

Sources of Exchange Rate Volatility in Thailand

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Abstract

This study aims to examine the pass-through effects of key macroeconomic variables on the exchange rate in Thailand by using a Vector Autoregressive (VAR) analysis. The macroeconomic variables used in this study are exchange rate, GDP, CPI, money supply, and oil price from the period of 1993Q1 through 2008Q4. The results from the VAR analysis suggest that first, all key macroeconomic variables, including GDP, CPI, money supply, and oil price, have affected exchange rate volatility from impulse response analysis. Second, for the variance decomposition analysis, CPI shock has the most influential effect on exchange rate volatility. Finally, the causality test suggests that GDP absorbs all of the effects from exchange rate, money supply, CPI, and oil price. At the same time, GDP affects money supply as well. In sum, the results imply that changes in key macroeconomic variables are likely accompanied by exchange rate volatility.

JEL Classification: F31, C22

Keywords: Exchange rate, VAR model, causality

1. Introduction

The exchange rate is one of the essential economic indicators of an economy's international competitiveness because it has a strong influence on economic developments, foreign trade, and capital account, which includes portfolio investment and foreign direct investment (FDI). Thus, many studies have attempted to focus on a linkage between macroeconomic variables and exchange rate volatility, particularly in terms of output, money growth, inflation, and interest rate volatility. Some of these papers have presented a significant relationship between macroeconomic variables and exchange rate volatility, such as Karras et al. (2005), Kopecky (2004), and Ito and Sato (2006). On the other hand, Flood and Rose (1995) have found that macroeconomic volatility is not an important source of exchange rate volatility for G-7 countries. This study aims to investigate the sources of exchange rate volatility in Thailand in order to understand the sources of fluctuations in exchange rate.

In general, the movements of exchange rate stem from several factors, such as economic fundamentals, policy intervention, and expectations. In many cases, the exchange rate movements are also driven by psychological factors. However, this study is intended to cover only fundamental economic factors. After the collapse of the Bretton Wood system about four decades ago, many empirical studies indicated that

exchange rate behavior has significantly changed since many countries switched to the floating rate regime. In addition, the increasing globalization of economies has led to higher volatility in exchange rate (Karras et al., 2005). Understanding the causes of exchange rate fluctuation helps both private and public sectors to reduce their risk from serious situations. Furthermore, policy makers are able to design policy instruments or intervention strategies to intervene in the exchange rate. This paper consists of five sections. Section 2 reviews the related literature. Section 3 presents methods used in the analysis. Section 4 presents empirical results, and the last section concludes.

2. Literature Review

Most of the literature in this area is concerned about whether the exchange rate changes have had a significant impact on macroeconomic variables, e.g. output, inflation, capital flow, and money supply. For instance, Ito and Sato (2006) focus on the pass-through effects of exchange rate changes on the domestic prices in East Asian countries, namely Indonesia, Korea, Thailand, Malaysia, and Singapore, by using the VAR framework. They find that the response of CPI to exchange rate shocks is positive and significant in Korea and Thailand, but the degree of exchange rate pass-through is much smaller in these countries than in Indonesia. Indonesia has the largest response of domestic variables to exchange rate shocks. Berument and Pasaogullari (2003) focus on the effects of real depreciation on the economic performance of Turkey, including three core variables, real exchange rate, inflation, and real output, by considering quarterly data from 1987:1 to 2001:3. This study employs a VAR analysis and Granger causality test to examine the relationship between them. They first analyzed the bivariate relationship between the set of the variables of interest. Consequently, VAR models are estimated, and the forecast error variance decompositions and impulse responses obtained from the VAR models are examined. The empirical evidence suggests that neither inflation nor output in the core model is influential in explaining the forecast error variance of the real exchange rate. However, in alternative models, including the current account and the capital account, reveal that the capital account and the current account have explanatory power in explaining the level of inflation and output that is consistent with economic theory. Moreover, the results show a negative effect between output and real exchange rate from the bivariate analysis. The Granger causality test does not show significant causality between the variables. However, they also found that a long-run relationship exists among the real exchange rate, inflation, and output. Similar to Odusola and Akinlo (2001) examine the impact of exchange rate depreciation on inflation and output in Nigeria by employing the VAR framework as well. Evidence from the study revealed the existence of mixed results of the impacts of exchange rate depreciation on output in both medium and long terms. These results tend to suggest that the adoption of a flexible exchange rate system does not necessarily lead to output expansion, particularly in the short term. Furthermore, they find that official exchange rate shocks are followed by increases in prices, money supply, and parallel exchange rate.

At the same time, macroeconomic factors are also believed to be a force behind exchange rate volatility. Thus, several studies, including this study, have provided another point of view investigating the sources of exchange rate volatility. For example, Karras et al. (2005) examine whether there were remarkable increases in exchange rate volatility as impulse or propagation after the end of the Bretton Woods era. This study employs the VAR model to investigate the relationships among

macroeconomic variables, including exchange rate, the Federal Funds rate, money stock (M_2), and industrial production. They use monthly and quarterly data from two periods; the first period is 1957:1 to 1971:12, under the Bretton Woods system, with low volatility. The second period is covered from the 1973:1 to 2000:12 under floating exchange rates with high volatility from developed countries; namely, the U.S., Canada, Germany, and the U.K. The results suggest that after the collapse of the Bretton Woods system, exchange rate volatility led to increase so much. The possible reasons are the changes in economic structures, e.g. regime switching and increases in variability, such as violent economic shocks. Furthermore, they found that the increased exchange rate volatility was entirely the result of more violent shocks. They also concluded that after the Bretton Woods period, exchange rate volatility was likely more supportive of the idea that impulse, rather than propagation. Another point of view, Kopecky (2004), by using high frequency exchange rate data, examined the reaction of the Czech Crown/USD spot exchange rate to public macroeconomic announcements originating from the U.S. and the Czech Republic. He directly tests the efficient market hypothesis. The exchange rate data cover the period 1997-2002, and the announcements of the actual/official data used in this paper consist of U.S. and Czech macroeconomic announcements for the same period of time. The analysis of the volatility yields a spike in the ten minutes following the Czech announcements; however, tests of an efficient market hypothesis do not support the specific effects of any announcements due to Czech macroeconomic announcements.

3. Methodology

For the study of sources of exchange rate volatility, I would like to examine the macroeconomic variables that influence this. The previous literature employed several methodologies to investigate the relationship between macroeconomic variables, such as least squares analysis, panel data studies, macro model simulations, and VAR models. With the many advantages of a VAR approach, like allowing for the investigation of the multivariate model and identifying structural shock through variance decomposition, the VAR model is motivated to choose the list of variables to capture important sources of volatility in this study. It is one of the most popular methodologies and is widely used for multivariate time series analysis.

Vector Auto Regressive (VAR) models have been widely used in empirical studies of macroeconomic issues since they were launched for such purposes by Sims (1980). He suggests that it should be feasible to estimate large scale macro-models as unrestricted reduced forms, treating all variables as endogenous. Sims also criticized the way in which classical simultaneous equation models are identified, as well as questioned the exogenous assumptions for some variables not necessarily backed by theoretical framework. In contrast, the VAR model overcomes this problem by treating all variables as endogenous variables. The tools employed by a VAR analysis, for example, Granger causality test, the co-integration test, impulse response analysis, the error correction mechanism, and variance decomposition. These applications can explain the relationship among variables and their behavior. However, in this study, I would like to concentrate on impulse response analysis, variance decomposition, and the causality test. Based on these considerations, I have selected a VAR model with five endogenous variables, as follows:

EX	=	Exchange Rate
Y	=	Gross Domestic Product (GDP)
CPI	=	Consumer Price Index
M	=	Money Supply
O	=	Oil price

The basic VAR process can be expressed in this form:

$$Y_t = \mu + \sum_{i=1}^p \phi_i Y_{t-i} + u_t, \quad t = 1, 2, \dots, T.$$

$$u_t = R\varepsilon_t, \quad p \geq 1 \text{ and } 1 \leq i \leq p$$

where,

Y_t	=	vectors are observable
μ	=	vector of intercept term
ϕ_i	=	vector of coefficient
ε_t	=	vector of error term
R	=	unknown fixed non-singular matrix

$$\varepsilon_t \sim \text{iid } N(0, I), \quad t = 1, 2, \dots, T$$

The data set in this study consists of quarterly time series data of macroeconomic variables; namely, the exchange rate, GDP, CPI, money supply, and oil price of Thailand. The data were obtained from the Bank of Thailand (<http://www.bot.or.th>), covering the period of 1993Q1 through 2008Q4.

4. Empirical Results

This study employs a 5-variable VAR, including exchange rate, GDP, consumer price index (CPI), money supply, and oil price. Structural shocks to exchange rate and other variables are identified through a Cholesky decomposition of innovations. It is investigated how exchange rate responds to macroeconomic variable shocks through the impulse response function analysis, variance decomposition, and causality test. For this study, the appropriate lag length of the VAR is determined by using standard model selection criteria HQ, the Hannan-Quinn information criterion. Adoption of a general-to-specific modeling approach points to a VAR of order 2 as an adequate representation of the data.

4.1 Stationary Tests

It is necessary first to determine whether the series is stationary. This study employs the augmented Dickey-Fuller (ADF) test (Dickey and Fuller, 1979, 1981) and the Phillips-Perron (PP) test (Phillips and Perron, 1988). The null hypothesis (H_0) of the ADF and PP tests is that the variable is non-stationary. A result rejecting H_0 means that it does not have a unit root and the series is static I(0). The unit root test is a method to determine whether the time series data are consistent with I(1) process with a stochastic

trend (non-stationary) or I(0) process that is stationary. The results are reported in Table 1 as following:

Table 1 ADF and PP test statistics

Unit Root Test	ADF-test		PP-test	
	No trend	Trend	No trend	Trend
EX	-1.890768	-1.116907	-1.724903	-1.380911
GDP	-0.912066	-2.742165	-0.548419	-2.476122
MS	0.113880	-1.145348	0.119379	-1.155296
CPI	-1.162158	-2.556774	-1.225044	-2.014802
OP	-0.788689	-4.235850*	-1.503218	-2.728950
Δ EX	-5.960286*	-6.020032*	-5.757267*	-5.827326*
Δ GDP	-2.381361	-2.251064	-8.255357*	-8.197784*
Δ MS	-6.418241*	-6.323665*	-6.425113*	-6.330766*
Δ CPI	-5.047447*	-4.943464*	-2.547266	-2.401674
Δ OP	-4.608140*	-2.912925	-1.648515	-1.459921

*denotes significance at the 1% level

**denotes significance at the 5% level

As can be seen from the table1, all variables are likely non-stationary at level. They all seem to stationary at first different or I (1) process.

4.2 Impulse Response

The impulse response analysis is one of the popular tools in empirical studies covering the dynamic relationship between macroeconomic variables within VAR models. It measures the time profile to the effect of shock or impulse on the expected future values of a variable. This study also employs this application to investigate the response of exchange rate to other macroeconomic variables. The results are shown as follows:

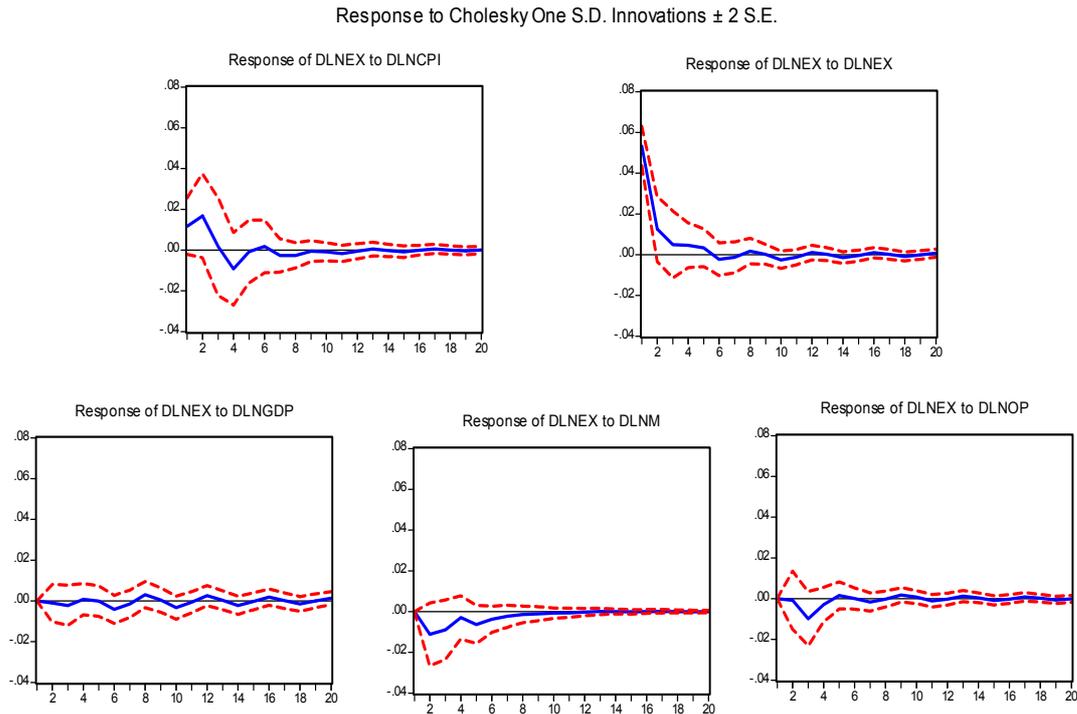


Figure 1. Impulse response of exchange rate to other economic variables

The results display the impact of the one-unit volatility shock from key macroeconomic variables on exchange rate volatility. They suggest that exchange rate responds to all macroeconomic variable shocks, including CPI, GDP, money supply, and oil price. The highest level of exchange rate volatility response is attributable to its own shocks. However, shock from GDP has little impact and highly persistent effect that take more than 5 years to stabilize, followed by money supply shock of around 2 years. For the rest, it takes only 5-6 quarters or more than one year to return to equilibrium.

4.3 Variance Decomposition

The properties of the estimated VAR models are also often described with the help of variance decomposition. The graph shows what percentage of total variance is explained by each macroeconomic variable. This is an average over years. The results of the variance decomposition tests are presented as follows:

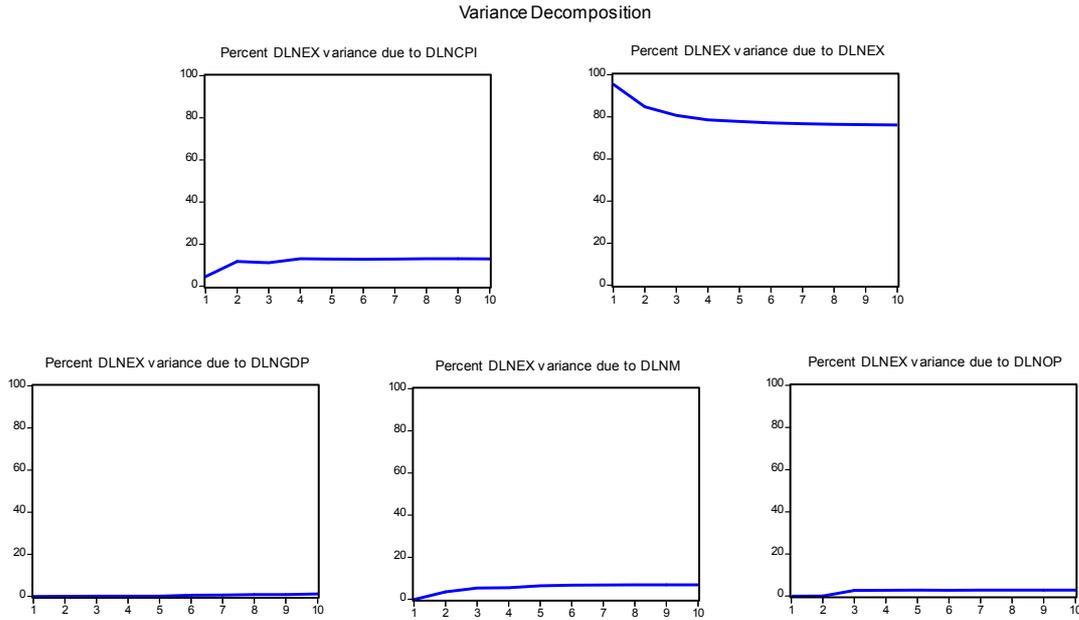


Figure 2. Variance decomposition of exchange rate to other economic variables

The results show that 1% of CPI shock has the most influence on exchange rate volatility, of about 11.8 %, followed by 6.7 % and 2.7 % from money supply and oil price shocks, respectively. Similar to impulse response analysis, variance decomposition presents the that exchange rate responses a small volume (less than 1%) to GDP shock.

4.4 Causality Test

The concept of a causality test was first introduced by Granger (1969). It explains the cause and effect between two variables, or pairwise analysis. In this part of the present study, I would like to examine the cause and effect between exchange rate, GDP, CPI, money supply, and oil price by using the causality test. Suppose X_t and Y_t are the time series that we want to test. Necessary condition, X_t and Y_t are stationary with a zero mean.

$$\Delta Y_t = \alpha_0 + \sum_{i=1}^P \alpha_i \Delta Y_{t-i} + \sum_{i=1}^P \beta_i \Delta X_{t-i} + e_t$$

(X_t causes Y_t if β_i is not equal to zero)

$$\Delta X_t = a_0 + \sum_{i=1}^P a_i \Delta Y_{t-i} + \sum_{i=1}^P \gamma_i \Delta X_{t-i} + u_t$$

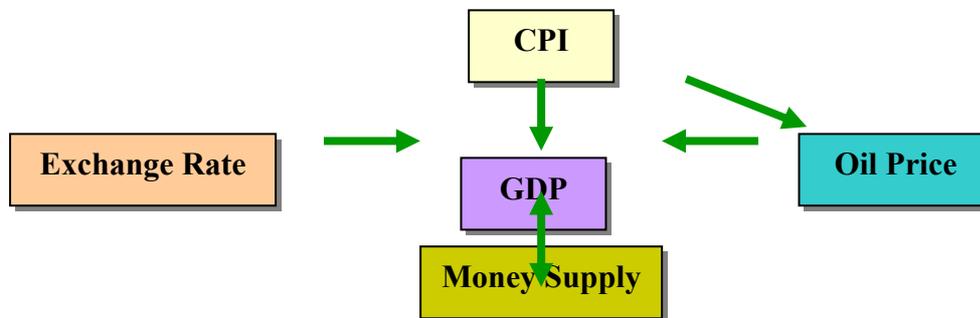
(Y_t causes X_t if a_i is not equal to zero)

The results indicate a feedback phenomenon between macroeconomic variables in three ways: uni-directional, bi-directional, and no causality. The results of the causality test are presented in the following:

Table 2 Causality Test

Variable	Relationship	χ -squared	P-value
Δ GDP and Δ MS	Δ GDP \longrightarrow Δ MS	8.774745	0.0124*
	Δ MS \longrightarrow Δ GDP	8.216164	0.0164*
Δ GDP and Δ EX	Δ EX \longrightarrow Δ GDP	9.190217	0.0101*
Δ GDP and Δ CPI	Δ CPI \longrightarrow Δ GDP	6.135014	0.0465*
Δ GDP and Δ OP	Δ OP \longrightarrow Δ GDP	10.92879	0.0042*
Δ CPI and Δ OP	Δ CPI \longrightarrow Δ OP	11.07685	0.0039*
The rests	no causality		

Note: A \longrightarrow B denotes causality running from variable A to variable B
 *denotes significance at the 5% level.

**Figure 3.** Causality of macroeconomic variables

The results suggest that in the case of Thailand, the GDP absorbs all of the macroeconomic effects, including exchange rate, money supply, CPI and oil price. This means that changes in these variables have an impact on GDP. Furthermore, GDP and money supply have a bi-directional causality, and changes in the CPI cause oil prices to change as well. These relationships imply that policy makers are able to use the money supply as an intermediate target of monetary policy in order to achieve their ultimate target, economic growth. However, the finding of a non-significant F-value suggests that no macroeconomic variables had causality to exchange rate in the case of Thailand during this period of time. This seems to contradict the previous results from the impulse response analysis and variance decomposition.

5. Conclusions

This study has examined the sources of exchange rate volatility for the period from 1993Q1 to 2008Q4 by using the VAR model with the application of impulse response analysis, variance decomposition, and causality test. The results indicate reasonable and statistically significant coefficients. From the impulse response analysis and variance decomposition, it can be seen that exchange rate volatility depends on all of the effects of the selected macroeconomic variable shocks; namely, CPI, GDP, money supply, and oil price. In terms of the impulse response analysis, exchange rate has a small volume impact and long time adjustment to equilibrium from GDP shocks while CPI shock exhibits the highest degree of force on exchange rate volatility via the variance decomposition tool. However, the causality tests show different results from the

previous ones. GDP is affected by all of the selected macroeconomic variables, but there were no sources of exchange rate volatility from these macroeconomic variables in the case of Thailand during this period.

In summary, the results from the impulse response analysis and the variance decomposition imply that changes in Thailand's key macroeconomic variables are likely to be accompanied by changes in exchange rate volatility. However, the causality test presents conflicting results in that there are no sources of exchange rate volatility from GDP, CPI, money supply, or oil price.

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