–1.614	–7.451**	1.614	–7.401**	–1.540	–6.776**	1.272^	0.197^^
	–3.505**	–6.198**	–2.832**	–2.825**	–5.052**	–14.358**	0.037^^	0.110^^

* and ** indicate *t*-values being significant at 5% and 1% level respectively implying no unit root in the series.

^ indicates that the series is non-stationary and ^^ denotes that the series is stationary.

[a] Critical value of ADF and PP test at 5% level is –2.89; DF-GLS test at 5% level is –1.95.

[b] Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test assumes that the null hypothesis is stationary and the critical value at 1% level is 0.739.

Table 4
VAR lag length selection criterion.

	LR[a]		*AIC*[b]		*SIC*[c]	
Lag	*Model 1*	*Model 2*	*Model 1*	*Model 2*	*Model 1*	*Model 2*
1	59.52104	67.34665	–17.29334	–9.746949	–16.33728*	–9.176171
2	75.54920	74.60314	–17.84827	–10.34373	–16.09549	–9.316327
3	37.71637	78.38658*	–17.82980	–11.04542	–15.28030	–9.561400*
4	47.32339*	26.06749	–18.07204	–11.05112	–14.72582	–9.110474
8	37.49295	24.55819	–19.00402*	–11.10766*	–12.47093	–7.340523

*Denotes lag length that minimizes criterion.

[a] LR: sequential modified LR test statistic (test at 5% level)

[b] AIC: Akaike Information Criterion selection.

[c] SBC: Schwarz Bayesian Criterion.

External shocks

The external shocks have a little role to explain the growth rate of real GDP fluctuations. The world interest rate shock explains around 10% in long run. Terms of trade shocks account for roughly 10% in short-run and decreasing trend after 2 years. The Terms of trade shock mainly explain the movement of real exchange rate and price in long run at 10% and 36% respectively.

The impulse response functions in figure 2 has shown the impact of terms of trade shock seem to decrease the output permanently in long run. In additional, the terms of trade shocks effect the output at

Table 5
Variance Decomposition from model 1[a]

	Forecast		*Structural shock*				
Variable	*Period*	*Std. error*	*World interest rate*	*Terms of trade*	*Supply*	*Demand*	*Nominal*
Real GDP	1	0.03	0.23	0.37	91.20	0.66	7.54
	5	0.04	1.33	11.62	66.38	12.92	7.76
	12	0.05	8.90	9.24	63.27	10.86	7.74
	30	0.06	10.30	6.70	68.03	9.47	5.50
Real Exchange rate	1	0.04	0.25	10.91	1.29	74.54	13.01
	5	0.05	3.88	11.22	14.28	57.79	12.84
	12	0.05	4.90	11.65	14.20	56.22	13.02
	30	0.05	4.97	11.60	14.60	55.84	12.98
Price Level	1	0.01	0.87	36.47	0.00	7.42	55.24
	5	0.01	4.38	36.77	2.54	8.50	47.81
	12	0.01	4.92	31.58	8.79	11.39	43.32
	30	0.01	5.57	28.93	14.60	11.16	39.74

[a]Entries show percentage of forecast-error variance explained by each structural shock for the selected.

higher magnitude than the world interest rate shock. The world interest rate shock has a little affect to real GDP. It seems to increase real GDP after the first year and converse to base line path after the third years. The dynamic response of real exchange rate and price are mainly driven by terms of trade shock. The terms of trade shock lead to depreciate real exchange rate and increase the price in short run.

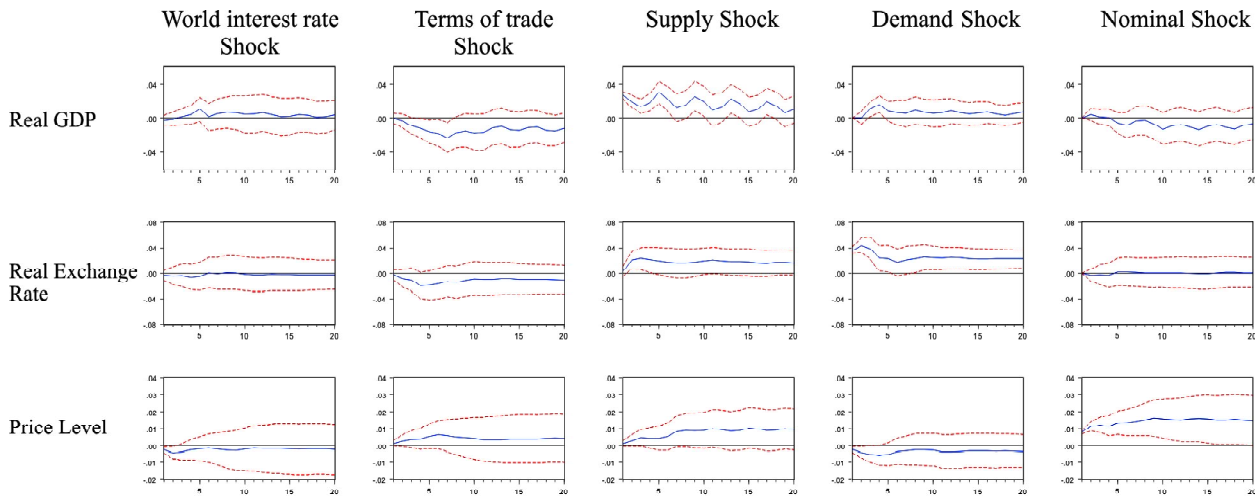

Figure 2: Impulse responses using the model 1

Domestic shocks

The movement of the growth rate of real GDP, real exchange rate and price fluctuations is mainly explained by domestic shocks around 90% (table 5) in the first year. But the external shocks have a small role by the fraction around 10%. For domestic shocks, the supply (technology) shock is the major source of macroeconomic fluctuation in Thai economy, which explain around 66%. The demand shock (IS) and nominal shock (LM) are 13% and 8% in short-run. In the long run, both demand and nominal shocks trend to slightly decreasing over time. The results are similar to many research, for instance Shapiro and Watson (1988), Gali (1992), Hoffmasiter and Roldos (1996 and 2001). They indicating the important role of technology shock as the major source of macroeconomic fluctuations. Additionally, the output growth fluctuation can explain significantly by demand and nominal shocks. The fiscal shock has increasing trend in the next periods. It confirming that government should carefully focus on fiscal policies to reach the stable state. The impact of nominal shock has a little effect on output by decreased more significantly over 3 years. The real exchange rate variances are mostly determined by the demand shock. It approximately 74% and gradually decrease in long run. The major source of price movement is nominal shock. It accounts for over 55% and decline rapidly after 2 years.

The dynamic of adjustment has shown in figure 2, the impulse response of supply shock drives the real GDP at a higher magnitude than other kind of shocks in both short run and long run. It clearly that, the government of Thailand should employ the supply side to push up economy. The dynamic adjustment of demand shock lead to output growth fluctuations in short run and thereafter converse to base line path in long run. But the real GDP has a little effect to nominal shock by gradually decrease in the long run. The nominal shock has a smallest effect to real exchange rate in the first year. The higher magnitude of supply and demand shocks lead to appreciation of real exchange rate both short run and long run. The nominal shock lead to increase price higher than supply shock. But the demand shock decrease price at the first year and converse to base line path in long run.

2. Open Economy Model Base on *AD – AS* Shocks (Model 2)

In this part, we have focused on impact of *AD* (productivity and labor supply) and *AS* (fiscal and monetary) shocks to explain business cycles in a small open economy like Thailand. We identify four structural shocks; Monetary, fiscal, productivity and labor supply shocks. The results indicate that the sequence of shocks help us to explain the fluctuations of the macroeconomic from the last two decades.

Aggregate demand shocks

The first model let us know that the fiscal and nominal shocks play a small role to explain real GDP fluctuation. It similar to the second model. The variance decompositions have shown in table 6. The fluctuations of real GDP growth rate are explained by monetary and fiscal shocks about 22% and 15%. in short run. The monetary shock declines rapidly after the first year and the fiscal shock gradually decline after two years. Hence, both the fiscal and monetary shocks are important sources of the real GDP growth rate fluctuation in short run. Finally, the fiscal and monetary shocks have a small role to explain real wage fluctuation.

The fluctuations of unemployment rate are the large share by fiscal and monetary shocks around 33% and 48% in short run. It clear that the movement of unemployment rate is causing by monetary

Table 6
Variance decomposition of real GDP from the model 2[a]

	Forecast		*Structural shock*			
Variable	*Period*	*Std. error*	*Productivity*	*Labor supply*	*Fiscal*	*Monetary policy*
Real wage	1	0.03	91.40	6.48	1.32	0.80
	5	0.03	81.23	10.35	6.50	1.92
	12	0.03	78.20	12.14	7.40	2.26
	30	0.03	76.30	13.90	7.52	2.29
Real GDP	1	0.03	3.20	59.20	22.20	15.41
	5	0.04	10.13	54.81	24.66	10.39
	12	0.05	9.36	62.03	19.32	9.29
	30	0.05	8.00	67.28	17.01	7.71
Real exchange rate	1	0.03	10.14	4.84	58.33	26.69
	5	0.04	13.06	17.03	48.40	21.52
	12	0.04	13.35	16.92	48.48	21.25
	30	0.04	13.33	17.38	48.21	21.08
Unemployment rate	1	0.37	2.15	15.72	33.71	48.42
	5	0.61	18.97	16.73	15.04	49.26
	12	0.67	17.66	23.50	13.10	45.74
	30	0.69	16.70	27.89	12.70	42.72

[a]Entries show percentage of forecast-error variance explained by each structural shock for the selected.

policy. The fluctuations of real exchange rate are explaining by fiscal and monetary policy shocks about 58% and 26% and thereafter decline in long run. The fiscal shock is the most important behind the variation on the real exchange rate in long run.

The impulse response or cumulative dynamic effects of fiscal and monetary disturbances shown in the figure 3. The monetary shock has only a small negative effect on real GDP and real wage in the first year and thereafter positive effect in next year. In additional, these finding suggest that fiscal shocks have a little output effect and leaving output unchanged in the long run. The real wage response to fiscal shock by increase at the first year and thereafter decline rapidly to zero standard deviation band. The real exchange rate response to fiscal shock by appreciate at higher magnitude than monetary shock. Consistent with Dornbusch's overshooting model. The response of these variables thereafter decreases gradually to the long run path. After three years, the standard error is stable. The monetary shock has a larger positive effect on the unemployment rate. But the fiscal shock decrease unemployment rate overtime.

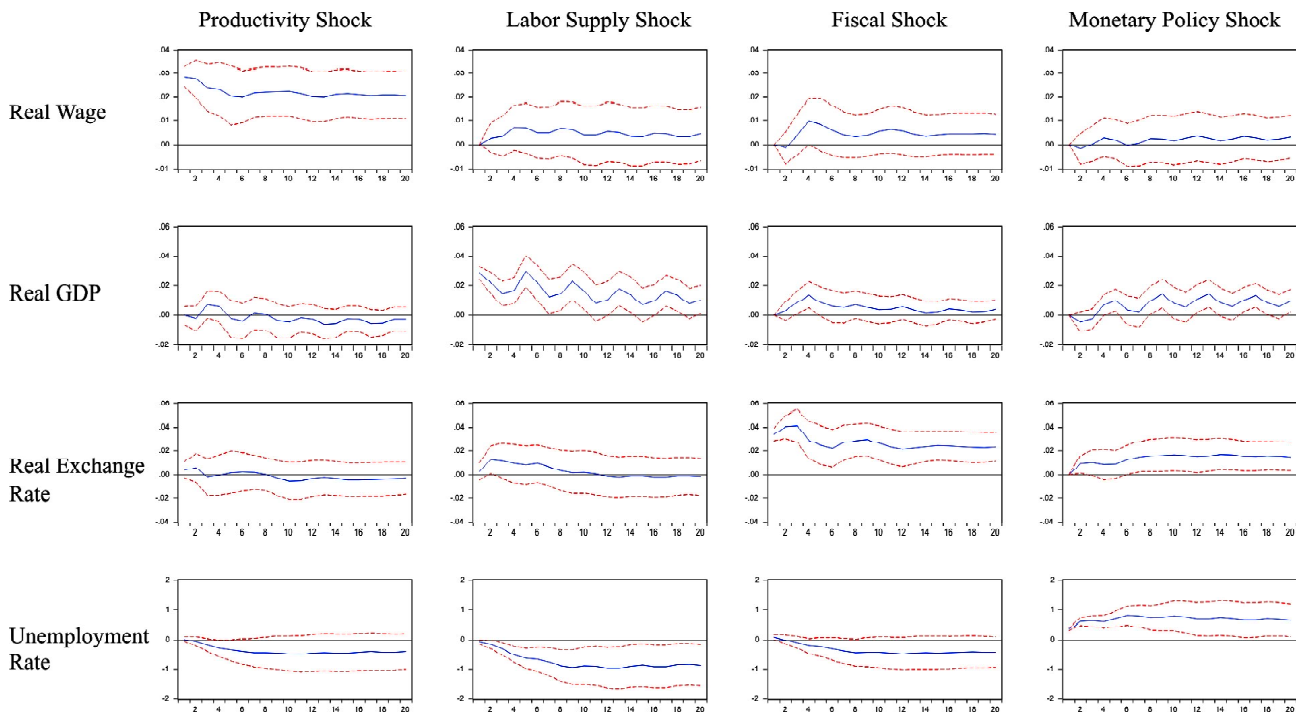

Figure 3: Impulse responses using the model 2.

Aggregate supply shocks

The variance decomposition of aggregate supply disturbance account for 60% to explain the fluctuation of real GDP growth rate (table 6). In detail, the labor supply and productivity shocks explain about 50% and 10%. The labor supply and productivity shocks gradually increases the real GDP in long run. But the productivity shock decreases the real GDP in long run. Labor supply and productivity shocks explain respectively 15% and 2% of unemployment variation and gradually increases in long run. Productivity and Labor supply shocks explain about 10% and 5% of real exchange rate variation in the first year and stable at 13% and 17% after two years. Finally, productivity shock has the most important to explain variation in real wage more than 90%. But the labor supply shock explains about 10%.

The dynamic adjustment of productivity shock has a short and long run positive effect on real wage at higher magnitude than the labor supply shock. The labor supply shock increases real GDP permanently over time. The productivity shock increases real GDP at the first year and converse to the base line path. The productivity shock hasn't clearly effect to the real exchange rate. The labor supply shock appreciates the real exchange rate in short run. The productivity and labor supply shocks to the unemployment rate falls temporality. But the labor supply shock decreases the unemployment rate at higher magnitude AS demand for employment rise to increase by enough to match the higher supply potential.

5. CONCLUSIONS AND SUMMARY

The objective of this paper is to analyze the main sources of macroeconomic fluctuations in Thailand. In order to identify the sources of macroeconomic fluctuations, the study employ the Structural Vector Autoregression (VAR) with data covered from 1993 to 2016. The first model analyses the main sources

from external shocks (world interest rate and terms of trade shocks) and domestic shocks (supply, demand and nominal shocks). The second model analyses the main sources from aggregate supply shocks (productivity and labor supply) and aggregate demand shocks (fiscal and monetary shocks).

The empirical evidence from the first model suggests some interesting of the business cycles fluctuations in the Thai economy. The technology shock (supply shock) play the large role in explaining the growth rate of output fluctuations. This evidence is related to available evidence for the previous studies (Blanchard and Quah (1989), Shapiro and Watson (1988) and Gali (1992)). The demand shock has important role in long run. But the nominal shock has important role in short run. This study also finds a small role for external shocks in explaining macroeconomic fluctuations. But the dynamic adjustment of real GDP to terms of trade shock is high magnitude. These implies that the important of foreign inflation for Thai economy. The result from this study contrast with Mendoza (1995) finds that external shocks, in particular terms of trade shocks, explain roughly 50 per cent of the output fluctuations in Latin American countries. The real exchange rate is largely determined by demand shock, one would expect. This is consistent with the evidence for developing countries (Froot and Rogoff, 1991). The movement in the rate of inflation for Thai economy during sample period are mostly by domestic shocks.

The second model, we identified shocks with the standard Keynesian theory on macroeconomic fluctuations. However, following a monetary and a fiscal shock has temporary effects on real GDP. The labor supply shocks are the main source of real GDP fluctuation. The productivity shock has a small role for explain the real GDP fluctuations in long run. The fact that labor supply has a large effect on real GDP may suggest that authority who capture the part of macroeconomic policy that has been especially aimed to stabilize economic growth. Hence, both the *AD* and the AS shocks are important sources of the fluctuations in Thai economy in the short run. But the AS shocks are important in long run.

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