สยามวิชาการ ปีที่ 23 เล่มที่ 2 ฉบับที่ 41 สิงหาคม 2565 – ธันวาคม 2565
Siam Academic Review Vol.23, No.2, Issue 41, August 2022 – December 2022

Received: Mar. 19, 2022 ● Revised: Aug. 3, 2022 ● Accepted: Aug. 6, 2022

A Probit Model and Probability of Monetary Policy Decision: Thailand Case

แบบจำลองโพรบิตกับความน่าจะเป็นในการตัดสินใจดำเนินนโยบายการเงิน: กรณีประเทศไทย

Varunya Suksawang [1]
Pichit Eamsopana [2]
Pratya Pinmanee [2]
Surachai Pattarabanjird [2]

Abstract

This paper created a probit model to test what were the important factors affecting the probability of making a monetary policy decision. It followed next to apply the model to forecast the probability of making a monetary policy decision under the given inflation and economic growth rates. The results indicated that the change in headline inflation rate had negative impact on the probability of making an easy monetary policy decision. In other words, if the size of change in headline inflation rate increased, the probability of an easy monetary policy decision would decrease. The finding of this study coincided with the economic concept because the easy monetary policy increases gross domestic product but at the same time puts upward pressure on general price level causing condition of inflation. The greater the change in headline inflation rate in size, inflation condition is even more intense. As a result, the probability of making a decision to implement an easy monetary policy is reduced.

[1] Lecturer, Department of Finance and Investment, Faculty of Business Administration, Siam University, 38 Petchkasem Road, Bangwa, Phasicharoen, Bangkok 10160, Thailand, Corresponding Author, email: varunya.suk@siam.edu

[2] Lecturer, Department of Finance and Investment, Faculty of Business Administration, Siam University, 38 Petchkasem Road, Bangwa, Phasicharoen, Bangkok 10160, Thailand

Keywords: *Probit Model, Probability of Monetary Policy Decision*

บทคัดย่อ

บทความนี้ต้องการสร้างแบบจำลองโพรบิตเพื่อทำการทดสอบว่า ปัจจัยสำคัญใดส่งผลกระทบต่อความน่าจะเป็นในการตัดสินใจดำเนินนโยบายการเงิน จากนั้นจึงนำแบบจำลองโพรบิตมาทำนายความน่าจะเป็นในการตัดสินใจดำเนินนโยบายการเงินภายใต้อัตราเงินเฟ้อและอัตราการขยายตัวทางเศรษฐกิจที่กำหนดมาให้ ผลการศึกษาพบว่า การเปลี่ยนแปลงอัตราเงินเฟ้อทั่วไปมีผลกระทบเชิงลบต่อความน่าจะเป็นในการตัดสินใจดำเนินนโยบายการเงินแบบผ่อนคลาย กล่าวอีกนัยหนึ่ง ถ้าการเปลี่ยนแปลงอัตราเงินเฟ้อทั่วไปมีขนาดเพิ่มขึ้น ความน่าจะเป็นของการดำเนินนโยบายการเงินแบบผ่อนคลายจะมีค่าลดลง ผลการศึกษาที่ได้สอดคล้องกับแนวคิดทางทฤษฎี ทั้งนี้เพราะนโยบายการเงินแบบผ่อนคลายช่วยเพิ่มรายได้ประชาชาติ แต่ในขณะเดียวกันก็เพิ่มระดับราคาทั่วไปทำให้เกิดภาวะเงินเฟ้อ ยิ่งการเปลี่ยนแปลงอัตราเงินเฟ้อทั่วไปมีขนาดเพิ่มขึ้น ภาวะเงินเฟ้อก็ยิ่งรุนแรงมากขึ้น เป็นเหตุให้ความน่าจะเป็นในการตัดสินใจดำเนินนโยบายการเงินแบบผ่อนคลายลดลง

คำสำคัญ: *แบบจำลองโพรบิต, ความน่าจะเป็นในการตัดสินใจดำเนินนโยบายการเงิน*

Introduction

The macroeconomic policy consists of the monetary policy and fiscal policy. The monetary policy can be divided into 2 types. The first type, easy monetary policy, is to increase money supply in the economic system to stimulate the gross spending, national income, along with the production and employment with the objective of solving the economic downturn and unemployment. The second type, tight monetary policy, is to decrease money supply in the economic system to solve the problem of inflation (Mingmaninakin, 2016). The Bank of Thailand will send a signal to pursue an easy monetary policy by decreasing the policy interest rate (bilateral bond repurchase rate, 1-day term) and will send a signal to pursue a tight monetary policy by increasing the policy interest rate. The decision to implement a particular monetary policy is made by Monetary Policy Committee (MPC) of The Bank of Thailand. The committee meets to make a policy decision in every 6 weeks or 8 times in a year. At present, a monetary policy decision is taken under the inflation targeting (from May 23, 2000 to present). In 2021, the movement of the headline inflation is determined between 1 and 3 percent range (Bank of

Thailand, 2021). Therefore, the rate of inflation is the most important factor in determining the monetary policy.

However, if we use the AD-AS model to analyze the monetary policy, we can see that it actually has impact on the headline inflation and the national income. The easy monetary policy increases the quantity of money available in the economy causing inflation but it increases the national income resulting to a positive effect on the economic growth. On the contrary, a tight monetary policy decreases the money supply alleviating the problem of inflation but it causes lessening of the national income resulting to a negative effect on the economic growth (Noiprom, 2018). For this reason, making monetary policy decision, it is the result to win one and to lose the other. An interesting research question is that, in practice, (in principle, it is to keep the target of the inflation rate as a priority) The Bank of Thailand will pursue to make the choice between to control the inflation rate and to stimulate the growth rate of the economy. This paper tries to answer this question by using a probit model in order to test what important factors affecting the probability of making a monetary policy decision and next it attempts to forecast the probability of making monetary policy decision under given inflation and economic growth rates.

Literature Reviews

Waiquamdee and Mahuttikarn (2006) studied Thailand's development of the monetary policy during 10 years after the 1997 Thailand financial crisis. They found that before the crisis, The Bank of Thailand used the monetary policy of exchange rate targeting, keeping the Baht stable. This policy helped international trade and investment quite well but there was a limitation, which was preventing monetary policy to maintain domestic economic stability. In addition, the Baht speculation problem arose. After the crisis, in August 1997, The Bank of Thailand used the monetary policy of monetary targeting and later in May 2000, it was changed to inflation targeting monetary policy until the present. Within the framework of the inflation targeting, The Bank of Thailand will signal monetary policy action through the policy interest rate with the objective to control the movement of inflation rate within the framework. One major change alongside the adoption of the inflation targeting was policy transparency, e.g., inviting external experts to join the MPC, press conferences on the results of the Monetary Policy

Committee meetings, etc. This study of Waiquamdee and Mahuttikarn (2006) indicated that inflation played a key role in monetary policy decision.

Noosuwan (2012) studied the probabilistic determinants of monetary policy of South Korea, Thailand, and The Philippines using a probit model. The dependent variables were directions of the policy rate change, i.e., increased (+), unchanged (0), and decreased (-). The independent variables were determined from the Taylor Rule, i.e., previous policy rate, direction of the policy rate change of the previous period, gap between the observed inflation rate and the desired rate, output growth, rate of change of domestic currency, growth rate of world oil prices, The Federal Reserve's policy interest rate changes, and the rate of increase in the supply of broad money. They used time series data from January 2000 to July 2011 and found that in South Korea, the output growth impacted the probability of change in the policy rate. In Thailand, the probability of change in the policy rate was influenced by the previous policy rate, gap between the observed inflation rate and the desired rate, output growth, the Federal Reserve's policy interest rate changes, and the rate of increase in the supply of broad money. Finally, in The Philippines, direction of the policy rate change of the previous period, gap between the observed inflation rate and the desired rate, rate of change of domestic currency, growth rate of world oil prices, and The Federal Reserve's policy interest rate changes impacted the probability of change in the policy rate.

Khuamgerd, Wanaset, and Silphipat (2013) studied Granger causality among policy rate, inflation rate, 3 months fixed deposit interest rate, index of stock exchange of Thailand, real Thai Baht index, labor cost index per 1 unit of production, minimum loan rate of commercial banks, and gross domestic product. They used quarterly time series data from quarter 4 of 2000 to quarter 4 of 2012 in total of 49 quarters and found that changes of inflation rate and 3 months fixed deposit interest rate were the cause of the policy interest rate change.

Sherdshai, Wanaset, and Sajjanand (2014) studied relationship among money supply, policy interest rate, and inflation of Thailand using data of broad money supply, policy interest rate, and general consumer price index from quarter 1 of 2002 to quarter 4 of 2012. They used Cointegration Test and Granger Causality Test and found that in the long run, there was equilibrium relationship (Cointegration) among broad money supply, policy interest rate, and general consumer price index. A change in the general consumer price index caused a change

in the policy interest rate and a change in the policy interest rate caused a change in broad money supply. This study implied that the inflation rate was a major factor that influenced an increase or a decrease in the policy interest rate. Then, a change in the policy interest rate would impact money supply in the economy.

Wongsawas (2016) studied impact of money supply to Thailand economic growth using yearly time series data from 1997 to 2013 from many reliable sources. The study found that in the long run, there was equilibrium relationship (Cointegration) between the broad money supply and the economic growth. Moreover, in the short run, if the broad money supply and the economic growth deviated from the long run equilibrium, the result of Error Correction Model suggested that there was a mechanism to bring the two variables back to the long run equilibrium again. This study indicated that an easy monetary policy increased money supply and was able to stimulate the economy. Therefore, the economic growth could be one of factors that The Bank of Thailand used to make monetary policy decisions.

Method

Data

We used quarterly time series data from quarter 1 of 2008 to quarter 4 of 2020 that included economic growth rate, headline inflation rate, and decision to change (or not change) the policy interest rate. These data were obtained from The Bank of Thailand's monetary reports, March of 2008 to December of 2020.

Unit Root Test

An econometric study about time series data commonly begins from data stationary testing. This is because economic time series data are often non stationary, stochastic trend, e.g., income and spending tend to rise together, positive correlation, but the trend is just a coincidence and unreliable. We use Augmented Dickey-Fuller Test (Stock and Watson, 2007) for the data stationary testing.

Equations

$$\Delta X_t = \propto + \gamma X_{t-1} + \sum_{i=1}^{4} \varphi_i \Delta X_{t-1} + e_t \quad (1)$$

The hypotheses

$H_0: \gamma = 0$ (Non stationary)

$H_1: \gamma \neq 0$

where

α, γ, φ are parameters

e_t is an error at time of t

X_t is a variable to be tested

Rejection of $H_0: \gamma = 0$ indicates that the variable is stationary and can be used in the probit model.

Probit Model

Stock and Watson (2007)'s probit model for probability in making an easy monetary policy decision can be written as

$$Pr(EMP = 1|\Delta GDP_t, \Delta INF_t) = \emptyset(Z) \quad (2)$$

$$Z = \beta_0 + \beta_1 \Delta GDP_t + \beta_2 \Delta INF_t \quad (3)$$

where

$Pr(\Delta GDP_t, \Delta INF_t)$ is probability of an easy monetary policy decision given rates of change in the economic growth and the headline inflation.

EMP is an easy monetary policy decision. $EMP = 1$ if The Bank of Thailand decreases the policy interest rate and $EMP = 0$ if The Bank of Thailand increases or maintains the policy interest rate.

ΔGDP_t is change in economic growth rate

ΔINF_t is change in headline inflation rate

Z is the statistic number of the *Z* probability distribution

$\emptyset$ is cumulative probability distribution function

$\beta_0, \beta_1, \beta_2$ are parameters

The hypotheses

$H_0: \beta_1 = 0$ (Change in economic growth rate does not play a role in the decision to implement an easy monetary policy)

$H_1: \beta_1 \neq 0$

$H_0: \beta_2 = 0$ (Change in headline inflation rate does not play a role in the decision to implement an easy monetary policy)

$H_1: \beta_2 \neq 0$

The probit model for a tight monetary policy can be written as

$$Pr(RMP = 1|\Delta GDP_t, \Delta INF_t) = \emptyset(Z) \quad (4)$$

$$Z = b_0 + b_1\Delta GDP_t + b_2\Delta INF_t \quad (5)$$

where

$Pr(\Delta GDP_t, \Delta INF_t)$ is probability of a tight monetary policy decision given rates of change in the economic growth and the headline inflation.

RMP is a tight monetary policy decision. $RMP = 1$ if The Bank of Thailand increases the policy interest rate and $RMP = 0$ if The Bank of Thailand decreases or maintains the policy interest rate.

b_0, b_1, b_2 are parameters

We use the probit model to test whether or not current changes in economic growth rate and headline inflation rate can predict current monetary decision. If the current changes can predict the decision, the probability of the monetary policy decision should be more than 50 percent.

Results

Stationary test

Table 1 shows stationary test of changes in economic growth rates |ADF t-statistic| of 5.500137 while |critical value| is 3.577723. |ADF t-statistic| is greater than |critical value|.

Therefore, H_0 is rejected meaning that data of changes in economic growth rates are stationary (non stochastic).

Table 2 shows stationary test of changes in headline inflation rates |ADF t-statistic| of 7.873653 while |critical value| is 3.577723. |ADF t-statistic| is greater than |critical value|. Therefore, H_0 is rejected meaning that data of changes in headline inflation rates are stationary (non stochastic).

As a result, we can use data of changes in the economic growth rates and the headline inflation rates to develop a probit model to find probability of monetary policy decision.

Table 1 The result of the stationary test of changes in the economic growth rates

Null Hypothesis: D(GDP) has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic based on AIC, MAXLAG=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.500137	0.0000
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Source: by calculation

Table 2 The result of the stationary test of changes in the headline inflation rates

Null Hypothesis: D(INF) has a unit root

Exogenous: Constant

Lag Length: 3 (Automatic based on AIC, MAXLAG=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.873653	0.0000
Test critical values:	1% level	-3.577723	
	5% level	-2.925169	
	10% level	-2.600658	

*MacKinnon (1996) one-sided p-values.

Source: by calculation

Probability of an easy monetary policy decision

Table 3 shows the probit model estimation for calculating the probability of an easy monetary policy decisions:

$$\Pr(\mathrm{EMP} = 1|\Delta\mathrm{GDP}_t, \Delta\mathrm{INF}_t) = \emptyset(\mathrm{Z}) \quad (6)$$

$$\mathrm{Z} = -0.83232 + 0.021178\Delta\mathrm{GDP}_t - 0.86346\Delta\mathrm{INF}_t \quad (7)$$

$(\mathrm{Z} - \mathrm{statistics})$	(0.34036)	(-2.840029)
$(\mathrm{p} - \mathrm{value})$	(0.7336)	(0.0045)

β_1: the result of the hypothesis testing tells us that H_0 cannot be rejected meaning that a change in economic growth rate does not impact the probability of an easy monetary policy decision, $p-value$ is 0.7336 that is greater than the significance levels of 0.01, 0.05, and 0.1.

β_2: the result of the hypothesis testing tell us that H_0 is rejected meaning that change in headline inflation rate negatively impacts the probability of an easy monetary policy decision, the coefficient is negative and $p-value$ is 0.0045 that is less than the significance levels of 0.01, 0.05, and 0.1. In other words, if the change in headline inflation increases in size, the probability of an easy monetary policy is lower. This finding is consistent with the theoretical concept, i.e., an easy monetary policy increases gross domestic product while it also increases the price level causing the inflation. Hence, the larger the change in headline inflation, Inflation condition is even more intense causing probability of making a decision to implement an easy monetary policy to be reduced.

Then, insert values of ΔGDP_t and ΔINF_t in (7) to calculate Z.

After that, insert the calculated Z in (6), then look the Z distribution table to find the probability. The probability of an easy monetary policy decision should be more than 50 percent in the quarter when the policy interest rate cut is announced. Probability calculation results (shown in Table 5) tells us that from 2008 to 2020, there are 14 quarters of announcement of the policy interest rate cut. Five of them have the probit model predicting a probability above 50 percent, showing that changes in economic growth and changes in headline inflation rates can predict 5 quarters of 14 easy monetary policy decisions, accounted for 35.71 percent.

Table 4 shows the probit model estimation for calculating the probability of a tight monetary policy decision:

$$\Pr(\mathrm{RMP} = 1|\Delta\mathrm{GDP_t}, \Delta\mathrm{INF_t}) = \emptyset(\mathrm{Z}) \quad (8)$$

$$Z = -1.12062 - 0.071187\Delta\mathrm{GDP_t} + 0.111904\Delta\mathrm{INF_t} \quad (9)$$

$(\mathrm{Z} - \mathrm{statistics})$	(-0.929621)	(0.548405)
$(\mathrm{p} - \mathrm{value})$	(0.3526)	(0.5834)

β_1: the result of the hypothesis testing tells us that $\mathrm{H_0}$ cannot be rejected meaning that a change in economic growth rate does not impact the probability of a tight monetary policy decision, $\mathrm{p} - \mathrm{value}$ is 0.3526 that is greater than the significance levels of 0.01, 0.05, and 0.1.

β_2: the result of the hypothesis testing tells us that $\mathrm{H_0}$ cannot be rejected meaning that a change in economic growth rate does not impact the probability of a tight monetary policy decision, $\mathrm{p} - \mathrm{value}$ is 0.5834 that is greater than the significance levels of 0.01, 0.05, and 0.1.

Consequently, changes in rates of economic growth and headline inflation do not affect the probability of making a tight monetary policy decision.

Then, insert values of $\Delta\mathrm{GDP_t}$ and $\Delta\mathrm{INF_t}$ in (9) to calculate Z.

After that, insert the calculated Z in (8), then look the Z distribution table to find the probability. The probability of a tight monetary policy decision should be more than 50 percent in the quarter when the policy interest rate increase is announced. Probability calculation results (shown in Table 6) tells us that from 2008 to 2020, there are 7 quarters of announcement of the policy interest rate increase. However, the probit model predicts a probability below 50 percent in every quarter, showing that changes in economic growth and changes in headline inflation rates cannot predict tight monetary policy decisions.

Table 3 Probit model estimation result for an easy monetary policy decision

Dependent Variable: EMP

Method: ML - Binary Probit (Quadratic hill climbing)

Sample (adjusted): 2008Q2 2020Q4

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-0.832320	0.228971	-3.635050	0.0003
DGDP	0.021178	0.062221	0.340360	0.7336
DINF	-0.863460	0.304032	-2.840029	0.0045

M. dependent var	0.274510	S.D. dependent var	0.450708
S.E. of regression	0.391953	Akaike info criterion	0.992380
Sum squared resid	7.374106	Schwarz criterion	1.106017
Log likelihood	-22.30569	Hannan-Quinn criter.	1.035804
Restr. log likelihood	-29.97234	Avg. log likelihood	-0.437366
LR statistic (2 df)	15.33331	McFadden R-squared	0.255791
Probability (LR stat)	0.000468		

Obs with Dep = 0	37	Total obs	51
Obs with Dep = 1	14		

Source: by calculation

Table 4 Probit model estimation result for a tight monetary policy decision

Dependent Variable: RMP

Method: ML - Binary Probit (Quadratic hill climbing)

Sample (adjusted): 2008Q2 2020Q4

Included observations: 51 after adjustments

Variable	Coefficient	Std. Error	z-Statistic	Prob.
C	-1.120620	0.228170	-4.911343	0.0000
DGDP	-0.071187	0.076577	-0.929621	0.3526
DINF	0.111904	0.204053	0.548405	0.5834

M. dependent var	0.137255	S.D. dependent var	0.347540
S.E. of regression	0.353538	Akaike info criterion	0.899432
Sum squared resid	5.999483	Schwarz criterion	1.013069
Log likelihood	-19.93551	Hannan-Quinn criter.	0.942856
R. log likelihood	-20.39739	Avg. log likelihood	-0.390892
LR statistic (2 df)	0.923757	McFadden R-squared	0.022644
Probability (LR stat)	0.630099		

Obs with Dep = 0	44	Total obs	51
Obs with Dep = 1	7		

Source: by calculation

Table 5 Probability of an easy monetary policy decision in the quarter when the policy rate cut is announced

Announcement of the policy interest rate cut	Z	Probability $\emptyset(Z)$	Reference range, Probability of 0.5
Quarter 4 of 2008	3.482378	0.9986	more than 0.5
Quarter 1 of 2009	1.191275	0.8830	more than 0.5
Quarter 2 of 2009	1.351744	0.9115	more than 0.5
Quarter 4 of 2011	-0.881513	0.1894	less than 0.5
Quarter 1 of 2012	-0.168116	0.4325	less than 0.5
Quarter 4 of 2012	-0.868989	0.1922	less than 0.5
Quarter 2 of 2013	-0.198733	0.4207	less than 0.5
Quarter 4 of 2013	-0.881029	0.1894	less than 0.5
Quarter 1 of 2014	-1.104065	0.1357	less than 0.5
Quarter 1 of 2015	0.564041	0.7123	more than 0.5
Quarter 3 of 2019	-0.394237	0.3483	less than 0.5
Quarter 4 of 2019	-0.689277	0.2451	less than 0.5
Quarter 1 of 2020	-0.904325	0.1841	less than 0.5
Quarter 2 of 2020	1.632626	0.9484	more than 0.5

Source: by calculation

Table 6 Probability of a tight monetary policy decision in the quarter when the policy rate increase is announced

Announcement of the policy interest rate increase	Z	Probability $\emptyset(Z)$	Reference range, Probability of 0.5
Quarter 3 of 2008	-1.061648	0.1446	Less than 0.5
Quarter 3 of 2010	-0.892822	0.1867	Less than 0.5
Quarter 4 of 2010	-1.005723	0.1587	Less than 0.5
Quarter 1 of 2011	-1.091120	0.1379	Less than 0.5
Quarter 2 of 2011	-0.890745	0.1867	Less than 0.5
Quarter 3 of 2011	-1.163332	0.1230	Less than 0.5
Quarter 4 of 2018	-1.241665	0.1075	Less than 0.5

Source: by calculation

Conclusion

We used a probit model to test whether what factors affected the probability of making decision on monetary policy. Then, we predicted the probability of making monetary policy decision under given inflation and economic growth rates. The results of estimating and testing the probit model hypotheses concluded that changes in headline inflation had negative effect on the probability of easy monetary policy decisions. This was because easy monetary policy increases gross domestic product while at the same time increases the general price level, causing inflation. The greater the change in headline inflation in size, inflation condition was even more intense. As a result, the probability of making a decision to implement an easy monetary policy was reduced.

However, implementation of monetary policy to control inflation is a process that takes about 1 to 2 years from the announcement day of the policy interest rate adjustment (Moenjak, 2014). Therefore, a study of probabilistic determinants of a monetary policy decision should include inflation rate forecast for the next 1 to 2 years. The reason we did not include inflation rate forecast in the model was because we used quarterly data of inflation rates, while The Bank

of Thailand's inflation rate forecast was for the whole year. We recommend that those who wish to study the topic in the future try to use yearly data to include the inflation rate forecast in their models.

References

Bank of Thailand. (2021). *Monetary Policy Report: March 2021*. Bangkok: Bank of Thailand.

Khuamgerd, S., Wanaset, A., and Silphipat, S. (2013). *The Impacted of Monetary Policy Transmission on Inflation in Thailand after Implementation of Inflation Targeting Policy*. Paper presented in the 3rd STOU Graduate Research Conference, September 3-4, 2013 at Sukhothai Thammathirat Open University. (in Thai).

MacKinnon, J.G. (1996). Numerical Distribution Functions for Unit Root and Cointegration Tests. *Journal of Applied Econometrics, 11(6),* 601-618.

Mingmaninakin, W. (2016). *Principles of Macroeconomics*. Bangkok: Thammasat University Press. (in Thai).

Moenjak, T. (2014). *Central Banking: Theory and Practice in Sustaining Monetary and Financial Stability*. Singapore: John Wiley & Sons Singapore.

Noiprom, N. (2018). *Economics of Money and Banking*. Bangkok: Chulalongkorn University Press. (in Thai).

Noosuwan, C. (2012). Determinants of Central Bank's Decision on Policy Interest Rate under Inflation Targeting. *Thammasat Economic Journal, 30(1),* 84-127. (in Thai).

Sherdshai, P., Wanaset, A., and Sajjanand, S. (2014). *The Relationship between Money Supply, Policy Interest Rate, and Inflation of Thailand*. Paper presented in the 4th STOU Graduate Research Conference, November 26-27, 2014 at Sukhothai Thammathirat Open University. (in Thai).

Stock, J.H. and Watson, M.W. (2007). *Introduction to Econometrics*. New York: Pearson Education, Inc.

Waiquamdee, A. and Mahuttikarn, J. (2006). *Thailand's Monetary Policy over the Past Decade*. Paper presented in 2006 Annual Academic Seminar, December 9-10, 2006, Bank of Thailand. (in Thai).

Wongsawas, S. (2016). The Effects of Money Supply on Economic Growth of Thailand. *Journal of Thonburi University, 10(22),* 89-98. (In Thai).