The monetary policy transmission during the crisis: Evidence from Thailand

Miss Duangporn Lertsomphol

จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

An Independent Study Submitted in Partial Fulfillment of the Requirements
for the Degree of Master of Science in Finance
Department of Banking and Finance
FACULTY OF COMMERCE AND ACCOUNTANCY
Chulalongkorn University
Academic Year 2021
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กลไกการส่งผ่านนโยบายการเงินช่วงภาวะวิกฤติในประเทศไทย

น.ส.ดวงพร เลิศสมผล

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สารนิพนธ์นี้เป็นส่วนหนึ่งของการศึกษาตามหลักสูตรปริญญาวิทยาศาสตรมหาบัณฑิต
สาขาวิชาการเงิน ภาควิชาการธนาคารและการเงิน
คณะพาณิชยศาสตร์และการบัญชี จุฬาลงกรณ์มหาวิทยาลัย
ปีการศึกษา 2564
ลิขสิทธิ์ของจุฬาลงกรณ์มหาวิทยาลัย

Independent Study Title	The monetary policy transmission during the crisis: Evidence from Thailand
By	Miss Duangporn Lertsomphol
Field of Study	Finance
Thesis Advisor	Assistant Professor ANIRUT PISEDTASALASAI, Ph.D.

Accepted by the FACULTY OF COMMERCE AND ACCOUNTANCY, Chulalongkorn University in Partial Fulfillment of the Requirement for the Master of Science

INDEPENDENT STUDY COMMITTEE

..... Chairman
(Associate Professor SIRA SUCHINTABANDID, Ph.D.)

..... Advisor
(Assistant Professor ANIRUT PISEDTASALASAI, Ph.D.)

..... Examiner
(Associate Professor VIMUT VANITCHAREARNTHUM, Ph.D.)

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ดวงพร เลิศสมผล : กลไกการส่งผ่านนโยบายการเงินช่วงภาวะวิกฤติในประเทศไทย. (The monetary policy transmission during the crisis: Evidence from Thailand) อ.ที่ปรึกษาหลัก : ผศ. ดร.อนิรุต พิเสฏฐศลาศัย

การส่งผ่านอัตราดอกเบี้ย หมายถึง กระบวนการของการเปลี่ยนแปลงอัตราดอกเบี้ยนโยบายหรืออัตราดอกเบี้ยตลาดถูกส่งผ่านไปยังอัตราดอกเบี้ยของธนาคารพาณิชย์ กล่าวอีกนัยหนึ่ง การส่งนโยบายการเงินเป็นหนึ่งในเครื่องมือที่มีประโยชน์สำหรับการวิเคราะห์การตัดสินใจนโยบายการเงินที่มีประสิทธิภาพ บทความนี้ได้ทดสอบประสิทธิผลของการส่งผ่านการเปลี่ยนแปลงของอัตราตลาดเงินไปยังอัตราดอกเบี้ยเงินกู้ต่างๆ (MLR, MOR และ MRR) ในประเทศไทยตั้งแต่ปี 2551 ถึง พ.ศ. 2564 ซึ่งครอบคลุมช่วงวิกฤต รวมทั้งได้ประเมินลักษณะจำเพาะของธนาคารที่อาจส่งผลต่อการส่งผ่านด้วย การทดสอบใช้วิธี panel cointegration method and error correction model ด้วยข้อมูลรายเดือนจากธนาคารพาณิชย์แต่ละแห่ง

ผลลัพธ์แสดงให้เห็นว่าการส่งนโยบายการเงินไปยังอัตราดอกเบี้ยเงินกู้ทุกประเภทเป็นไปอย่างไม่สมบูรณ์ เนื่องจากความไม่สมดุลของข้อมูล ต้นทุน และการแข่งขันในตลาด และพบว่าโดยเฉพาะในช่วงวิกฤต การส่งผ่านนโยบายการเงินมีแนวโน้มที่จะอ่อนแอลงเพราะลูกหนี้เกิดความเสี่ยงที่สูงขึ้นและสภาวะทางการเงินที่แย่ลง นอกจากนี้ หากพิจารณาตามลักษณะจำเพาะของธนาคาร พบว่าอัตราส่วนเงินกองทุนที่แสดงถึงข้อจำกัดด้านกฎระเบียบ และอัตราส่วนเงินกู้ที่ไม่ก่อให้เกิดรายได้ (NPL) ซึ่งแสดงถึงคุณภาพของสินทรัพย์ในพอร์ตของธนาคาร นำไปสู่การผ่านอัตารดอกเบี้ยที่ลดลงในประเทศไทย

สาขาวิชา การเงิน ลายมือชื่อนิสิต .....

ปีการศึกษา 2564 ลายมือชื่อ อ.ที่ปรึกษาหลัก .....

6484038726 : MAJOR FINANCE
KEYWO RD: interest rate pass-through, passthrough, monetary policy transmission

Duangporn Lertsomphol : The monetary policy transmission during the crisis: Evidence from Thailand. Advisor: Asst. Prof. ANIRUT PISEDTASALASAI, Ph.D.

The interest rate pass-through is defined as the process by which changes in policy or money market rate are transmitted to commercial bank rates. In other words, monetary policy transmission is one of the useful tools for the analysis of effective monetary policy decisions. This paper examines the effectiveness of the interest rate passthrough from the money market rate to various lending rates (MLR, MOR, and MRR) in Thailand from 2008 to 2021 including crisis periods, and also assesses the impact of bank characteristics. Using the panel cointegration method and error correction model with monthly data from individual commercial banks.

The results show the incomplete transmission of monetary policy to all lending rates because of information asymmetry, costs, and market competition. During the crisis periods, the monetary policy transmission tends to become weaker since the distress causes higher risks and worse financial conditions. With regard to bank characteristics, the capital ratio implies the regulatory constraint, and the non-performing loan (NPL) ratio represents the quality of assets in the bank’s portfolio, both lead to the diminishing passthrough in Thailand.

Field of Study:	Finance	Student's Signature .....
Academic Year:	2021	Advisor's Signature .....

ACKNOWLEDGEMENTS

I would like to express my very great appreciation to my supervisor, Asst. Prof. ANIRUT PISEDTASALASAI, Ph.D. for his patient guidance, enthusiastic encouragement, and constructive suggestions during the entire process of this research.

I am grateful to Assoc. Prof. SIRA SUCHINTABANDID, Ph.D., and Assoc. Prof. VIMUT VANITCHAREARNTHUM, Ph.D., my committees who have provided me the extensive professional guidance and advice.

Duangporn Lertsomphol

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Chulalongkorn University

TABLE OF CONTENTS

Page

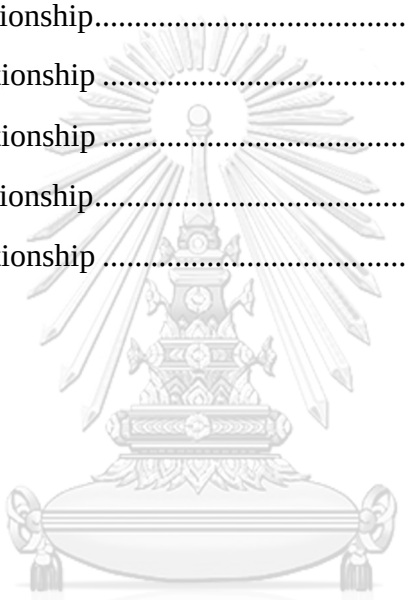
..... iii
ABSTRACT (THAI) iii
.....iv
ABSTRACT (ENGLISH).....iv
ACKNOWLEDGEMENTS.....v
TABLE OF CONTENTS.....vi
LIST OF TABLES.....vii
LIST OF FIGURES viii
REFERENCES 40
VITA.....43

จุฬาลงกรณ์มหาวิทยาลัย
Chulalongkorn University

LIST OF TABLES

Page

Table 1: Descriptive statistics 17
Table 2: Correlation analysis 18
Table 3: Unit root test 25
Table 4: Cointegration test 26
Table 5: Long run relationship 27
Table 6: Short run relationship 27
Table 7: Short run relationship 30
Table 8: Long run relationship 32
Table 9: Short run relationship 33



จุฬาลงกรณ์มหาวิทยาลัย
CHULALONGKORN UNIVERSITY

LIST OF FIGURES

Page

Figure 1: Transmission mechanism (Interest rate channel and Credit channel) 1

Figure 2: Policy interest rate between 2008-2021 period 2

Figure 3: Size of Thai financial market between 2001-2020 period 4

Figure 4: Thailand's GDP growth rate between 2001-2020 period (reference year = 2002) 4

Figure 5: Policy and lending interest rates in Thailand 16

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CHULALONGKORN UNIVERSITY

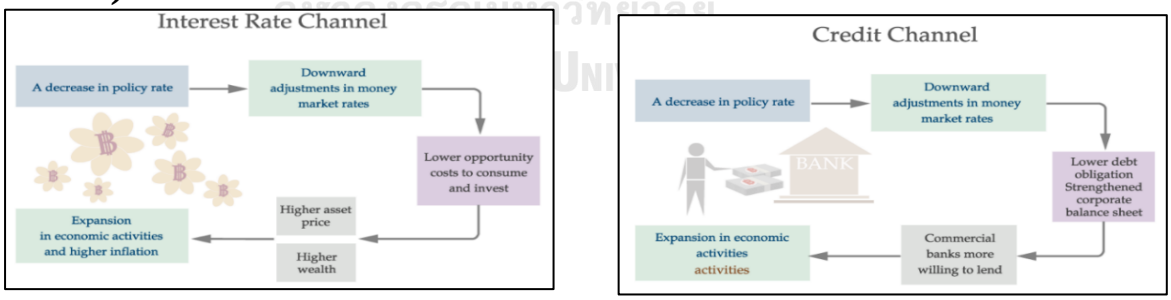
1. INTRODUCTION

1.1 Background

The monetary transmission mechanism

Monetary transmission is useful for the analysis of effective monetary policy decisions. The interest rate passthrough from official rates to retail rates is a key component in the monetary transmission process. Precisely, the interest rate pass-through is defined as the process which changes in policy or money market rate are transmitted to commercial bank rates. Indeed, a mechanism is important in achieving the goals of monetary policy to control price stability and create sustainable economic expansion. If the change in the policy rate is transmitted to changes in commercial bank lending rates completely at a reasonable period, the monetary transmission is considered effective. This leads to a well-organized and competitive financial system.

Figure 1: Transmission mechanism (Interest rate channel and Credit channel)



Source: Bank of Thailand

Figure 1 represents that when the central bank decides to cut the policy rate for economic expansion, affects the short-term money market rates and then influences long-term and commercial bank interest rates. From the interest rate channel's view, commercial banks have to manage

their portfolios to maintain competitiveness and generate profit. Consequently, retail interest rates that are charged on loans or offered on deposits will decline which means lower costs in consumption and investment. In addition, from the credit channel's view, debt obligations of businesses decline thus commercial banks are more willing to lend to businesses given lower risks.

The COVID-19 pandemic and the monetary policy transmission

The COVID-19 pandemic highly causes changes in the economic structure, business activities, and people's everyday life[1]. The economy around the world will be attacked by another worst recession after the global financial crisis a decade ago. Every country has to cope with this situation.

Figure 2: Policy interest rate between 2008-2021 period

This graph represents the policy interest rate movement during the 2008-2021 period that the lowest rate is from 2020 onwards because of the COVID-19 pandemic crisis. Data in this graph are monthly and shown in percentage.

Unit: %

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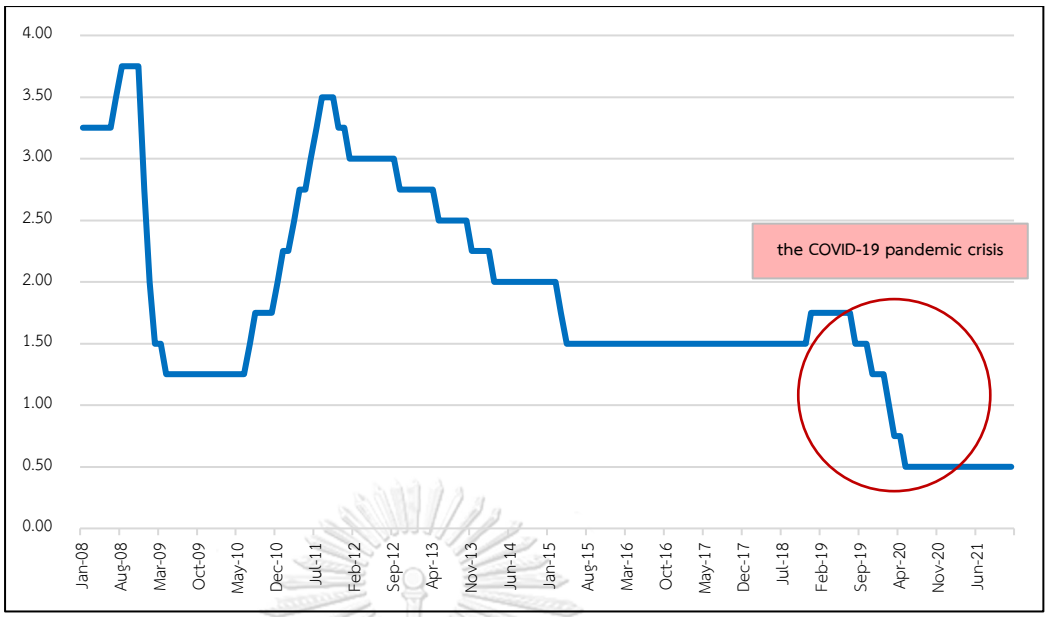
[1] https://www.bot.or.th/English/PressandSpeeches/Press/2020/Pages/n3463.aspx



Source: Bank of Thailand

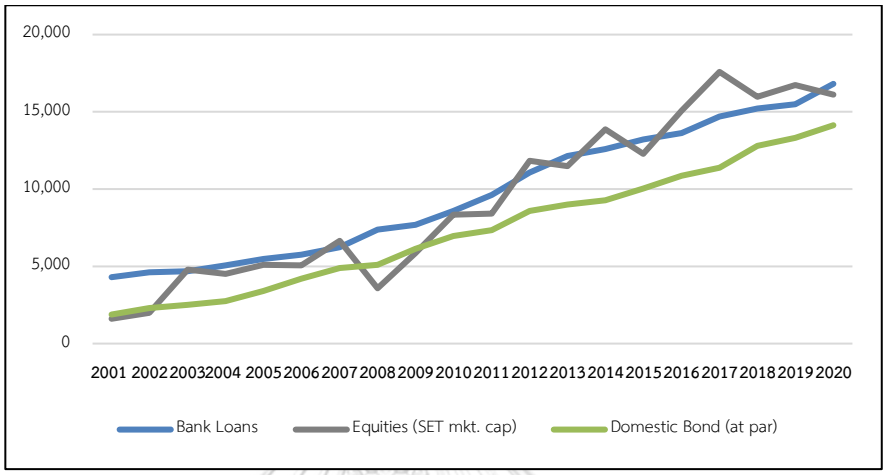
Several central banks around the world, including the Bank of Thailand (BOT), use monetary policy to solve the economic problems by cutting the policy rates to support their economies disrupted due to the COVID-19 outbreak. The Monetary Policy Committee (MPC) views that it is important to distribute liquidity to businesses and households through bank lending channels. [2] Therefore, MPC decides to decrease the policy rate four times from 1.25 to 0.5 percent in 2020 as shown in Figure 2, the lowest interest rate over two decades to relieve the impact of the coronavirus pandemic. Lowering interest rates causes cheaper borrowing costs and could encourage businesses and households to take loans and spend, which will stimulate Thailand's economy. Ideally, the commercial bank lending rates are expected to decline fully and timely following thedeclineg ofinolicy rate and the temporary reduction measure in the Financial Institutions Development Fund (FIDF) contribution[3].

[2] Monetary Policy Committee's Decision 1/2020, 2/2020, and 3/2020
[3] https://www.bot.or.th/Thai/FIPCS/Documents/FPG/2563/ThaiPDF/25630088.pdf

Figure 3: Size of Thai financial market between 2001-2020 period

This graph represents that bank loans, stock market, and bond market have increased during the 2001-2020 period while bank loans are the main part of the Thai financial market. Data in this graph are shown in billion baht.

Unit: THB billion



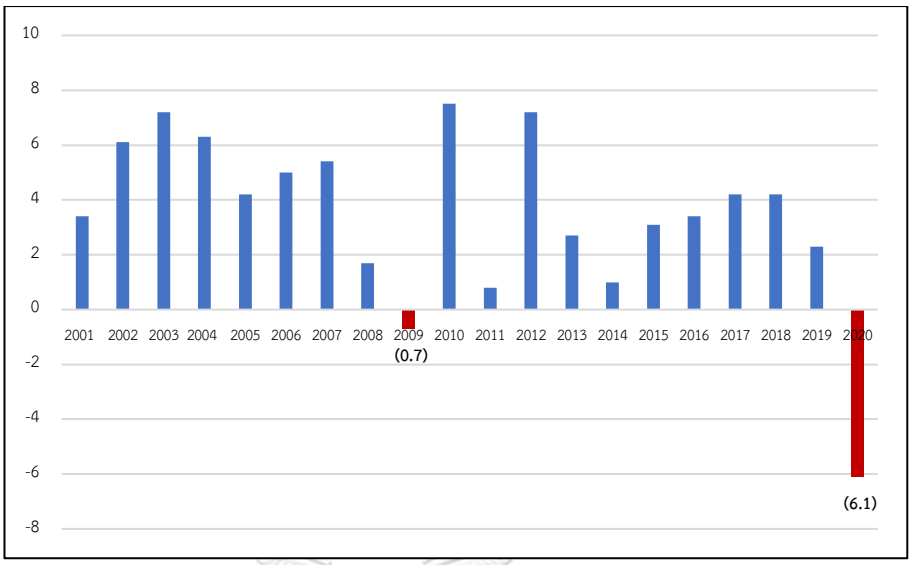
Source: ThaiBMA

Although the three main pillars of the Thai financial market in Figure 3 including bank loans, equities, and domestic bonds have been increasingly more balanced, the financial institutions still dominate the Thai market through the bank lending protocol. The total outstanding of bank loans was 16,814 billion baht in 2020, the largest portion of Thai financial markets, accounting for 36%. Equity ranked second, accounting for 34% while the Thai bond market accounted for 30% of the total outstanding. Therefore, banks remain a significant part of financial inclusion that corporates and individuals can access funds in Thailand for over two decades.

Figure 4: Thailand's GDP growth rate between 2001-2020 period (reference year = 2002)

This graph represents GDP growth rates in Thailand during 2001-to 2020 which are all positive numbers except in 2009 and 2020. Data in this graph are shown in percentage.

Unit: %



Source: ThaiBMA

To assess crisis periods in this study, Figure 4 shows that the global financial crisis and the COVID-19 pandemic negatively impacted Thailand's GDP growth in 2009 (-0.7%) and 2020 (-6.1%), respectively. Therefore, I define these as crisis periods.

1.2 Objectives and Contributions

The first purpose of this paper is to examine the effectiveness of the interest rates transmission mechanism from monetary policy rate to lending rates in Thailand. Bank lending in Thailand plays a significant role in which businesses and households can access funds that they should have benefited from the decrease in retail interest rates through the transmission mechanism. In addition, the interest rate transmission will not be instantaneous but needs a period of time to be effective. There are several supporting documents of incomplete pass-through in many countries. According to De Graeve et al. (2007), Zulkhibri (2012), and Mueller-Spahn (2008), they find similar results in Belgium, Malaysia, and Germany respectively that interest rates pass-through are incomplete depending on different retail products and banks. Moreover, Charoenseang and Manakit

(2007) results conclude that there is a long-term relationship between the policy rate and the market rates while the pass-through is relatively low in Thailand. Observing only a small immediate adjustment and modification in lending rates seem to be lower than deposit rates. With the passing of time, I may start exploring whether the transmission has been changed in Thailand. Therefore, I hypothesize the interest rate transmission in Thailand is imperfect however the degree of transmission and speed of change may vary across commercial banks and categories of lending rates.

The second objective is to investigate the passthrough from monetary policy to bank lending rates during the crisis, in comparison to the pre-crisis period. Many empirical studies on interest rate transmission have shown that when a crisis happens, this mechanism becomes less efficient compared to before the crisis period. Holton et al., 2018 observe the partial pass-through from changes in money market rates to lending rates, particularly for small loans, and conclude that bank characteristics lead to a weakened pass-through during the breaking point. On the other hand, Horvath et al., 2018 observe that the interest rate transmission is complete only in small loans while other loan categories are not complete. Their outcomes also present that the interest rate transmission during the crisis has been deteriorated owing to higher credit risks. The result from Gambacorta et al., 2015 is that lesser transmission compared to prior catastrophes is related to commercial banks charging higher risk premiums and the distressed financial conditions. Moreover, Tai et al., 2012 discover the gradual pass-through from money market rate to deposit and lending rates and also find sluggish adjustment rates after shocks occur. Thus, I hypothesize the lesser transmission during the crisis period in Thailand according to all research that I already mentioned above.

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The third objective is to investigate the influence of bank characteristics on changes in money market rate to lending rates and I hypothesize this relationship will occur because Holton et al., 2018 notice that the non-performing loans (NPLs) tend to be a significant element in a passthrough reduction. Another factor is the size of financial institutions that impacts pass-through rates for small loans but the capital is more important for large loans. On the other hand, Gambacorta (2005) concludes that bank size does not relate to a monetary policy in Italy. Not only the liquidity but also the capitalization influences monetary policy after a monetary tightening. However, bank size is irrelevant to monetary policy. Moreover, Altunbas et al., 2012 show that banks with higher capital and liquidity tend to have lower impacts during the crisis periods.

Therefore, this study makes a contribution to the literature on monetary policy transmission in the following ways. Firstly, the number of papers of the transmission during the crisis is limited in the Euro area and major advanced economies during the global financial crisis while only a few researchers are focusing on the emerging market economies (Holton et al., 2018; Horvath et al., 2018; Gambacorta et al., 2015; Tai et al., 2012). To illustrate, Disyatat and Vongsinsirikul (2002) find that interest rate pass-through in Thailand is lower compared to developed countries such as the US and European countries in the normal circumstance. Therefore, this study can provide in-depth studies about the transmission during the crisis in Thailand as a developing country and may contribute to the understanding of differences. Secondly, prior studies cover only one crisis, the global financial crisis (Holton et al., 2018; Horvath et al., 2018; Gambacorta et al., 2015) or the Asian crisis (Pih Nee Tai et al., 2012) while this paper examines data up to 2021 allowing for assessing not only the

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effects of that crisis but also the COVID-19 pandemic crisis**.** Therefore, this study can compare the result in prior to and during the crisis and also cover the outcome of two crisis shocks. Lastly, the evaluation and monitoring of the transmission of money market rates to bank retail rates have become more important for policymakers. The empirical investigations of interest rate transmission often show unlike results vary on the observed country or investigation period, and suggestions cannot be simply transferred from one studied country to another (Havranek et al., 2016). The study may lead to more effective monetary policy design and integrated implementation in the future that improves the transmission mechanism that can be specific for normal circumstances and during the crisis period. In addition, intensive supervision may apply to banks with lesser passthrough rates.

This paper is organized as follows. Section 2 reviews the related studies in the main literature concerning monetary policy transmission. Section 3 introduces the overview of the data. Section 4 presents the approaches to the methodology. Section 5 shows the empirical results of this study. Section 6 concludes all significant issues from the observation.

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2. LITERATURE REVIEW

I separate this section depending on the three different objectives of this paper. To begin with, investigating the effectiveness of the interest rates transmission mechanism, there are two groups of studies: using cross-country data, and providing evidence for specific countries. Overall, a greater number of research find incomplete interest rate transmission both for borrowers and depositors in the real economy.

Initially, in cross-country studies, De Bondt (2005) observes the interest rate transmission at the euro area level and suggests that the passthrough of interest rates is complete just for short maturities, but not for longer maturities. Additionally, the long-term pass-through effects mainly for lending rates are closely complete, while the immediate pass-throughs to deposit and lending rates are observed to be smaller.

The second category of studies concentrates their investigation on specific countries and most of these papers target advanced countries. Examples are studies by Gambacorta (2005) on Italy, Mueller-Spahn (2008) on Germany, and De Graeve, De Jonghe, Vander Vennet (2007) on Belgian. These studies disclose variations in the interest rate transmission across various kinds of financial institutions in specific countries. Indeed, Gambacorta (2005) explores the efficiency through the bank lending channel and finds existing differences in the interest rate pass-through. The long-run effects of monetary policy on lending portfolios have a negative effect. After using monetary tightening, the reduction in a lending portfolio is inferior for high capital and liquid banks while the bank size is not relevant. De Graeve, De Jonghe, Vander Vennet (2007) discover the monetary interest rate transmission to various products in Belgium. Their results confirm that the long-term transmission is typically partial in the majority of products in Belgium except for long-term time deposits, term loans, investment loans, and mortgage loans. Mueller-Spahn (2008) explores the monetary policy transmission mechanism in Germany and realizes parallel interpretations that the transmission mechanism in both the short-run and also the long-run are less than complete and there are differences across products and banks.

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Addressing the case of emerging markets, for example, the study by Zulkhibri (2012). This paper inspects the interest rate transmission in Malaysia from changing the monetary policy rate to retail rates by using the error correction model (ECM). As a result, pass-through effects in deposit and lending rates are imperfect. Nevertheless, the degree of pass-through and speed of adjustment are different depending on financial institutions and types of retail rates. In a similar line of research, Charoenseang and Manakit (2007) study the transmission mechanism of monetary policy to financial market rates in Thailand from 2000 to 2006 including deposit and also lending rates. They are examined by employing cointegration and error correction procedures from commercial banks and finance companies. The empirical results present that a long-run relationship between the policy rate and the financial market rates still exists but the transmission of monetary policy is relatively low as well as the short-term adjustment is only a small pass-through. In addition, lending rates seem to have lower adjustments than deposit rates.

Then, I briefly review the literature on the transmission mechanism of monetary policy during the crisis. Several researchers try to figure out how changes in the stance of monetary policy changed during crisis shocks and seek for main reasons for changes. Most of these studies focus on the Euro area in financial crisis and find that the monetary policy transmission weakens during the financial crisis indicating the low effectiveness of the monetary policy.

To illustrate, Holton, Costanza, and d'Arci (2018) examine which bank characteristics involve in the pass-through mechanism in 12-euro countries during the global financial crisis, and divide interest rate loans into two types - small and large loans- between 2007-2017. They use an

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error correction model (ECM) and panel ordinary least squares (OLS) with bank fixed effects that take into account macroeconomic variables and bank characteristics, such as bank size, capital level, liquidity level, banks' funding, risks, and asset impairment. These authors conclude that the pass-through is less than complete over this period, especially for small loans.

In a similar line of research, Horvath, Kotlebova, and Siranova (2018) explore the impacts of fragmentation in the financial market, European Central Bank (ECB) balance sheet policies, and negative rates on the monetary transmission mechanism in the euro countries between 2008–2016. They use the heterogeneous panel cointegration method and pooled mean group (PMG) estimator. Moreover, they divide loan interest rates into four groups: small loans, large loans, consumer loans, and housing loans. They find that the interest rate transmission is incomplete, except for small loans. Their results propose that interest rate transmission has been impaired by both higher credit risks and market fragmentation. The balance sheet policies benefit to diminish lending interest rates and cause more effective monetary policy transmission. However, they cannot find evidence to ensure that negative market rates have worsened interest rate transmission. As well as Havranek, Irsova, and Lesanovska (2016), employ the ECM framework and PMG estimator to examine whether market rates are passed over to deposit and borrowing rates between 2004-2014 in Czech. They observe that the long-term interest rate transmission is nearly complete in most products before the financial crisis, after that shock, it is sluggish except for mortgages.

Gambacorta, Illes, and Lombardi (2015) study the monetary policy transmission mechanism in Italy, Spain, the United Kingdom, and the United States between 2003-2013. They adopt the cointegrated test to

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ensure the long-run relationship between the policy rate and lending rates. To investigate the short-term connection between lending rates and the policy rate by using ECM. They also control the delinquency rates and credit default swap spreads as variables, then test for structural breaks after the Lehman Brothers' default. Their results show the lesser transmission of interest rates due to an increase in the mark-up during the crisis due to higher risk premium charged by banks and worsened financial conditions.

In the case of emerging countries, Pih Nee Tai, Siok Kun Sek, and Wai Mun Har (2012) explore the differences in the monetary policy transmission to retail rates across Asian countries namely Thailand, Hong Kong, Malaysia, Korea, Singapore, Philippines, and Indonesia. The data is divided into two sub-periods, pre-and post-crisis, by using the Seemingly Unrelated Regression (SUR) approach that is one of the Generalized Least Squares (GLS) methods. After the financial outbreak in 1997, most Asian countries have slower adjustment, except for Malaysia.

Following this, to observe the influence of bank characteristics on the monetary policy transmission, Holton et al., 2018 find that during the crisis, the NPLs ratio appears to be the most significant decrease in the transmission mechanism, and bank size influences transmission for small loans, and capital is more considerable for large loans. On the other hand, Gambacorta (2005) concludes that the long-run effects of monetary policy on lending portfolios have negative signs. After a monetary tightening, bank size is irrelevant while the decline in lending supply is lower for well-capitalized and high-liquid banks. Similarly, Altunbas et al., 2012 show that well-capitalized and high liquid before the crisis suffered a lower level of erosion of banks' solvency during the financial.

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3. DATA

3.1 Sample

To ensure the proper adaptation of commercial bank interest rates respond to changes in the stance of monetary policy that banks charge companies and households reflecting the cost of funds. According to Gregora, A. Melecký, M. Melecký (2019), they explore 52 empirical research in the interest pass-through area and find that the monthly data is commonly used more than 90%. Consequently, I use monthly panel data in this analysis that is in line with most of the previous studies.

The calculations in this paper are based on monthly bank-level data (i.e., lending rates, total asset ratio, capital ratio, and NPL ratio) from 15 commercial banks namely, Bangkok Bank, Krung Thai Bank, Kasikornbank, The Siam Commercial Bank, Bank of Ayudhya, TMB Bank (changing to TMBThanachart Bank Public Company Limited in 2021 after the merger between TMB Bank and Thanachart Bank), Thanachart Bank, United Overseas Bank (Thai) Company Ltd, CIMB THAI Bank, Standard Chartered Bank (Thai), TISCO Bank, Kiatnakin Phatra Bank, Land and Houses Bank, Industrial and Commercial Bank of China (Thai), and The Thai Credit Retail Bank. Also, the data on money market rates covers the period between January 2008 to December 2021, which consists of 168 data points.

3.2 Variables

The BOT develops a monetary policy that is decided by the Monetary Policy Committee (MPC) under the flexible inflation targeting framework to support economic growth without initiating inflation problems or financial inequalities. The MPC makes a monetary policy

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decision by either raising, maintaining, or lowering the policy interest rate with the motivation to accomplish an inflation target. The MPC uses the 1-day bilateral repurchase rate as the interest rate to signal shifts in monetary policy stance.[4] The BOT also uses these transactions to increase or drain reserves in the banking system. The transaction covers a purchase or sale of the securities with the agreement to reverse this contract at a specific condition in the future. Then, to capture the effect of change in monetary policy, I use the 1-day bilateral repurchase rate as a proxy of the monetary policy rate, which is targeted by monetary authorities and reflects banks' cost of funds. The source of these data is the BOT dataset.

In Thailand, there are two types of lending rates that are fixed-rate and floating rate. The fixed rate is the lending rate that is set as a specific number and doesn't move up or down according to the cost of financial institutions. It will fix throughout the loan term or during a specified period. Then, the floating rate is the loan interest rate that varies according to the financial institutions' cost. The financial institutions will announce this rate from time to time as reference interest rates of commercial banks such as Minimum Loan Rate (MLR), Minimum Overdraft Rate (MOR), and Minimum Retail Rate (MRR).[5]

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Therefore, the interest rate used by commercial banks to collect interest on loans from customers is a floating interest rate which reflects the lower cost of financial institutions when the policy rate decrease. I divide lending interest rates of the individual banks into three categories: MLR, MOR, and MRR to assess how differences between the results of

[4]https://www.bot.or.th/Thai/FinancialMarkets/MonetaryOperations/Documents/BOT%E2%80%99s%20Liquidity%20Management%20Framework%20Manual_EN(Apr%2017).pdf
[5] https://www.1213.or.th/th/serviceunderbot/loans/Pages/interest.aspx

these loans. I collect these data at the end of the month in 2008-2021 from the BOT dataset. The definitions of these interest rates are as follows. “MLR” means the lending rate per year on term loans that the bank charges major clients. For example, customers who have a good financial history or have sufficient collateral. MLR is usually used for long-term loans with fixed maturities, such as business loans. “MOR” means the lending rate on an overdraft facility that the bank charges major clients. “MRR” means the lending rate on retail loans such as credit cards, personal loans and housing loans that the bank charges major retail clients.

The main bank characteristics that could affect lending interest rates during the crisis are the size of financial institutions, capital adequacy, and asset quality. To begin with, the impact of size on lending rate setting from previous studies is unclear and questionable. Holton et al., 2018 observe that bank size affects pass-through for small loans. However, Gambacorta (2005) concludes that bank size is irrelevant. Next, a well-capitalized bank is characteristically high shielded from uncertain situations (Holton et al., 2018 and Altunbas et al., 2012), and thus I suppose that the change in monetary policy rate would be transmitted further smoothly by these banks. Then, the asset quality is measured as the NPLs ratio which has been a main constrain to bank balance sheet and profitability (Holton et.al, 2018). I expect those high levels of this variable initiate a weakening in the transmission mechanism of monetary policy. The source of these data is the BOT dataset and the formula is as follows.

$$\text{Size ratio} = \frac{\text{total assets of a bank}}{\text{total 15 commercial bank assets}} \quad (1)$$

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$$\text{Capital ratio (Tier 1 ratio)} = \frac{\text{tier 1 capital}}{\text{total risk weighted assets}} \quad (2)$$

$$\text{NPL ratio (Gross)} = \frac{\text{total NPL outstanding}}{\text{total outstanding loans}} \quad (3)$$

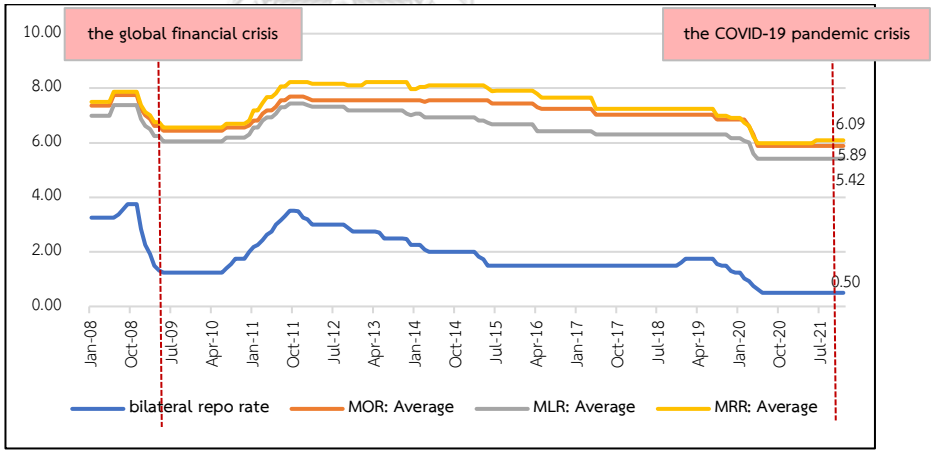
Afterward, to control the outcome of the global financial crisis and the COVID-19 pandemic, I create a dummy variable taking a value of one if they are the 2009 and 2020 periods.

3.3 Data descriptive

Figure 5: Policy and lending interest rates in Thailand

This chart represents the co-movement between the 1-day bilateral repurchase rate and lending rates between 2008-2021. BOT observes lending rates from 5 large commercial banks. Data in this graph are monthly and shown in percentage.

Unit: %



Source: Bank of Thailand (FM_RT_001_S2) and my calculation

When the MPC makes a decision to decrease the policy rate, that implied by the 1-day bilateral repurchase rate, this will put pressure on banks' funding costs, causing them to decrease the lending rates represented by Minimum Loan Rate (MLR), Minimum Overdraft Rate (MOR), and Minimum Retail Rate (MRR) that charge to borrowers in the

real economy. Figure 5 shows that the 1-day bilateral repurchase rate and lending rates tend to move along together over two decades and dramatically decline during the crisis period. As of December 2021, the bilateral repurchase rate, average MLR, average MOR, and average MRR are 0.50%, 5.42%, 5.89%, and 6.09%, respectively. These rates are the lowest rates from 2008 to 2021.

Table 1: Descriptive statistics

The table presents the summary statistics of all variables from January 2008 to December 2021. Data in this graph are calculated from 15 commercial banks.

MLR is the Minimum Loan Rate; MOR is the Minimum Overdraft Rate; MRR is the Minimum Retail Rate; Size is calculated by total assets of a bank divided by total 15 commercial bank assets; Capital is calculated by tier 1 capital divided by total risk weighted assets; NPL is calculated by total NPL outstanding divided by total outstanding loans.

Variables	bilateral repurchase rate	MLR	MOR	MRR	Size	Capital	NPL
Mean	0.0015	0.0058	0.0062	0.0066	0.0668	0.1533	0.0337
Minimum	0.0004	0.0044	0.0049	0.0048	0.0004	0.0357	0.0000
Maximum	0.0031	0.0075	0.0076	0.0106	0.2131	2.1621	0.1562
Standard Deviation	0.0007	0.0006	0.0006	0.0011	0.0656	0.1072	0.0207
Observations	2,520	2,514	2,514	2,463	2,514	2,349	2,496

Table 1 summarizes descriptive statistics for the sample data used in the analysis. The maximum rate of bilateral repurchase rate is 0.31% (3.75% per year) from September 2008 to November 2008 which is before the global financial crisis periods while the minimum rate is 0.04% (0.50% per year) from June 2020 to December 2021 which is during the COVID19 pandemic crisis. Also, the peaks of lending rates are observed at 0.75% to 1.06% (8.95% -12.75% annually) from small Thai banks (TCR and SCBT) whereas the lowest rates in the COVID19 period are around 0.44% to 0.49% (5.25%-5.82% annually). This indicates that the central bank decreased the policy rate during the crisis in order to stimulate the real economy.

On average, the bilateral repurchase rate is 0.15% per month (1.84% per year) and commercial banks tend to charge customers between 0.58%

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to 0.66% per month. The par of MLR is around 0.58% monthly (6.98% per year) which is the lowest rate among all commercial bank interest rates, the mean of MOR is 0.62% (7.43% per year) and MRR is 0.66% (7.95% per year) which is the highest rate charged to retail customers. In terms of asset impairment, the average NPL ratio is around 3.37%. The bank size represents by the asset size ratio which the mean is around 6.68% of total assets and the average capital ratio is 15.33%.

Table 2: Correlation analysis

The table presents the relationship between the money market interest rate and the commercial bank interest rates from January 2008 to December 2021.

MLR is the Minimum Loan Rate, MOR is the Minimum Overdraft Rate, and MRR is the Minimum Retail Rate.

Variables	bilateral repurchase rate	MLR	MOR	MRR
bilateral repurchase rate	1.0000			
MLR	0.5066	1.0000		
MOR	0.4901	0.9584	1.0000	
MRR	0.3386	0.5285	0.5438	1.0000

Based on Table 2, positive correlations exist between commercial interest rates (MLR, MOR, and MRR) and the bilateral repurchase rate as a proxy for the policy rate. A range in correlation analysis of the money market rate and lending rates is between 0.34 and 0.51, implying various degrees of correlation behaviors among types of interest rates. The bilateral repurchase rate and MLR tend to have the highest degree of correlation among the three kinds of lending rates. This correlation result indicates that the relationships between all interest rates tend to move in the same direction. Specifically, when the policymaker decreases the policy rate to stimulate economies, commercial banks will also decrease their interest rate charged in all groups of products. In contrast, if the central bank raises the policy rate for controlling inflation, banks should response by declining their interest rates to customers.

4. METHODOLOGY

4.1 Testing the stationary of series and the presence of cointegration

Before I investigate the effectiveness of the transmission and also the implications of the crisis and banks' characteristics, I have to assess the degree of integration of the series in the sample. According to Holton et.al, 2018 and Zulkhibri, 2012, I conduct an augmented Dickey-Fuller (ADF) test in the bilateral repurchase rate and retail interest rates as well as MLR, MOR, and MRR for the panel unit root testing (Fisher ADF) as the following equation:

$$\Delta y_t = \alpha y_{t-1} + \chi'\delta + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \ldots + \beta_p \Delta y_{t-p} + \varepsilon_t \quad (4)$$

The ADF is important to check whether the series is stationary or nonstationary that also allows for more than one lag in the test regression under the null hypothesis of a unit root by assuming that the y series follows and AR(p) process and adding p lagged differenced terms of the dependent variable y in the right-hand side. The Fisher's result will combine p-value from individual unit root tests. As money market rate and lending rates are I(1), we proceed for the cointegration analysis between these variables.

To test for the presence of cointegration, I conduct the Johansen's cointegration test (Johansen, 1988) to determine the number of cointegration relations in a sample under the null hypothesis is the number of cointegration. Johansen's methodology considers the vector autoregression (VAR) of order p given by

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + \varepsilon_t$$

where y_t is a k-vector of non-stationary I(1) variables and ε_t is a vector of innovations. This VAR can be re-written as,

$$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \acute{\Gamma}_i \Delta y_{t-i} + \varepsilon_t$$

(5)

where $\Pi = \sum_{i=1}^{p} A_i - I$ and $\acute{\Gamma}_i = -\sum_{j=i+1}^{p} A_j$

If the coefficient matrix Π has reduced rank r<k, there exists k x r matrices α and β each with rank r such that $\Pi = \alpha\beta'$ and $\beta' y_t$ is I(0). r is the number of cointegration relations (the cointegrating rank), each column of β is the cointegrating vectors and the elements of α is known as the adjustment parameters in the vector error correction model. This method is used to estimate the Π matrix from an unrestricted VAR and to test whether we can reject the restrictions implied by the reduced rank of Π. The assumption is that the level data y_t and the cointegration equation has linear trends:

$$\Pi y_{t-1} = \alpha\,(\beta y_{t-1} + \rho_0 + \rho_1 t) + \alpha.\gamma_0$$

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Johansen's cointegration test proposes two different likelihood ratio tests of the significance and thus the reduced rank of the Π matrix: the trace test and maximum eigenvalue test are computed as:

$$LR_{tr}(r|k) = -T \sum_{i=r+1}^{k} \log(1 - \lambda_i)$$

$$LR_{mev}(r|r+1) = -T \log(1 - \lambda_{r+1}) = LR_{tr}(r|k) - LR_{tr}(r+1|k)$$

where T is the sample size and λ_i is the i-th largest eigenvalue of the matrix Π.

This can proceed sequentially until it fails to reject. For example, if result rejects the null hypothesis of zero cointegration (none) and fails to reject the null hypothesis of one cointegration, this implies that the series are cointegrated at one relation. That means a long-run relationship has occurred among these variables. The trace statistic and the maximum eigenvalue statistic for the null hypothesis of r cointegrating relations

Since the long-term relationship between the money market rate to lending rates has existed, the degree of the passthrough effects can determine the effectiveness of the pass-through mechanism and be estimated by using panel ordinary least squares (OLS) from the cointegrating equation that is similar to Holton et.al, 2018. I also apply the Akaike information criterion (AIC) to automatically choose the optimum number of leads and lags length in the model. This model allows for making implications of the long-term interest rate passthrough. After having the cointegration result, I analyze the relationship between variables following the prior study from Horvath et al (2018), Holton et.al, 2018 and Havranek (2016). I use the error correction model (ECM) to analyze the short-run relationship between the money market rate and lending rates that estimate the short-run error correction toward long-run equilibrium. This model allows for making inferences regarding the short-term transmission mechanisms of monetary policy. Nevertheless, the immediate reaction of lending rates to changes in the stance of monetary policy and how fast banks adjust the interest rate charged to clients is also important (Havranek, Irsova, and Lesanovska, 2016). Therefore, the ECM is widely used more than 75% in the monetary transmission mechanism studies (Jirí Gregora, Aleš Melecký, Martin Melecký, 2019).

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4.2 Measuring the effectiveness of the transmission mechanism of monetary policy

Hypothesis 1: the incomplete long-term transmission

The long-term relationship can be estimated from the cointegrating equation as follows:

$$lr_{i,t} = \lambda_{i,t} + \beta_1 mr_t + \varepsilon_{i,t} \quad (6)$$

where t=1, 2, …, 168 index periods of the observed data and i=1, 2, …, 15 index Thai individual banks. $lr_{i,t}$ represents the lending rates including MLR, MOR and MRR, mr_t is the money market rate as a bilateral repurchase rate, $\varepsilon_{i,t}$ is the disturbance term, $\lambda_{i,t}$ represents markup, and β_1 measures the long-term relationship between the two rates. If $\beta_1 = 1$, long-term transmission is observed as complete. If $\beta_1 < 1$, long-term transmission is considered imperfect and I expect to find this relationship in Thailand that is also typically observe in many prior studies. (Disyatat et al., 2002; Gambacorta, 2005; Mueller-Spahn, 2008; De Graeve, De Jonghe, Vander Vennet, 2007; Zulkhibri, 2012; and Charoenseang and Manakit, 2007).

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I also use a single equation that generalized error correction model (ECM) as:

$$\Delta lr_{i,t} = \sum_{j=1}^{n} \alpha_i \Delta lr_{i,t-j} + \sum_{j=0}^{n} \delta_i \Delta mr_{t-j} + \beta_{0,i} (lr_{i,t-1} - \phi_1 mr_{t-1} - \lambda_{i,t}) + \varepsilon_{i,t} \quad (7)$$

where $\Delta lr_{i,t}$ is changes in bank's lending rates, Δmr_t denotes changes in money market rates, δ_i means the commercial bank short term

reaction response to changes in the stance of monetary policy, and β_0 denotes the speed of adjustment (the more negative number, the faster adjustment to the long- run equilibrium). Following from Horvath et al (2018), monthly changes in borrowing rates at time t ($\Delta lr_{i,t}$) depend on their past changes, changes in money market rates (Δmr_t) presenting movements in the monetary policy, and "error" term comes from the relationship between the level of lending rates and the level of money market rate in the previous period and also the mark-up.

4.3 Measuring the change in the monetary transmission mechanism during the crisis periods

Hypothesis 2: the lesser transmission during crisis

According to Holton, Costanza, and d'Arci (2018), Horvath, Kotlebova, and Siranova (2018), Havranek, Irsova, and Lesanovska (2016), Gambacorta, Illes, and Lombardi (2015), Pih Nee Tai, Siok Kun Sek, and Wai Mun Har (2012), they find the lesser pass-through during the crisis in comparison to before crisis period.

Applying the model concept from Horvath et al (2018) that use dummy variable represent the negative interest period in the Euro area, I extend the error correction model to examine whether the crisis affects the reaction of lending rates to market rates (π_i) by including a dummy variable as D that if the outbreak of the crisis occurs, take the value of one and the value of zero for other periods. To estimate the speed of adjustment ($\beta_{0,i}$) and short run relationship (δ_i), I also include D in the model from equation 7 in order to capturing crisis periods

$$\Delta lr_{i,t} = \sum_{j=1}^{n} \alpha_i \, \Delta lr_{i,t-j} + \sum_{j=0}^{n} \delta_i \, \Delta mr_{t-j} + \sum_{j=0}^{n} \pi_i D_{t-j} + \beta_{0,i} (lr_{i,t-1} - \phi_1 mr_{t-1} - \phi_2 D_{t-1} - \lambda_{i,t}) + \varepsilon_{i,t} \quad (8)$$

4.4 Measuring the effect of bank characteristics on the transmission mechanism

Hypothesis 3: size, capital, and asset quality lead to changes in transmission during the crisis

Holton et al., 2018 find that the NPL ratio is a significant variable that bring to the reduction in transmission. The bank size affects transmission especially for small loans, while the capital is more important for large loans. On the contrary, Gambacorta (2005) concludes that bank size is unrelated. Also, the results from Altunbas et al (2012) show that commercial banks with high capital and liquidity have a lower impact during the crisis.

Adding bank-level variables that are used by Holton, Costanza, and d'Arci (2018), to define whether characteristics are related to differences in commercial banks' response to changes in money market rate. I stand for these additional variables as size, capital, and NPL.

The equation 9 is estimated the long run relationship between variables $(\beta_1, \beta_2, \beta_3, \beta_4, \beta_5)$ by heterogeneous panel cointegration regression:

$$lr_{i,t} = \lambda_i + \beta_1 mr_{i,t} + \beta_2 D + \beta_3 Size_{i,t} + \beta_4 Captial_{i,t} + \beta_5 NPL_{i,t} + \varepsilon_{i,t} \quad (9)$$

Also, the equation 10 is applied for the short-run by ECM:

$$\Delta lr_{i,t} = \sum_{j=1}^{n} \alpha_i \, \Delta lr_{i,t-j} + \sum_{j=0}^{n} \delta_i \, \Delta mr_{t-j} + \sum_{j=0}^{n} \pi_i D_{t-j} + \sum_{j=0}^{n} \theta_i \Delta Size_{i,t-j} + \sum_{j=0}^{n} \varphi_i \Delta Capital_{i,t-j} + \sum_{j=0}^{n} \sigma_i \Delta NPL_{i,t-j} + \beta_{0,i}$$

$$(\mathrm{lr}_{i,t-1} - \phi_1 \mathrm{mr}_{t-1} - \phi_2 \mathrm{D}_{t-1} - \phi_3 \mathrm{Size}_{i,t-1} - \phi_2 \mathrm{Capital}_{i,t-1} - \phi_3 \mathrm{NPL}_{i,t-1} - \lambda_{i,t}) + \varepsilon_{i,t} \quad (10)$$

5. EMPIRICAL RESULTS

In this section aims at analyzing the results that show the relationship between the money market rate as proxy of the policy rate and lending interest rates charged by commercial banks in Thailand. The long- and short run relationships of theses variables are estimated by panel OLS cointegration regression and error correction procedures, respectively.

5.1 The panel unit root and the existence of cointegration

Table 3: Unit root test

The table represents the ADF test both in level and first difference results by using the equation 4 as follows and testing include 4 lags and trend:

$$\Delta y_t = \alpha y_{t-1} + \chi' \delta + \beta_1 \Delta y_{t-1} + \beta_2 \Delta y_{t-2} + \ldots + \beta_p \Delta y_{t-p} + \varepsilon_t$$

The null hypothesis is that the series has a unit root. * Represent significance at the 1% level.

	(1) Levels	(2) Differences
	Chi sq	**Chi sq**
bilateral repurchase rate	35.91	254.926*
MLR	22.50	192.711*
MOR	12.18	213.404*
MRR	9.08	211.356*

I start with testing panel unit roots for the bilateral repurchase rate and commercial bank lending rates which are MLR, MOR, and MRR by using an augmented Dickey-Fuller (ADF)- Fisher to check the stationarity. Table 3 represents the ADF results which column (1) fail to reject the null hypothesis of the unit-root test in level while column (2)

rejects the null hypothesis of the unit-root test in first difference at 1% significant level. These results imply that the series is non-stationary in the level whereas outputs indicate that all interest rate series are stationary form in first difference. Thus, bilateral repurchase rate, MLR, MOR, and MRR are I(1) series.

Table 4: Cointegration test

The table represents the Johansen cointegration results by using the equation 5 as follows and testing include the level data y_t and the cointegration equation has linear trend:

$\Delta y_t = \Pi y_{t-1} + \sum_{i=1}^{p-1} \acute{\Gamma}i\, \Delta y_{t-i} + \varepsilon_t$

The null hypothesis is the number of cointegration in sample. * Represent significance at the 5% level.

Hypothesized No. of CE(s)	(1) Eigenvalue	(2) Trace Statistics	(3) Max-Eigen Statistic
None	0.0407	131.3005	101.7088
At most 1	0.0067	29.5916*	16.3754*

Due to the relationship between these variables being I(1), I proceed with the cointegration test. The result of the panel cointegration is shown in Table 4 by using the Johansen cointegration. Not only Trace statistics (column 2) but also Max-Eigen statistics (column 3) indicate that there is at least one cointegrating at the 5% level. These results reject the null hypothesis of no cointegration and fail to reject the null hypothesis of at most one cointegration relation. Precisely, all of the retail interest rates are cointegrated with the bilateral repurchase rate with at least one cointegration vector which means there is a long-run relationship between the market interest rate and retail rates.

Therefore, I can perform the panel OLS to estimate the long-run cointegration between variables and also apply the error correction model (ECM) to estimate short-run adjustment in the interest rates transmission mechanism.

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Chulalongkorn University

5.2 The effectiveness of the transmission mechanism of monetary policy

Table 5: Long run relationship

The results reported in the table are estimated by panel dynamic OLS cointegration regression and obtained from equation 6:

$lr_{i,t} = \lambda + \beta_1 mr_t + \varepsilon_{i,t}$ which $lr_{i,t}$ is the lending rate, mr_t is the benchmark market interest rate, and the degree of passthrough is measured by the slope, β_1.

The t-statistics are in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

	MLR	**MOR**	**MRR**
bilateral repurchase rate *(mr)*	0.6076***	0.6292***	0.7165***
	(39.7314)	(28.1920)	(17.0336)
Adjusted R-squared	0.9131	0.7989	0.7866

Table 6: Short run relationship

The results reported in the table are estimated by error correction model (ECM) and obtained from the equation 7:

$\Delta lr_{i,t} = \sum_{j=1}^{n} \alpha_i \Delta lr_{i,t-j} + \sum_{j=0}^{n} \delta_i \Delta mr_{t-j} + \beta_{0,i} (lr_{i,t-1} - \phi_1 mr_{t-1} - \lambda_{i,t}) + \varepsilon_{i,t}$ which β_0 is the speed of adjustment, and the short term passthrough is measured by the slope, δ_i.

The t-statistics are in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

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	MLR	**MOR**	**MRR**
Speed adjustment (β_0)	-0.0002	-0.0005	-0.0008**
	(-0.4018)	(-1.5235)	(0.0010)
bilateral repurchase rate $_{t-1}$ *(Δmr_{t-1})*	0.2204***	0.1972***	0.1945***
	(11.5395)	(10.1761)	(5.1830)
bilateral repurchase rate $_{t-2}$ (Δmr_{t-2})	0.0399**	0.0408***	0.0840**
	(1.9248)	(1.9195)	(1.9946)
bilateral repurchase rate $_{t-3}$ (Δmr_{t-3})	0.0605***	0.0735***	0.0467
	(3.1912)	(3.7865)	(1.2328)
mark-up (constant)	0.0000	0.0000	0.0000
	(-0.2173)	(-0.1245)	(-0.2173)
Adjusted R-squared	0.1495	0.1481	0.0390

With regard to the degree of passthrough, the results in table 5 show that for all types of commercial bank lending rates are not complete in the transmission mechanism. These observations are generally consistent with findings from prior studies. All slope coefficients are found positive, below one, and statistical significance at 1% significant level. The pass-through rates are around 60% up to70%. Clearly, the passthrough effect of MLR, MOR, and MRR are 60.76%, 62.92% and 71.65% respectively. This represents the lending rate for retail customers is the most efficient transmission from changes in money market rate compared to others. Moreover, the adjusted R-squared of three models are between 78.66% to 91.31% which are quite high and imply that models are good fit.

In case of emerging markets, Charoenseang et al. (2007) and Disyatat et al. (2002) also find the incomplete pass-through rate in Thailand and the average transmission effect is around 26.50% and 50%, respectively that are lower than I observed in this sample. This may indicate the development of the interest rate transmission in Thailand. However, the interest rate passthrough in Thailand is still lower than developed countries such as the US, UK, Germany, Australia and Singapore presented by Disyatat et al. (2002) that tend to be full in the long-run. The results of incomplete pass through are also in line with the observation in Malaysia that presented by Zulkhibri (2012) which the pass-through rate is approximately 50%. Zulkhibri (2012) presented that the reason for the low transmission from money market rate through lending rates may due to less competitive market in the banking system and the asymmetric information as adverse selection and the moral hazard reasons.

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Comparing to the advanced economy markets, De Graeve et al. (2007) discovers the partial transmission in majority of products in Belgium except for long-term time deposit, term loan, investment loan, and mortgage loans. In term of products, term loan and investment loan in Belgium are similar to MLR in Thailand that indicates the opposite results in long term-passthrough. The passthrough effects of term loan and investment loan are 99% and 96% respectively that considered as complete. Current account overdrafts (84%) and consumer credit (65%) in Belgium are comparable to MOR (65%) and MRR (77%) in Thailand. De Graeve et al. (2007) conclude that corporate loans (i.e., term loans and investment loans) are more complete to changes in money market rates relative to consumer loans while the results from this observation in Thailand may conclude in the opposite side.

Next, the short run dynamic analysis is estimated by the error correction model (ECM) and the results are shown in Table 6. All coefficients of short-run pass through are significantly positive in the first lag of bilateral repurchase rate and there are in the range between 19.45% and 22.04%. That means lending rates take short run effect from the adjustment in the bilateral repurchase rate around only 20%. Moreover, I perform the Wald test to confirm that lags of bilateral repurchase rate is significant variables at 1% level to theses model fit in the short-run. Also, the speed adjustments are negative and nearly zero. I find that the speed of adjustment of MRR is significantly negative which implies that MRR is mean reversion to the long-run equilibrium. Specifically, MRR will move up if it is below the equilibrium level and move down when it is above the equilibrium level. This result is consistent result with

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Charoenseang et al. (2007) that show the adjustment speed of MRR is significantly negative.

In summary, Disyatat et al. (2002) provide reasons that retail rates in Thailand are sticky, in other words, the incomplete passthrough from changes in money market rate to retail rates. The partial transmission due to the information asymmetry, switching costs and adjustment costs. Precisely, the information asymmetry leads to decreasing creditworthiness of borrowers. The switching costs come up with collecting new information that reduce the incentive for borrowers to change banks. Also, banks have adjustment costs for preparation of changing rates. In addition, Zulkhibri (2012) also concludes that the incomplete transmission for lending rates may occur because of the low competitiveness among banks in financial system, switching costs, and also asymmetric information reasons.

5.3 The change in the monetary transmission mechanism during the crisis

Table 7: Short run relationship

The results reported in the table are estimated by error correction model (ECM) and obtained from the equation 8:

$\Delta lr_{i,t} = \sum_{j=1}^{n} \alpha_i \Delta lr_{i,t-j} + \sum_{j=0}^{n} \delta_i \Delta mr_{t-j} + \sum_{j=0}^{n} \pi_i D_{t-j} + \beta_{0,i} (lr_{i,t-1} - \phi_1 mr_{t-1} - \phi_2 D_{t-1} - \lambda_{i,t}) + \varepsilon_{i,t}$ which β_0 is the speed of adjustment, the short term passthrough is measured by the slope, δ_i and π_i captures the effect of crisis periods.

The t-statistics are in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

	MLR	MOR	MRR
Speed adjustment (β0)	-0.0015**	-0.0004***	-0.0016**
	(-2.1938)	(-4.1659)	(-2.9177)
bilateral repurchase rate $_{t-1}$ (Δmr_{t-1})	0.2113***	0.1871***	0.1693***
	(11.1684)	(9.8391)	(4.5650)
bilateral repurchase rate $_{t-2}$ (Δmr_{t-2})	0.0404**	0.0336	0.0685
	(1.9098)	(1.5603)	(1.5774)
bilateral repurchase rate $_{t-3}$ (Δmr_{t-3})	0.0234	0.0259	-0.0161
	(1.2004)	(1.3072)	(-0.4087)
crisis $_{t-1}$ (Δdummy $_{t-1}$)	0.0000***	0.0000**	0.0000
	(3.3982)	(2.4506)	(1.1571)
crisis $_{t-2}$ (Δdummy $_{t-2}$)	0.0000*	0.0000***	0.0000
	(-1.9012)	(-2.9703)	(-1.0015)
crisis $_{t-3}$ (Δdummy $_{t-3}$)	-0.0001***	-0.0001***	-0.0002***
	(-7.7025)	(8.7100)	(-7.7911)
mark-up (constant)	0.0000	0.0000	0.0000
	(-0.0067)	(-0.1245)	(0.1615)
Adjusted R-squared	0.1771	0.1859	0.0673

The MLR, MOR, and MRR take effect from the short run adjustment in the bilateral repurchase rate in the first lag with 21.13%, 18.71%, and 16.93%, respectively as shown in Table 7. Also, the crisis is significant in the short run model but provides much less impact than the bilateral repurchase rate. The Wald test results remain unchanged and also show that both lags of bilateral repurchase rate and crisis variables are significant at 1% level to all lending rates short-run models. The coefficients of speed adjustment are negative and in the range from -0.002 to -0.001. In addition, the speed adjustment coefficients to the equilibrium of lending rates are significantly negative: this mean that if an exogeneous shock happens, 0.15%, 0.04%, and 0.16% of the deviation of MLR, MOR, and MRR from money market rate is absorbed within the first month. Comparing to the study in Italy, Spain, the UK, and the US by Gambacorta et al. (2015), they find the coefficients of the speed adjustment are between -0.07 to -0.36. This indicates that if the shock such as crisis occurs, the deviation in transmission that absorbed in the

first month (7%-36%) in advanced countries are much higher than in Thailand.

To sum up, Gambacorta et al., 2015 conclude that the lesser interest rate passthroughs during the crisis because borrowers have worse financial conditions due to distress and also banks charge higher risk premiums to borrowers. Horvath et al., 2018 also suggest that the weakened transmission as the result due to higher credit risk in the global financial crisis period. These imply that under the financial distress, banks hold riskier assets in their portfolio because borrowers may have higher risk to default or bankruptcy. Therefore, commercial banks may be less efficient in passing on the changes in money market rate to lending rates due to crisis.

5.4 The effect of bank characteristics on the transmission mechanism

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Table 8: Long run relationship

The results reported in the table are estimated by panel dynamic OLS cointegration regression and obtained from the equation 9:

$lr_{i,t} = \lambda_i + \beta_1 mr_t + \beta_2 D + \beta_3 Size_{i,t} + \beta_4 Captial_{i,t} + \beta_5 NPL_{i,t} + \varepsilon_{i,t}$ which $lr_{i,t}$ is the lending rate, mr_t is the benchmark market interest rate, the degree of passthrough is measured by the slope, β_1, β_2 captures the effect of crisis periods, β_3 β_4 β_5 measure the impact of bank characteristics.

The t-statistics are in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

	MLR	MOR	MRR
bilateral repurchase rate *(mr)*	0.5344***	0.4579***	0.5250***
	(29.5453)	(17.4696)	(10.0091)
crisis *(dummy)*	-0.0001***	-0.0004***	-0.0004***
	(-6.6919)	(-9.9929)	(-5.3881)
Size	-0.0000	-0.0027	-0.0068**
	(-0.0025)	(-1.3266)	(-2.3212)
Capital	0.0006**	0.0001	-0.0008*
	(2.0990)	(0.3427)	(-1.7744)
NPL	-0.0038***	-0.0044***	-0.0056***
	(-5.4432)	(-4.4820)	(-3.7294)
Adjusted R-squared	0.9454	0.8180	0.8390

Table 9: Short run relationship

The results reported in the table are estimated by error correction model (ECM) and obtained from the equation 10:

$\Delta \mathrm{lr}_{i,t} = \sum_{j=1}^{n} \alpha_i \, \Delta \mathrm{lr}_{i,t-j} + \sum_{j=0}^{n} \delta_i \, \Delta \mathrm{mr}_{t-j} + \sum_{j=0}^{n} \pi_i \mathrm{D}_{t-j} + \sum_{j=0}^{n} \theta_i \Delta \mathrm{Size}_{i,t-j} + \sum_{j=0}^{n} \varphi_i \Delta \mathrm{Capital}_{i,t-j} + \sum_{j=0}^{n} \sigma_i \Delta \mathrm{NPL}_{i,t-j} + \beta_{0,i} \, (\mathrm{lr}_{i,t-1} - \phi_1 \mathrm{mr}_{t-1} - \phi_2 \mathrm{D}_{t-1} - \phi_3 \mathrm{Size}_{i,t-1} - \phi_2 \mathrm{Capital}_{i,t-1} - \phi_3 \mathrm{NPL}_{i,t-1} - \lambda_{i,t}) + \varepsilon_{i,t}$ which β_0 is the speed of adjustment, the short term passthrough is measured by the slope, δ_i, $\pi_i$captures the effect of crisis periods, θ_i $\varphi_i \sigma_i$ represent the impact of bank characteristics.

The t-statistics are in parentheses. ***, **, * represent significance at the 1%, 5%, and 10% level, respectively.

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	MLR	MOR	MRR
Speed adjustment (β0)	-0.0002***	-0.0037***	-0.0010***
	(-3.3003)	(-5.3122)	(-2.6095)
bilateral repurchase rate $_{t-1}$ (Δmr_{t-1})	0.1956***	0.1991***	0.1774***
	(8.8318)	(8.5454)	(3.1739)
bilateral repurchase rate $_{t-2}$ (Δmr $_{t-2}$)	0.0719***	0.0745***	0.1475**
	(3.1171)	(3.0389)	(2.5197)
bilateral repurchase rate $_{t-3}$ (Δmr $_{t-3}$)	0.0414**	0.0292	-0.0566
	(2.0075)	(1.3370)	(-1.0999)
crisis $_{t-1}$ (Δdummy $_{t-1}$)	0.0000**	0.0000	-0.0001
	(1.8455)	(0.3530)	(-0.3776)
crisis $_{t-2}$ (Δdummy $_{t-2}$)	0.0000	0.0000	0.0000
	(0.4959)	(-0.7107)	(0.2253)
crisis $_{t-3}$ (Δdummy $_{t-3}$)	-0.0001***	-0.0001***	-0.0002***
	(-8.8954)	(-9.4384)	(-7.7625)
Δ Size $_{t-1}$	-0.0001	-0.0002	-0.0001
	(-0.2492)	(-0.4205)	(-0.0763)
Δ Size $_{t-2}$	0.0006	0.0006	0.0008
	(1.0300)	(0.9882)	(0.5340)
Δ Size $_{t-3}$	0.0001	-0.0001	0.0005
	(0.3111)	(-0.0979)	(0.3350)
Δ Capital $_{t-1}$	-0.0001***	-0.0001***	-0.0001***
	(-4.6544)	(-4.7704)	(-2.6352)
Δ Capital $_{t-2}$	0.0000***	0.0000**	0.0001
	(2.6697)	(1.9849)	(0.7887)
Δ Capital $_{t-3}$	0.0000	0.0000	0.0000
	(0.8834)	(0.7812)	(0.2992)
Δ NPL $_{t-1}$	-0.0013***	-0.0011**	-0.0012
	(-3.3531)	(-2.5353)	(-1.0418)
Δ NPL $_{t-2}$	-0.0006	-0.0005	-0.0014
	(-1.5828)	(-1.1958)	(-1.2684)
Δ NPL $_{t-3}$	-0.0013***	-0.0011***	-0.0014
	(-3.2685)	(-2.7478)	(-1.2089)
mark-up (constant)	0.0000	0.0000	0.0000
	(0.8769)	(1.2166)	(0.0437)
Adjusted R-squared	0.2029	0.2194	0.0641

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The significant long run relationships between lending rates and the money market rate still exist while the monetary policy transmission is less than complete. These results are consistent with Holton et al., 2018 that find the incomplete passthrough in Euro countries. The coefficients in table 8 show that passthrough rates of MLR, MOR, and MRR are 53.44%, 45.79%, and 52.50%, sequentially. Also, the adjusted R-squared

from these regressions are between 81.80% to 94.54% which imply that models are good fit.

The bilateral repurchase rate, and crisis are significant at 1% level that affect long run transmission of monetary policy to all types of lending rates. In term of bank characteristics, NPL provide the negative effect through the transmission, bank capital is significant to all lending rates except for MOR while bank size has significant negative impact only for MRR.

In the short-run perspective as shown in Table 9, the immediate pass-through to lending rates are observed to be in the range of 17.74% to 19.91% in the first lag. According to bank characteristics, the capital ratio leads to decreasing passthrough for all commercial bank rates, followed by the NPL ratio except for MRR, and the bank size is insignificant in every loan rate deviation. In addition, the Wald test result to confirm whether variables are significant to that model fit. These show the similar conclusion that lags of bilateral repurchase rate, crisis periods, banks' capital are significant to all lending rates while NPL ratio significantly improves model fit of MLR and MOR. Conversely, size is not relevant in short run relationship.

First, there is no evidence to support that bank size is significant in the monetary policy transmission for this sample. That means the bank size does not affect to all kinds of lending rate passthroughs in Thailand. The results are in line with Gambacorta (2005) who concludes that bank size is irrelevant to a monetary policy after the monetary tightening in Italy. On the other hand, Holton et al., 2018 observe the bank size affect the passthrough for smaller loans in European Countries during financial

crisis. Regarding the capital ratio, the results show that the higher capital ratio the bank has, the less passthrough the bank response to. I also find that the capital is relevant to changes in money market rate to all lending rates in Thailand. This observation can be confirmed by Holton et al., 2018. They find the capital ratio is important to the interest rate passthrough, especially for larger loans. With regard to asset quality represented by NPL ratios, I observe that NPL leads to negative impact on the passthrough of the changing in money market rate into lending rates except for retail loans. The results are in parallel with Holton et al., 2018, they discover the high level of NPLs decrease the transmission for both small and large loans. They also present that the asset quality is the significant portion of the deviation in loan rates from money market rates during the crisis.

In conclusion, Holton et al., 2018 conclude that the capital is related to bank's lending capacity due to the key element of regulatory constraints. The banks with increased capital requirements may charge higher margins or decrease lending to borrowers who face with large requirements. Also, the NPL ratio implies the asset impairment in loan portfolio that the higher NPL ratio may also reflect the borrowers with higher default risk and at risk of bankruptcy under the financial distress. Gambacorta (2005) explains that bank size does not affect the banks' reaction to a monetary policy change because of a closer relationship between customers and banks. This indicates that customers will not switch banks even if that banks inefficient response to the interest rate transmission.

6. CONCLUSION

I make a significant contribution to the literature on the monetary policy transmission including the passthrough during the crisis periods and the impact of bank characteristics. The evidences in Thailand over a decade presented in this paper show that the long term passthrough to all kinds of lending rates still exist but are less than complete. Information asymmetry, costs, and market competition cause the incomplete transmission of monetary policy to lending rates. These results are in line with many prior studies both in developing and developed countries while the degree of passthrough vary across countries and the period of observations. In case of Thailand, this result provides the higher long - term pass-through rates than prior observations while they are still lower than some advanced economy countries presented by previous studies.

Also, the lesser interest rate passthroughs during the crisis periods that observed in Thailand including the global financial crisis and COVID-19 pandemic crisis that is similar to prior studies both in emerging countries and advanced economy countries. Since, borrowers have higher credit risk during the crisis and also banks charge higher risk premiums, the weakened interest rate transmission during the crisis occurs. This implies the less efficient of monetary policy transmission when the crisis occurs.

Regarding bank characteristics, I find that the capitalization leads to the declining of the monetary policy transmission to all commercial bank lending rates, followed by NPL ratio except for MRR, and the bank size is insignificant in every loan rate passthrough. Results are confirmed by previous research in European countries. The capital ratio implies the

regulatory constraint led to the diminishing passthrough in Thailand. Also, higher NPL ratio, the riskier borrowers that banks have. Thus, banks with high NPL ratio will not pass on full interest rates transmission into lending rates.

An incomplete interest rate passthrough can lead to the inefficient of monetary policy to transfer the gain of changing interest rates to households and firms in real economy. This study may lead to more effective monetary policy in the future that improves the transmission mechanism in Thailand that can be specific for normal circumstances and during the crisis period. Policy makers may provide more aggressive policy for incomplete passthrough. This paper may offer the key indicators of individual bank characteristics that should be crucial to keep an eye on. Precisely, supervisors can closely monitor banks with specific characters that tend to less or slower response in the transmission mechanism to control for the well-functioning and levels of competition in the banking system. Moreover, the more passthrough rate that the banks response, the more benefit to population in country they receive.

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Chulalongkorn University

VITA

NAME	Duangporn Lertsomphol
DATE OF BIRTH	28 September 1992
PLACE OF BIRTH	Bangkok, Thailand
INSTITUTIONS ATTENDED	Chulalongkorn University
HOME ADDRESS	54 Chakrabongse Road, Talat Yot, Phra Nakhon, Bangkok, 10200

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