Chapter 8

DETERMINANTS OF MONETARY POLICY TRANSMISSION VIA BANK LENDING CHANNEL IN THAILAND: A THRESHOLD VECTOR AUTOREGRESSION APPROACH

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1. Introduction

“Most economists would agree that, at least in the short-run, monetary policy can significantly influence the course of the real economy...There is far less agreement, however, about exactly how monetary policy exerts its influence.”

Excerpt from “Inside the Black Box: The Credit Channel of Monetary Policy Transmission,” Bernanke and Gertler (1995)

We have come a long way toward unraveling the black box on monetary transmission mechanism. Since the theoretical underpinnings of various channels have been found, an extensive sum of empirical researches have shed some light on what happen in the interim from changes in monetary policy to changes in output and inflation. In light of Thailand experience, the empirical results point to a transmission mechanism in which banks play an important role, through the adjustment of both price and quality of loans, relative to exchange rate and asset price channel. Disyatat and Vongsinsirikul (2002) argue that the traditional interest rate channel accounts for around half of output

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response after 2 years while Charoenseang and Manakit (2007) show that shocks to policy rate increase private credits significantly for about 4 month, which in turn help stimulate output mainly through private investment. Consequently, given the economy’s heavy reliance on the banking sector, monetary policy effectiveness is believed to depend largely on commercial banks’ rate adjustment as well as sensitivity of credits and deposits following changes in policy rate in Thailand.

In a changing economy, the channels of monetary transmission are unlikely to be constant over time. According to the preliminary studies done for recent policy easing cycle, the sensitivity of retail rates to money market rates’ reduction appears to decline, thereby suggesting a weakening interest rate pass-through after 2010. Meanwhile, monetary easing in Thailand seems to have less influence in boosting bank loan in the current credit decelerating trend. Therefore, in order to continuously ensure appropriate design and successful conduct of monetary policy, it is of great importance to be alerted of the impact of changes that alter the economic effects of given monetary policy measures. The main objective of this paper is thus to revisit the transmission via banking sector and identify the determinants behind those changes for Thai economy.

While there are studies that look into the influences of bank friction on monetary policy effectiveness both theoretical and empirical6, this paper’s aim is to test the effect of the boarder economic landscape on monetary policy effectiveness. Motivated by the current state of economy, we ask whether monetary policy is effective in an economic downturn period. Intuitively, the initial economic condition determines where we are on the aggregate supply curve and how large is the aggregate demand shift as a result of a monetary policy shock, hence the change in equilibrium output. A shift in aggregate demand could be larger when the economy is below par and firms are underleveraged but this trend could be offset by the effect of worsening business confidence. On the other hand, in an economic downturn phase, when there are large amounts of spare capacity available, the aggregate supply curve is expected to be very elastic. Hence, the effect of monetary easing on output is expected to be higher.

With the above hypothesis in mind, we ask whether/how the impact of monetary policy on macroeconomic dynamics changes with the phase of business cycle for Thailand. To conduct an empirical exercise, the threshold vector autoregression (TVAR) methodology is employed as it is appropriate for modeling regime shifts, i.e., shift between subpar and above par GDP regime. Our results

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indicate that the dynamics of the interactions among credit market condition, economic activities, and monetary policy seems to change as the economy moves from a subpar growth regime to an above-par regime. Although credit growth tends to show smaller response to monetary policy easing, possibly due to subdued private sector confidence, output response seems to be higher during a downturn when the economy is more likely to be have low capacity utilization.

To set stage for our discussion on monetary policy transmission, we begin by reviewing the conceptual framework of how transmission channels via banks could change with the phase of the business cycle in Section 2. Section 3 contains a brief overview/stylized facts on the transmission mechanism in Thailand. The methodology and database are presented in Section 4, followed by the empirical results from the TVAR analysis in Section 5. Section 6 concludes and the technical details are presented in the appendices.

2. Literature Review and Conceptual Framework

2.1 Conceptual Framework and Theoretical Considerations

Over the past decade, there are a growing number of literatures which seek to provide evidence that the effectiveness of monetary policy depends, among other factors, on the state of economic activities. This section provides a simple framework for investigating the various theories underpinning this concept. The merit of such a framework is that it allows us to bridge the arguments which rest on different assumptions and lines of reasoning suggested by each model with their following empirical results.

According to the traditional macroeconomic concept, the equilibrium of real output and the price level is determined by the intersection of the aggregate supply and the aggregate demand curves. Monetary policy affects such equilibrium, via its influence on aggregate demand. Monetary easing, for instance, lowers interbank financing costs, and commercial banks typically pass on the lower cost to their customers in terms of lower lending rates. At the same time, as funding costs become lower, banks also tend to expand their loan supply. As a result, private spending and aggregate output rise. Nevertheless, there is empirical evidence which suggests that loan demand and supply might also depend on factors other than costs of funds. The following section outlines the key determinants of loan demand and loan supply respectively. Finally, after considering the equilibrium in the credit market – which determines the aggregate demand curve – and the curvature of the aggregate supply curve, we then move on to explain how monetary policy effectiveness varies with the state of economic activities.
Transmission of monetary policy relies crucially on its role in influencing credit demand in three ways, as summarized in the following functional form.

\[ Loan \ demand = f(lending \ rate, \ expectation \ on \ economic \ outlook, \ borrower’s \ balance \ sheet) \]

Firstly, firms will increase their borrowing if the cost of funds falls below the internal rate of return. In this sense, the traditional strand of monetary transmission contends that monetary easing reduces the firm’s cost of fund, which then induces aggregate demand. However, such a conclusion rests importantly on the assumption that banks will pass on the lower cost to firms.

Secondly, firms’ demand for borrowing is positively correlated with their expectation on the outlook of the economy. A bright economic prospect will prompt firms to acquire more credits to fund their investments. This notion is supported by Kashyap, Stein, and Wilcox (1993) who provide evidence of a positive relationship between economic conditions and the demand for bank credit. Nevertheless, it is important to stress that such a conclusion requires monetary policy to be sufficiently credible, so that the monetary easing action is perceived to contribute to a brighter growth prospect going forward. In the absence of such credibility, the demand for loans may not be as responsive to the monetary stimulus.

Thirdly, firms’ demand for borrowing is also subject to the prevailing conditions of their balance sheets. Highly-leveraged firms or firms with deteriorating balance sheet conditions tend to face limitations in their external financing. In this respect, monetary easing can alleviate such tensions in their balance sheets, as a corresponding fall in the discount rate helps increase the net present value of firms’ assets. The channel in which monetary policy exerts its influence on firm’s balance sheet is generally referred to as the ‘balance sheet channel,’ which is one of the two strands of the credit channel of transmission.

On the supply side, the key factors which determine bank loan supply are the following:

\[ Loan \ supply = f(external \ finance \ premium, \ expectation \ on \ borrower’s \ balance \ sheet, \ level \ of \ risk \ aversion) \]

First of all, the financing condition of a financial intermediary has an influence on the supply of credit. Monetary policy exerts influence on a bank’s external...
funding cost by directly setting the policy rate, which in turn acts as short-term benchmark rates in the financial markets. At the same time, monetary policy influences market expectation of future path of interest rate, which then affects the costs of longer-term financing. In addition, monetary easing indirectly affects the default risk premium which banks face in tapping market financing due to its influence on banks’ balance sheets. Monetary easing which pump up asset prices also improve banks’ net worth in the same way as the effects of the aforementioned effects on firms’ balance sheet.

Firms’ balance sheets also play a role in determining the provision of credit. Bernanke and Gertler (1989) designed a model of business cycle with the inclusion of the role of firms’ balance sheets for highlighting this concept. Assuming that a bank maximizes profit and has to deal with imperfect information of the borrowers, the expected net worth of a firm serves as a leading indicator of a borrower’s probability to default. As a firm’s wealth deteriorates, adding to the possibility of a default, a bank may guard its wealth against such default risks by tightening the credit condition and vice-versa. The key implication is that this mechanism becomes a source of pro-cyclicality, exacerbating the downturn and fueling the expansion. Bayoumi and Melander (2008) developed the macrofinancial linkages and found significant evidence that credit conditions have influence on real spending.

Finally, loan supply may also vary with risk aversion of financial intermediaries which changes in response to business/economic outlook. Kahneman and Tversky (1979) proposed the so-called prospect theory which argues that when economic agents become risk averse in an environment, consumption will fall below a habit-based reference level – a concept which could also help explain the behavior of banks. The implication is that an economic recession usually concurs with some sort of confidence crisis, which further acts as a propagator of negative shocks to economic growth, delaying the recovery.

Putting together the factors affecting loan demand and supply would result in the equilibrium in the loan market. This, in turn, determines the magnitude of the shift in the aggregate demand curve following a monetary easing action. In the low-growth regime, for instance, if the sentiment factor dominates a fall in financing costs, then a shift in aggregate demand (AD) will be marginal. However, in the absence of negative sentiment or uncertainty, a shift in AD will be relatively larger.

The shape of the aggregate supply curve also plays a role in determining the effectiveness of monetary policy. Keynes is among the earlier supporters of
this argument which suggests that the aggregate supply (AS) curve is positively-sloped up to the expected price level and vertical afterwards as the economy reaches its long-run potential. The Keynesian concept implies that monetary policy shocks in the state of high economic activity are neutral but those in a low-activity environment are effective, implying that monetary policy is more powerful in a state of low economic growth than in the period of expansion.

Related theories include the ‘costly price adjustment’ strand, cited in Tsiddon (1993), and Ball and Mankiw (1994). Ball and Mankiw (1994) proposed the so-called “Menu Cost” model which is derived on microeconomic foundations. The model assumes that a single firm bears “the Menu Cost” of adjusting prices to maintain the relative price of its goods to the overall price, in a backdrop of continuing positive inflation. The authors argue that a positive inflation rate helps offset a negative shock in overall prices, bringing the relative price back to its preferable level without needing any downward adjustment. On the contrary, inflation acts as propagator of positive shock to the overall price and the firm has to raise its price even higher to shore up its relative price towards the desired level. Thus, a firm is more likely to adjust their price upwards rather than downwards, with implications of a convex aggregate supply curve.

Based on this simple AD-AS framework, the resulting equilibrium output depends on two forces – the magnitude of shift in the AD curve, and the slope of the AS curve. For instance, in a state of high economic activity, a monetary easing shock may shift AD significantly, but given the relatively steep AS curve, the effect on output would become smaller.

2.2 Empirical Evidence

2.2.1 Reviews of Literatures on Monetary Policy Transmission in Thailand

Literatures on transmission via the banking sector in Thailand are divided into two main strands. The first strand of research concerns the quantitative assessment of the consequences of a change in the policy rate on macroeconomic variables and how they change over time. The second strand focuses on the determinants of the transmission mechanism. Finally, we also outline the key factors underlying the evolution of monetary transmission in the past decade.

Regarding traditional interest rate channel, the prominent view is that there was a significant decline in the pass-through from the policy rate to bank retail rates in Thailand following the East Asian financial crisis in 1997. Using the
Error Correction Model (ECM) analysis, Disyatat and Vongsinsirikul (2002) argued that the retail rates in Thailand is generally sticky to policy rate movement compared to those in developed countries and they became stickier in the aftermath of the crisis. These results are consistent with Atchana and Singhachai (2008), whose work documents a decline in the responsiveness of retail rates to policy rate changes following the financial crisis, with stickiness of policy pass-through being most evident around 2004-2005. Also, Charoenseang and Manakit (2007) found that despite the observable long-run relationship between the policy rate and money market rates, the pass-through effect of the policy rate on banks’ retail rates is quite low, at about 20% during 2000-2006. The authors also estimated the vector autoregression (VAR) system on Thailand data during 2000-2006 and found that the policy rate does not strongly influence the lending rate, suggesting a weaker transmission through interest rate channel after the adoption of inflation targeting in 2000.

According to the abovementioned literatures, level of competition and the liquidity in the banking sector are noted as the two main catalysts. Disyatat and Vongsinsirikul (2002) contend that a cost of rate adjustment is higher in the less competitive banking sector than in a more competitive system. In addition Atchana and Singhachai (2008) argue that the degree of risk aversion in the banking system has changed since the outbreak of the 1997 financial crisis, as bank reserves greater portion of cash and liquid assets in excess of the legal requirement. Against this backdrop, marginal tightening in monetary policy would not be able to tempt banks to raise its lending rates. Charoenseang and Manakit (2007) draw a similar conclusion on excess liquidity. It was not until mid-2015 that the excess liquidity started to reduce, after which the interest rate pass-through began to pick up more evidently.

Most of the literatures on monetary transmission generally agree that the bank lending channel could help amplify the effect of interest rate shock beyond what would be predicted if the monetary policy were to transmit its effect through the interest rate channel alone. According to Disyatat and Vongsinsirikul (2002), monetary tightening leads to a fall in bank credits with about 3 quarters lag and bank loans also have significant implication on the impulse response of GDP from interest rate shocks. Similarly, Charoenseang and Manakit (2007) found that shocks to monetary policy induced major changes in commercial banks credits to private sector for about 4 months while commercial bank credits have strong impact on private investment.

However, there is a growing recognition that the significance of the credit channel and the importance of bank loans have declined since the crisis period.
As argued by Disyatat and Vongsinsirikul (2002), the sensitivity of loan supply to monetary shocks has gone down since 1999, along with effectiveness of monetary policy associated with the bank lending channel. By comparing the VAR of the whole sample and truncated data of up to 1999, the paper finds that the response of output and bank credits to monetary policy of a similar size is more pronounced in the pre-crisis period. The authors argued that this is attributed to a rise in prominence of non-deposit funding for banks, which serve as a cushion against a tightening of monetary policy, in turn reducing the sensitivity of loan supply and output to monetary shocks. Also, a firm can substitute nonbank financing for bank loans when monetary policy tightens.

In addition, Disyatat and Vongsinsirikul (2002) also focused on the financial health of the banking and corporate sector which affects how monetary shock is translated into bank credit, the chief motivation of our study. By effectively constraining new bank lending, a continued weakness in the banking sector following the crisis, tended to offset the impact of monetary easing. At the same time, excess capacity and balance sheet weakness in the corporate sector also act as a constraint on investment demand, thereby blunting the credit channel of monetary policy. We will elaborate more on this argument.

Nonetheless, there are also a few literatures, providing evidences in favor of an improved bank lending channel. Amarase and Rungcharoenkitkul (2014) offers a model to support the fact that greater bank competition and lower risk-free rate raise the screening costs, eventually leading to a pooling equilibrium involving larger credits at cheaper prices. In context of the Thai experience, a shift in Specialized Financial Institutions’ (SFIs) lending strategy may have triggered a transition of equilibrium from credit rationing to credit boom. As competition and risk-taking intensified during the 2011-2013 easing episode, banks strategically increased credit supply, as reflected by a compressed spread. Therefore, bank competition can play an important part in strengthening the impact of monetary policy on bank lending and economy during the current easing cycle.

In sum, based on literature of the Thai experience, banks are still central elements in monetary policy transmission mechanism. Nevertheless, its relevance has declined mainly through the price perspective. On top of the monetary policy framework which should influence the degree of transmission, the literature also point to (i) excess liquidity and competition in banking sector; (ii) financial deepening; and, (iii) financial health of banks.
2.2.2 Evidence of Non-linear Monetary Policy Influence on Real Output

Many literatures confirm the non-linear interaction between monetary policy and real output with regard to a state of economy. In the case of developed countries, the earlier study of Garcia and Schaller (2002) examined the goodness of fit of the Markov-switching model which treats the state of economy as a latent variable versus the linear model in simulating the response of output to policy rate. Their results confirm the existence of the asymmetry regarding the economic environment. Lo and Piger (2003) also deploy VAR analysis on the US data during 1954Q3 to 2002Q4 and find strong evidence of time variation in the relationship between monetary policy and output. Regressing the probabilities of change in this relationship on several state variables, the authors find strong evidence that regime shifts can be well explained by the phase of the business cycle. The study, however, finds no strong evidence in favor of asymmetry with regard to the direction of policy action and does not test whether policy direction matters within each growth regime. Some of the literatures adopt the threshold vector autoregression (TVAR) model, including Balke (2000) who tested the two-regime switching model and Avdjiev and Zeng (2014) who developed a three-regime switching model in similar spirit to Balke (2000). Both studies corroborate the existence of the asymmetry. Other papers include Weise (1999), and Thoma (1994).

Using U.S. data, empirical literatures show mixed results. The first group favors the argument for more potent monetary policy in a state of low-economic growth than those in high growth periods, namely Weise (1999), Balke (2000), Garcia and Schaller (2002), and Lo and Piger (2003) and Avdjiev and Zeng (2014). Estimations deployed in Garcia and Schaller (2002) affirms that the effect of monetary tightening on output is more powerful during recessions than during expansions.

According to the credit-rationing proposition, Balke (2000) finds that monetary tightening shocks are more potent in the tight-credit environment which is concurrent with the state of subdued economic activity and confidence. So do Avdjiev and Zeng (2014), who argue that monetary easing is more effective when economic agents are under credit constraint than when the agents are already fully financed. Note that the nature of asymmetry with regard to a state of economy depends on whether monetary policy action is expansionary or contractionary.
On the other hand, there is also evidence supporting the claim that monetary tightening is more effective in the low-growth regime. Thoma (1994) finds that monetary tightening has a stronger adverse effect on output which is significant during the three to five quarters after the policy action is taken. On the contrary, contractionary policy has no significant effect during recessions. Monetary policy is also found more potent in a state of high growth rates by Tenreyro and Thwaites (2015), consistent with the “pushing on the string” concept.

In the case of the Asian economies, there are mixed evidences on both the existence of non-linearity and in which regime monetary policy is more powerful. Hooi et al. (2008) employed a Generalized Hamilton Markov switching model in the same spirit as the prior work of Garcia and Schaller (2002). Utilizing quarterly data of Indonesia, Malaysia, Philippines and Thailand during 1974Q1 to 2003Q1, the results confirm the existence of asymmetry with respect to a state of economy and shows that monetary policy has larger effects on output during expansions. Shen (2000) applied a time-varying asymmetric model on Chinese Taipei data and failed to reject the linearity of a relationship between monetary policy and output. However, the point estimates imply that monetary tightening is more effective during the contraction and confirms the hypothesis of credit-rationing.

3. Overview of Thailand’s Monetary Policy and its Transmission

This section aims to provide stylized facts on how the dynamics between credit, economic activities, and monetary policy should interact during the period of economic downturn in Thailand. By analyzing a set of selected variables according to the conceptual framework laid out in second section, we will attempt to provide an analysis regarding the size of the aggregate demand shift and slope of the aggregate supply curve which should serve as an initial evidence on how credit conditions and eventually economic activities should change in response to monetary easing in a period of economic slump in Thailand. Simply put, this section serves as a qualitative review of the effectiveness of monetary easing in Thailand, before proceeding to the quantitative results from the TVAR approach in the following sections.

3.1 Aggregate Demand Curve and Credit Market Condition

As described in last section, the equilibrium credit and the size of shift in the AD curve is determined by both interest rates, i.e., external finance premium (EFP), and the sentiment of economic agents regarding economic outlook.
In the case of Thailand, in the period where GDP growth is subpar, the amount of credit could be highly responsive to monetary easing considering the possibility of reduction in EFP (proxied by probability of default for the Thai banking sector). As can be seen in Figure 1, the high level of EFP during the subpar growth implies a large space for reduction after monetary easing. Furthermore, the potential response of bank net worth (proxied by bank capital) to positive a policy shock and the association negative relationship between bank net worth and EFP (Figure 2) could provide amplification for the effect of monetary easing on the amount of credit supply. In other words, after monetary easing, banks’ net worth could increase, causing a decline in the EFP. With lower cost of funds, banks are more willing to increase their lending, thus contributing to a greater effect on output.

Figure 1
External Finance Premium and Economic Growth

![Figure 1](image)

Source: National Economic and Social Development Board, Bloomberg, Authors’ calculations.

Figure 2
External Finance Premium and Bank Capital

![Figure 2](image)

Source: Bank of Thailand, Bloomberg, Authors’ calculations.
Having said that, the fact that confidence is relatively low during subpar economic growth than in high-growth regime (Figure 3 and 4), this could mean that the pass-through of monetary easing to credit could be limited during the low-growth phase. In a period of economic downturn, banks tend to increase their credit standards, while firms have the tendency to lower their demand for loans given the worse sentiments. Hence, credit is likely to respond less to monetary easing during the subpar growth regime.

**Figure 3**

GDP Growth and Consumer Confidence

Source: University of the Thai Chamber of Commerce, National Economic and Social Development Board, Authors’ calculations.

**Figure 4**

GDP Growth and Business Sentiments

Source: National Economic and Social Development Board, Bank of Thailand, Authors’ calculations.

In determining the overall effect of a monetary shock on equilibrium credit and thus the size of shift in the AD curve during economic downturn, the EFP and the sentiment factor should both be taken into account. This is the essence of Section 5 where quantitative exercises are carried out to examine the overall effect of a monetary policy shock.
3.2 Aggregate Supply Curve and the Equilibrium Output

In addition to the size of shift in the AD curve, the slope of the AS curve is also vital in determining the output effect of monetary easing. As shown in Figure 5, in the declining phase of the business cycle, there are large quantities of spare capacity available (low capital utilization), suggesting that the AS curve is very elastic at low levels of output (Figure 6). Hence, monetary easing, which shift the demand curve to the right, could lead to greater impact on output.

**Figure 5**
GDP Growth and Capital Utilization

Source: National Economic and Social Development Board, Bank of Thailand, Authors’ calculations.

**Figure 6**
GDP Growth and Headline Inflation

Source: Bank of Thailand, Authors’ calculations.
4. Empirical Methodology

4.1 Model Specification

In this paper, the Threshold Vector Autoregression (TVAR) is used to explore the monetary policy transmission via the bank lending channel. As opposed to a linear VAR model, the TVAR enables us to test whether the effectiveness of monetary policy varies with the prevailing macroeconomic conditions. Moreover, another advantage of the TVAR is that it allows for non-linearity stemming from regime switching and asymmetric reaction to shocks. This is because the threshold variable is also included in the system of endogenous variables.

Several literatures which look at the monetary transmission mechanism via the bank lending channel use credit market conditions (Balke, 2000) as threshold variables. For instance, Avdjiev and Zeng (2014) employs real GDP growth as a threshold variable for separating two distinct phases of the business cycle.

The TVAR model specification used in this paper is as follows:

\[ Y_t = A Y_{t-1} I(c_{t-d} > \gamma) + B Y_{t-1} (1 - I(c_{t-d} > \gamma)) + \varepsilon_t \]

where \( Y_t \) is a vector containing endogenous variables, \( A \) and \( B \) are lag polynomial matrices while \( \varepsilon_t \) is structural disturbance term, \( c_{t-d} \) is the value of the threshold variable at time \( t - d \), where \( d \) is the lagged period of such variable, \( \gamma \) is the threshold value, which is determined using a selection criterion described in the following section. \( I(c_{t-d} > \gamma) \) is a function that takes the value 1 if the value of the threshold variable at time \( t \) exceeds \( \gamma \), and 0 otherwise.

We estimate the preceding TVAR model using monthly Thailand data that runs from January 2000 to March 2015. In our model, \( Y_t \) consists of 4 variables: (i) real GDP growth, which is translated from quarterly to monthly using the coincidence economic indicator as a proxy. This variable is also a threshold variable; (ii) inflation is calculated as the growth rate of headline CPI; (iii) policy rate; and, (iv) real private credit growth. Definition of variables and data sources can be found in Appendix A.

\[ \text{Definition of variables and data sources can be found in Appendix A.} \]

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7. All of the variables in growth rate form are calculated in terms of the current month’s data compare with the same period last year (year-over-year, yoy).
With regard to the selection of a regime variable, we emulate Avdjiev and Zeng (2014) whose study used real GDP growth to capture the dynamics of the relationship among the endogenous variables as output growth changes. Furthermore, the U.S. Industrial Production Index and Thai flooding dummy variables are used as exogenous variables, as they are factors which would likely affect domestic output, but are beyond the control of domestic monetary policy. Finally, we use a similar ordering of variables in the VAR system akin to those of most standard VAR literatures that adopt a recursive structure.

With regard to the lag order selection, our objective is to strike a balance between minimizing the conventional information criterion and maintaining a sizable number of observations in each regime to ensure reliability of results. In our case, although higher lags lower the information criterion, it results in too few observations in one regime or the other. With this in mind, we consider that VAR of order 1 to be the optimal choice, as this yields a meaningful number of observations in each regime, while not significantly compromising on the information criterion.

4.2 Threshold Value Selection

While estimating model (1), it is important to formally test for the presence of non-linearity, with a linear VAR under the null hypothesis and a threshold VAR under the alternative. A complication arises as the threshold value is unknown because the parameter $\gamma$ is identified only under the alternative, leading to a so-called nuisance parameter problem. A common testing approach consists of first conducting a grid search over $c_t$ and the possible threshold values, estimating each time the selected specification of the TVAR model and computing the test statistics on the restriction of equality between the linear and the non-linear models (see, for instance, Hansen (1996), and Balke (2000)).

The estimated threshold values are those that maximize the log determinant of the “structural” residuals. To avoid the overfitting problem, we trim some of the highest and lowest values, as is the case in Hansen (1996) and Balke (2000).

4.3 Impulse Response Function

We emulate Koop et al. (1996) in the construction of a Generalized Impulse Response Function for non-linearity models. The definition of the Generalized

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8. Schwarz information criterion (SIC).
Impulse Response Function (GIRF) is the response of a specific variable after a one-time shock hits the forecast of the variables in the model.

Firstly, we estimate the GIRF as follows:

\[
E[Y_{t+k} | \Omega_{t-1}, u_t] - E[Y_{t+k} | \Omega_{t-1}]
\]  

(2)

where \( \Omega_{t-1} \) is the past information set at time \( t - 1 \) and \( u_t \) is a particular realization of the exogenous shock. Typically, the effect of a single exogenous shock is examined at a time, so that value of the \( i \)th element in \( u_t \), \( u_t^i \) is set to a specific value. The difficulty arises because, in the TVAR, the moving-average representation is not linear in the shocks (either across shocks or across time). As a result, unlike linear models, the impulse-response function for the nonlinear model is conditional on the entire past history of the variables and the size and direction of the shock.

The conditional expectations of \( Y_{t+k} \) are calculated by simulating the model using randomly drawn shocks. To compute \( E[Y_{t+k} | \Omega_{t-1}] \), we use the random sample \( u_{t+k} \) by taking the bootstrap sample from the estimated model residual, \( u_t \). We repeat the simulation for \( -u_{t+j} \) in order to eliminate any asymmetry that might arise from sampling variation in the draws of \( u_{t+j} \). This is repeated 5,000 times, and the resulting average is the estimated conditional expectation.

5. Empirical Results

Based on the methodology outlined in the previous section, the estimated threshold of real GDP growth is 3.27% (year-on-year). Such a threshold essentially separates the observations into two regimes, henceforth called the high-growth regime and the low-growth regime. In this paper, our focus is on analyzing the impacts of monetary easing on three key macro variables: real GDP growth, headline inflation, and real credit growth.

The following section reports the responses of each variable under the two growth regimes, following a one-time monetary shock. As the responses are symmetric, we will only report the impacts of a monetary easing action, which seems more relevant given the current situation in Thailand. Finally, consistent with the literature of other economies, we expect monetary easing to have a larger impact on the real variables in the low-growth regime than in the high-growth regime. Details of the estimated equations are provided in Appendix B.
5.1 Responses of Real GDP Growth

In both regimes, real GDP growth responds positively to monetary easing, which in this case, is a one standard deviation (one-SD) shock in the policy interest rate. However, as seen in Figure 7, the magnitude of the response is higher in the low-growth regime than in the high-growth regime. In the low-growth regime, the response of real GDP growth peaks at around 0.28 SD (equivalent to 0.98% yoy), one quarter after the policy rate cut, while the peak is only 0.08 SD (0.28% yoy) in the high-growth regime. In both regimes, the effects of the shock die down at around the eighth quarter, after which the responses turn slightly negative.

In short, monetary easing seems to be more effective in raising output when the economy is in a low-growth regime than in a high-growth one – in line with our expectation. Nevertheless, the swift reaction of output to monetary shocks remains puzzling, particularly in contrast with the conventional notion that monetary policy typically has a lag of around 6-8 quarters.

5.2 Responses of Headline Inflation

In both regimes, headline inflation responds positively to monetary easing. No price puzzle is detected in the 35-month horizon investigated. Similar to the responses of output, monetary easing raises inflation more when in the low-growth regime than in the high-growth one. In the low-growth regime, the response of inflation peaks at around 0.16 SD (equivalent to 0.31% yoy), while the magnitude is halved in the high-growth regime. In both regimes, the peaked responses of inflation occur approximately two quarters after the shock. Regarding the persistence of the responses, the effects of the shock on inflation are virtually zero after twelve quarters.

5.3 Responses of Bank Credit

Overall, bank credit responds positively to monetary easing. In the low-growth regime, however, there is credit puzzle during the first three quarters, when bank credit falls and bottoms out after the first quarter. From Figure 7, it can be seen that bank credit responds more to monetary easing when in the low-growth regime than in the high-growth one, with the peak responses of around 0.27 SD (equivalent to 2.24% yoy) and 0.18 SD (1.51% yoy) respectively. In both regimes, the effects of monetary easing on bank credit gradually die down but remain fairly sizable even at the end of the 35-month horizon.
Figure 7
Responses of Real Variables to a One-SD Negative Monetary Shock

Source: Authors’ calculations.

Figure 8
Economic Growth and Detrended Bank Capital

Source: Bank of Thailand, authors’ calculations.
In an attempt to explain the different responses of bank credit in the two regimes, we investigated the role of bank capital in influencing the credit supply, by using capital as a threshold variable instead of real GDP growth. At the same time, bank capital is included as an endogenous variable in the VAR system in order to investigate its role as a shock propagator. In essence, this exercise allows us to track the evolution of bank credit after its capital is affected by monetary easing. In undertaking such an exercise, we opt for the de-trended capital ratio rather than the level of bank capital itself, as the latter is non-stationary and trends with economic growth over time. Therefore, removing its trend allows us to observe, in a more meaningful way, how bank capital evolves with the business cycle, on top of banks’ own discretion on capital holding. At the same time, this manipulation allows us to observe the interaction between bank capital and the state of economic activities. Indeed, a basic plot of real GDP growth and de-trended bank capital in Figure 8 shows that the two series are fairly correlated, particularly in the aftermath of the Global Financial Crisis in 2008.

Comparing the two charts on the left-hand-side of Figure 9, it is obvious that bank capital responds differently to monetary easing, depending on the initial condition of capital. In a low-capital regime, bank capital initially falls following a negative monetary shock, whereas in a high-capital regime bank capital responds positively. A fall in bank capital during the first two quarters helps explain the credit puzzle in the bottom right chart in Figure 9.

9. Henceforth, this de-trended bank capital will be referred to as ‘bank capital’ for simplicity’s sake.

10. Following the same methodology as the GDP exercise, the estimated threshold for de-trended capital is -0.22% (yoy).
5.4 Significance of Results

As explained in the methodology section, several attempts have been made to improve the significance of the regression. Exogenous variables such as the Industrial Production (IP) Index of the U.S. and the dummy variable for the flooding incident are included in the final model specification as they are factors which likely affect domestic output but are beyond control of domestic monetary policy. A number of other variables are also included, but seem to contribute only marginally to the overall significance of the regression.

Despite the aforementioned attempts, the explanatory power of the TVAR model remains fairly low for both regimes. As seen in Figure 10, the standard-error bands are therefore wide compared to the mean of responses for all three real variables, particularly for bank credit. This implies that the reported responses of real variables to monetary shocks are not statistically significant.

11. See Appendix B for the estimated equations.
6. Conclusion

We have come a long way in unveiling the black box on monetary transmission mechanism. In the case of Thailand, the empirical results point to a transmission mechanism in which banks play an important role, through the adjustment of both price and quality of loans, relative to the exchange rate and asset price channel. However, according to the preliminary studies done for the recent policy easing cycle, the quantity of bank lending and hence output, may not be as responsive to monetary policy actions as the central bank desires. Motivated by such a trend, the main objective of this paper is to identify the determinants behind those changes for the Thai economy. In particular, this paper asks whether and how the impact of monetary policy on macroeconomic dynamic changes with the phase of the business cycle, that is whether monetary policy is still effective during the economic downturns.

Intuitively, the initial economic conditions determine where we are on the aggregate supply curve and how large aggregate demand shifts in response to a monetary policy shock, with the resulting change in the equilibrium output. A shift in aggregate demand could be larger when economic growth is below par and firms are underleveraged but this could be offset by the effect of worsening business confidence. On the other hand, in the downturn phase, when there is ample spare capacity, the aggregate supply curve is relatively elastic. Hence,
the effect of monetary easing on output is expected to be higher than is the case during the boom times.

In conducting the empirical study to test the above hypothesis, the TVAR model with four endogenous variables, namely GDP growth, inflation, credit, and policy rate is adopted. Our results, which are consistent with the stylized fact found for Thailand’s data, provide evidence that the dynamics of the interactions among credit market conditions, economic activities, and monetary policy is likely to change as the economy moves from subpar growth regime to above-par regime. Although credit growth shows a smaller response to monetary policy easing during the initial period, possibly due to subdued private sector confidence, the output response seems to be higher during the downturn when the economy is more likely to have low capacity utilization.

At first glance, it might seem that our finding of greater effectiveness of monetary policy in the low-growth regime contradicts the anecdotal evidence of the recent sluggish recovery in Thailand. However, it should, by no means, convey the message that monetary easing is effective in the current economic backdrop, as there could be other factors that may hinder the accommodative power of monetary policy on output, but are not captured in our model. In order to fully comprehend the interplay of these factors, the model can be further improved to study their dynamics using different regime variables. The candidates for regime variables that have received attention by monetary policy transmission studies include the bank business model, financial market development and global liquidity.
References


Appendices

Appendix A: Definition of Variables and Data Sources

**Capital Adequacy Ratio (CAPR)**
Measuring adequacy of capital funds serving as absorption of losses potentially generated by risky assets, capital adequacy ratio is equal to aggregate capital funds divided by risk-weighted assets in percent. The data covers those of commercial banks registered in Thailand and also foreign bank branches and publicly reported on a monthly basis. Commercial banks are subject to Basel-based capital regulations. Banks registered in Thailand are required to maintain the ratio not below 8.5% since 1988 while foreign bank branches are subject to a 8.5% minimum requirement since 2013, compared to 7.5% during August 1988 and December 2012. *(Table F1_CB_030 and F1_CB_030_S2 Bank of Thailand Statistics)*

**Real Credit Growth (RCREDYOY)**
Credit is defined as end-month outstanding amount of commercial banks credit to domestic Other Nonfinancial Corporations (ONFCs), households, and Nonprofit Institutions Serving Household Sector (NPISH), in accordance with the Monetary and Financial Statistical Manual (MFSM2000). Credit growth is in year-over-year basis and expressed in percentage. *(Table EC_MB_012 Bank of Thailand Statistics (Jan-2000 to Dec-2002) and commercial bank private credit data used internally by Monetary Policy Group of Bank of Thailand (Jan-2003 to Mar-2015)*

**Real GDP Growth (RGDPYOY)**
Started with the quarterly dataset compiled by the National Economic and Social Development Board (NESDB), we constructed the monthly data of Gross Domestic Products by using interpolation to convert quarterly GDP to monthly data. While, we proxy movement of monthly GDP each month with movements of Coincidence Economic Indicator. The indicator is constructed from 5 components including real imports, manufacturing production index, real gross value added tax, volume sales of automobiles and real debit to demand deposit. GDP growth is on year-over-year basis and express in percentage. *(URL: http:/www.nesdb.go.th/Default.aspx?tabid=95)*

**Policy Rate (POL)**
The policy rate is the rate that The Monetary Policy Committee announced to conduct monetary policy in Thailand under the inflation-targeting framework. The 14-day repurchase rate (RP rate) was used as the policy interest rate up
until 16 January 2007, after which the policy interest rate was switched to the 1-day RP rate. Since 12 February 2008, with the closure of the BOT-run RP market, this was switched to the 1-day bilateral RP rate. Policy rate is on percent per annum basis and expressed in the end of the month. *(Table FM_RT_001 and FM_RT_001_S2 Bank of Thailand Statistics)*

*Headline Inflation Rate (HLCPIYOY)*

The headline consumption price index dataset collected by Ministry of Commerce used as inflation because the Monetary Policy committee has agreed to propose new monetary policy target for 2015. The new target is set for the annual average of headline inflation in 2015 to be at 2.5 percent with a tolerance band of ± 1.5 percent. Inflation rate is in year-over-year basis and expressed in percentage. *(URL: http://www.price.moc.go.th/content1.aspx?cid=1)*

*US Industrial production index (USIPIYOY)*

The US industrial production index measures the real output of all manufacturing, mining, and electric and gas utility establishments. Because of Thailand is a small open economy, it is important for controlling external factors. To distinguish the impact of policy rate to real GDP growth and headline inflation from global effects, US Industrial production is included as exogenous variable.

*Thai Flooding Dummy Variable (DUMFLD)*

Thailand has experienced severe flooding in 2011 that impacts to sharp drop in manufacturing sector and slump Real GDP growth. We applied the same way as US industrial production index variable by controlling other factor to influence monetary transmission mechanism. It takes a value of 1 for data since October 2011 to December 2011, and 0 otherwise.
## Appendix B: Estimation Results

### Table 1: Estimation Results: Whole Sample

<table>
<thead>
<tr>
<th>Dependent variables:</th>
<th>(1) RGDPYoy</th>
<th>(2) HLCPIYoy</th>
<th>(3) RCREDYoy</th>
<th>(4) POL</th>
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<tr>
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<td>0.19</td>
<td>-0.42</td>
<td>0.03</td>
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<td>(S.E.)</td>
<td>(0.40)</td>
<td>(0.14)</td>
<td>(0.49)</td>
<td>(0.04)</td>
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<td>(0.40)</td>
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<td>(0.11)</td>
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<td>USIPYIYoy</td>
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<td>0.02 *</td>
<td>-0.01</td>
<td>0.00</td>
</tr>
<tr>
<td>(S.E.)</td>
<td>(0.04)</td>
<td>(0.01)</td>
<td>(0.04)</td>
<td>(0.00)</td>
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<td>RGDPYIYoy(-1)</td>
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<td>0.02</td>
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<tr>
<td>(S.E.)</td>
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<td>(0.02)</td>
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<td>(0.00)</td>
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<td>HLCPIYIYoy(-1)</td>
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<td>0.05 ***</td>
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<td>(S.E.)</td>
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<td>(0.03)</td>
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<td>-0.004</td>
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<tr>
<td>(S.E.)</td>
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<td>(0.01)</td>
<td>(0.02)</td>
<td>(0.00)</td>
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<td>POL(-1)</td>
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<td>0.93 ***</td>
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<td>(S.E.)</td>
<td>(0.16)</td>
<td>(0.06)</td>
<td>(0.20)</td>
<td>(0.02)</td>
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</table>

Number of observation: 180
Degree of freedom: 173
Significant level of F-stat (p-val): 0.0000
Log likelihood: -355.7
D-W statistics: 1.7

Note: *, **, *** significant at 10%, 5% and 1% respectively.
Sources: Authors’ calculations.
Table 2: Estimation Results: Subsample in High Growth Regime

<table>
<thead>
<tr>
<th>Dependent variables:</th>
<th>(1) GDPPOY</th>
<th>(2) HLCPPOY</th>
<th>(3) RCRDPOY</th>
<th>(4) POL</th>
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</thead>
<tbody>
<tr>
<td>Constant (S.E.)</td>
<td>1.79 ** (0.70)</td>
<td>0.28 (0.19)</td>
<td>0.70 (1.03)</td>
<td>0.05 (0.06)</td>
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<tr>
<td>DUMFLED</td>
<td>0.00 ***</td>
<td>0.00 ***</td>
<td>0.00 ***</td>
<td>0.00 ***</td>
</tr>
<tr>
<td>USPIPOY (S.E.)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
<td>(0.00)</td>
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<td>RGDPOYOY(-1)</td>
<td>0.74 *** (0.07)</td>
<td>-0.01 (0.02)</td>
<td>-0.02 (0.10)</td>
<td>-0.01 (0.01)</td>
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<td>HLCPOYOY(-1)</td>
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<td>1.01 (0.02)</td>
<td>0.02 (0.11)</td>
<td>0.06 *** (0.01)</td>
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<td>RCRDPOY(-1)</td>
<td>0.02 (0.12)</td>
<td>0.01 (0.03)</td>
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<td>0.01 (0.01)</td>
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<tr>
<td>POL(-1)</td>
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<td>-0.08 * (0.01)</td>
<td>-0.07 (0.04)</td>
<td>0.94 *** (0.02)</td>
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Number of observations: 115
Degree of freedom: 109
Significant level of F-stat (p-val): 0.0000
Log likelihood: -225.8
D-W statistics: 1.8

Note: *, **, *** significant at 10%, 5% and 1% respectively.
Sources: Authors’ calculations.

Table 3: Estimation Results: Subsample in Low Growth Regime

<table>
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<tr>
<th>Dependent variables:</th>
<th>(1) GDPPOY</th>
<th>(2) HLCPPOY</th>
<th>(3) RCRDPOY</th>
<th>(4) POL</th>
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</thead>
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<td>Constant (S.E.)</td>
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<td>DUMFLED</td>
<td>-2.76 ** (1.23)</td>
<td>0.91 (0.60)</td>
<td>-1.55 ** (0.69)</td>
<td>0.22 (0.14)</td>
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<tr>
<td>USPIPOY (S.E.)</td>
<td>0.07 (0.12)</td>
<td>0.01 (0.04)</td>
<td>0.02 (0.03)</td>
<td>-0.004 (0.01)</td>
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<tr>
<td>RGDPOYOY(-1)</td>
<td>0.62 *** (0.05)</td>
<td>0.13 ** (0.02)</td>
<td>-0.04 (0.03)</td>
<td>0.04 *** (0.01)</td>
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<tr>
<td>HLCPOYOY(-1)</td>
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<td>0.89 *** (0.10)</td>
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<td>0.09 *** (0.02)</td>
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<td>RCRDPOY(-1)</td>
<td>0.00 (0.04)</td>
<td>0.01 (0.02)</td>
<td>0.99 *** (0.02)</td>
<td>0.01 ** (0.00)</td>
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<tr>
<td>POL(-1)</td>
<td>-1.33 * (0.66)</td>
<td>-0.35 (0.33)</td>
<td>0.77 ** (0.38)</td>
<td>0.68 *** (0.38)</td>
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Number of observations: 65
Degree of freedom: 58
Significant level of F-stat (p-val): 0.0000
Log likelihood: -123.4
D-W statistics: 1.6

Note: *, **, *** significant at 10%, 5% and 1% respectively.
Sources: Authors’ calculations.