Charles University

Faculty of Social Sciences

Institute of Economic Studies

MASTER'S THESIS

Development strategy of commercial banks

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, May 14, 2020   Firstname Lastname

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Acknowledgments

Abstract

In this article, we analyze the key factors that determine the net interest margin (NIM) of EU commercial banks in the current economic environment. We examine a large number of annual data samples of 252 commercial banks in EU member states from 2015 to 2020. During this period, most countries experienced extremely low or even negative interest rates. In this article we test three hypotheses. First, commercial banks committed to providing financial products and services show the highest net interest margin (NIM). Second, the net interest margin of small commercial banks has dropped significantly under conditions of negative interest rate. Third, the net interest margin of Western European countries has dropped significantly under conditions of negative interest rate. Similar to other studies, we have obtained the positive-concave relationship between interest rates and NIM, and the regression coefficients of other bank-related variables and macroeconomic variables have also achieved similar results. Compared with other studies, we innovatively consider the impact of countries with different economic levels on the net present value of commercial banks. Finally, we comprehensively regress the results and conclude what development strategies commercial banks should use in the current economic situation.

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Acronyms

NIM Net interest margin

ROA Return on assets

ROE Return on equity

GDP Gross domestic product

ZLB Zero lower bound

GMM Generalized method of moments estimator

OLS Ordinary least squares estimator

Master's Thesis Proposal

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Author:	**Yuye Zheng**	Supervisor:	Prof. Ing. Karel Janda, Dr., Ph.D., M.A.
Specialization:	MEF	Defense Planned:	2021 summer

Proposed Topic:

Development strategy of commercial banks

Motivation:

Commercial banks play an important role in the entire economic system, providing financial services to the public and enterprises, and ensuring economic stability and sustainability. With the development of economy and Internet, commercial banks will undergo tremendous transform in their development. Now they are bearing the huge impact of the global outbreak of the corona virus. Banking sector is under significant pressure. How commercial banks should develop in the future is a question worthy of study.Therefore, this thesis will try to analyze what kind of development strategies commercial banks should apply under the current economic and technological situation, what impact did the outbreak of the corona virus have on commercial banks, what strategies commercial banks should adopt to prevent shocks, and what strategies can maintain   the stability and even development of commercial banks and the entire economic system .

Hypotheses:

1. Hypothesis #1:Based on the economic level,divide the region into Central and Eastern Europe,non-performing assets represent the impact from economic changes.
2. Hypothesis #2:Years of association with bank has no significant difference in the customer perception while using e- delivery channels in public and private sector banks.
3. Hypothesis #3:As commercial banking institutions merge into larger organizations, they are likely to reduce the shares of their loan portfolios earmarked for small business loans.

Methodology:

I will choose 20 commercial banks data in the last 15 years from central Europe and eastern Europe,use linear regression to test the relation between their non-performing assets and GDP. Explain under different economic condition how will it influence commercial banks.Aim

is to analyze the trends in NPAs in terms of values, gross and net NPAs as a percentage of gross advances and net advances, gross and net NPAs as a percentage of Total Assets respectively.

Since the commercial loans of small banks are usually small in scale and highly localized, small banks tend to develop together with small business customers. However, as banks become larger and more complex in their organizational structure, their business focus will tend to be large commercial customers or more standardized businesses. In order to assess the empirical significance of the hypothesis, this thesis will compare the small business loan-to-asset ratio of banks.

Expected Contribution:

In this thesis I expected to conclude a framework of development strategy of commercial banks which suit for the current economic and technology situation,what kind of transformation should commercial banks make.especially analyze what impacts has corona virus brought and what should commercial banks do to prevent from this kind of shock,to give some advice about risk management.I hope the results could help commercial banks develop well then could perform better in economic system.

Outline:

There would be 5 parts of the thesis. First is introduction,I would introduce the function of commercial banks and the importance to form a plan of development. Second is literature review,summary of the current situation that commercial banks are facing,challenges and chances. Third is the method introduce and model. Fourth is the framework of development strategy of commercial banks and possible shortcomings of the framework. Last would be conclusion.

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1.Introduction

This thesis aims to find the key determinants of commercial banks net interest margin (NIM) under the current economic situations. Commercial banks are obviously important financial institutions, playing a very important role in the economic system. Working as an intermediary in the economic system, a commercial bank provides financial services to the public and promotes the operation of the economic system. With the development of the economy and worldwide banking sector, there should be significant adjustments on the development strategies of commercial banks. As the global corona virus outbreak exhibits an impact on global economy, the banking industry is under huge pressure. Based on Eurostat database we can see that most of the countries are having very low or even negative interest rate. How commercial banks should develop in the future is a question worthy of study. Therefore, this thesis will analyze the current status of commercial banks and suggest the development strategies that commercial banks should adopt under the current economic and technological situation. This study use the annual data of 252 commercial banks in European Union during time period from 2015 to 2020 to find out the determinants of commercial banks performance. Moreover we want to analyze the impact of the corona virus outbreak on the economy and commercial banks to get inspiration about what strategies should commercial banks adopt to prevent shocks, and what indexes worth our studying to maintain the stability and even growth of commercial banks as well as the entire economic system.

Since 2015 the interest rates in European Union countries started to show negative values. Previous studies (Hanzlik and Teply, 2019) found positive concave relationship of short term interest rate with NIM, it means the impact of net interest margin (NIM) is more sensitive when the interest rate is close to zero. So the studying about banks profitability needs further research.The topics about banks performance are always popular, however the researches about key determinants of commercial banks NIM are still needed to be further studied. So this topic attracted a lot of researchers, our research is based on their results.

Traditionally, the development indicators of banks only focus on the scale and depth of the banking system, rather than on the use of banking products and services, the speed of development, and the risk management

capabilities of responding to shocks. And the traditional indicators also used to explain the relationship between banking development and economic growth. Bikker and Vervliet (2017) chose the variables from bank profits and risk taking aspects, they divided the variables into bank specific interest rate and macroeconomic environment variables. Similar as them, Hanzlik and Teply (2019) chose variables from these aspects and also introduced dummy variables for estimate the heterogeneity of banks, moreover they introduced instrumental variables for dealing with the problem of correlation between the variables they chose. Based on their researches we chose net loan to total assets, loan loss reserves to gross customer loans, impaired loans to gross customer loans, growth in net customer loans, cost to income ratio and operating expense to average risk-weighted assets as bank specific variables and real GDP growth rate, inflation rate, unemployment rate and interest rate as macroeconomic specific variables, We also chose several dummy variables about bank size, specialization and negative interest rate to test banks heterogeneity.

Due to the characters of the dataset the estimation using system generalized method of moments (GMM) will be performed. Three hypotheses will be tested. First, banks specializing in offering financial products and services report the highest NIM.The chart we draw based on the data shows banks specialized in financial products report the highest NIM. In the study of Bikker and Vervliet (2017), banks with higher total non - interest income over total income ratio have lower NIM, their point can also support this hypothesis. Second, small banks NIM dropped significantly when interest rates are negative. Based on intuitive experience, the profitability of commercial banks is closely related to the size of the bank. The size of the bank determines the operating efficiency and cost of the banking system. Berger and Humphrey (1997), Spathes et al. (2002) and Aladwan (2015) had also confirmed this point very well. But small banks are usually more sensitive to the change of interest rate because they rely more on retail deposits. Therefore, we assume that the growth of the bank is related to the size of the bank.Third, Western European countries' NIM is affected more than the rest of the countries. In Fišerová et al. (2015), they expected that foreign banks can make more profit in less developed countries. So we assume that in more developed countries, banks would be more sensitive to the decreasing interest rate.

We found that lagged dependent variables are highly correlated with NIM, so it proved it is correct to use system GMM. Staikouras and Wood (2004) said the profitability of European banks is not only affected by factors related to their management decisions, but also by changes in the external macroeconomic environment. And our result are consistent with Hanzlik and Teply (2020), Bikker and Vervliet (2017) that interest rate have positive concave relationship with NIM. At the same time real GDP growth rate and inflation rate also have positive coefficients, but in our results unemployment only shows an insignificant negative coefficient and this is similar as the results of Hanzlik and Teply (2020). About bank specific variables we generally found that variables related to customer loans have positive impact on banks profitability and higher cost and risk would have negative impact on their performance.

This thesis contains five parts. First part is introduction which basically introduces the topic and explains why it is worth study. Second part includes theory background and literature review, this part talks about the functions of commercial banks and their impact on economy, analyzes the profitability of banks and then concludes with the determination of the variables which probably have effect on commercial banks' growth. Then we discuss the European banking sector, the background of commercial banks and their current status,and what adjustments were adopted.The third part introduces our hypotheses and data analysis. The fourth part is the description of methodology and fifth part shows the results. The last part gives the conclusion.

2.Theoretical analysis

2.1 The role of commercial banks

Commercial bank is the financial institution which accepts deposits, makes loans, provides financial product and saving account to business and individuals as well as cash and treasury management, offers transaction accounts and other services. Commercial banks pay interest to costumer and charge a higher rate of interest from loans therefore make their main profits from this mechanism. In addition, commercial banks can also make profits from the financial products they provide.For example, checking accounts, the

use of debt cards and credit card swipes require payment. There will be fines for overdrafts and late payments on bank-issued credit cards, and maintenance fees for many savings and investment accounts. And the interest rate of most credit cards far exceeds the interest rate of any other type of loan. At the same time, commercial banks are also facing the possibility of losses from loans defaults and bad debt.Commercial banks play an important role in economy, they provide various kinds of financial services to public thence ensuring the stability and growth of economy. So it is worth to study their development strategies for not only their stability and growth but also the whole economy. Especially during 2020-2022, because of the COVID-19 epidemic, the stability of the global economic system has been facing big challenge, many industries are facing the possibility of bankruptcy, and the government's stimulus plan has mostly come to commercial banks.

The relevant financial services of commercial banks have made a huge contribution to the EU economy and played a huge role in promoting employment. First, financial support for enterprises promotes enterprise development and thus expands employment. Second, the development of the banking industry itself provides more jobs, one in every hundred jobs in the EU is in the banking industry. According to the statistics of the European Banking Federation (2020) at of the end of 2019, more than 2.6 million people were employed in the banking industry in the EU. Over 3% of economic growth in the past few years has come from the banking industry.Since 2009, the number of credit institutions has been on a downward trend, and the banking industry has begun to merge,with the number falling to 5981 in 2019 (EBF,2020). The merger of the banking industry has reduced overcapacity and is committed to enhancing profitability.

Adenomon et al. (2019) analyzed the contributions of commercial banks to GDP growth in Nigeria. They used secondary data collected from the Nigerian Central Bank's Statistical Bulletin. The data covers the period from 1981 to 2015. Annual data on loans, loan interest rates, prepayments, savings, and GDP of financial institutions are collected. The data uses natural logarithm conversion to the natural logarithm conversion of financial institution GDP, the natural logarithm conversion of loan interest rate, the natural logarithm conversion of loans and advances, and the natural logarithm conversion of weighted average savings. The natural logarithmic transformation of the GDP of financial institutions is used as the dependent

variable.This study applied the ARDL model to test the contribution of commercial banks to GDP growth. The ARDL model shows that loans, advance payments and loan interest rates are significantly positively correlated with GDP, but in this model savings are not significant.

2.2 Commercial banks performance

As this study is expected to identify the development strategies of commercials banks, in other word we need to find out the determinants of banks profitability and which variables can represent bank growth. Commercial banks are important parts in financial system, their profits can make up the part from loan loss, good profitability also can attract new capital. However, Hack and Nicholls (2021) mention that higher profitability also refers to higher risk taking because banks are mostly making profits from loans, so very high profits could also mean lacking of competition. In addition, from Brunnermeier &Koby (2018) results we see that banks' profits can also influence the banks' willingness of offering new credit therefore affects monetary policy transmission.

In plenty of studies of banks performance we can see that ROA, ROE and NIM are widely used as the dependent variables for representing the bank performance. Horobet et al. (2021) have a study about determinants of banks profitability, they use all of these three indicators as dependent variables to estimate banks performance. Fiserova et al. (2015) also used all the three measurements. Except these three measurements of profitability, the profit as reported on banks balance sheets is also investigated in the study of Bikker and Vervliet (2017). But Hanzlik and Teply (2019) only use net interest margin as dependent variables. They mention that NIM are closely linked to overall interest rate, so it allowed us to study about banks' transmission into macroeconomic conditions and monetary policy. In this thesis we aim to find a good strategy for commercial banks development under the current economic conditions, for examples low or negative interest rate, NIM would be a good measurement for bank performance. From the definition of net interest margin, it is a measure of net interest return on banks earning assets, it allowed us to see the differences of banks incomes across time.

Similar to other types of retail loans, the credit card business may achieve significant growth. Credit card business can distinguish commercial banks from competitors in the non-banking industry. According to

KResearch's survey (2018) on the behavior of Metropolis credit card holders in Bangkok, people spend 1.8 to 2.5 times more on credit cards than normal. In 2019, about 71.2% of the cardholders surveyed believed that their spending plan might not be lower than the previous year. Compared with Europe, the situation will not be very different. Therefore, we expect that with various preferential policies for the first use of credit cards, credit card expenditures may grow close to 10%. So we can assume credit cards have an impact on commercial banks' growth rate. Inspired by Bikker and Vervliet (2017) we would try to find the key determinants of banks performance from profits and risk-taking. European banks generally use profitability to evaluate bank performance, and the indicators for evaluating bank performance are return on total assets (ROA) and return on total equity (ROE). Although important information about bank performance can be obtained through accounting and financial ratios, in order to help commercial banks increase bank growth rates, this study takes into account loans, bank size and bank specialization and economic condition of mother countries, and studies the effects of these variables on commercial bank performance.

Many studies have involved the impact of bank size on bank profitability, and it has always been an important variable. We can get from the previous literature that the size of a bank is closely related to its capital adequacy ratio, because large-scale banks generally want to raise cheap capital to increase profits. Similar studies have shown that the size of a bank is related to and directly proportional to the capital adequacy ratio. Spathes (2002) used the ROE of Greek banks to investigate the effectiveness of large and small Greek banks. Using data from 1990 to 1999, he found that large banks are more efficient than small banks. Small banks are characterized by high return on equity (ROE), while large banks are characterized by high return on assets (ROA). Berger and Humphrey (1997) found that large size banks are more efficient than small size banks. We can find that bank scale has a positive impact on bank profitability and large size banks are more efficient. However, Aladwan (2015) found that there were size effect, small sized banks showed higher performance when compared to large scale banks. Relative to the size of commercial banks we can also consider the number of branches. With the growing of commercial banks they will need larger market then they would choose to establish more branches to cover other area they never reached, reduce the number of branches or merge to reduce costs. Avery and Samolyk (2000) found that in the rural market, mergers are associated with

lower loan growth. In particular, the merger of small banks has a higher correlation with local loan growth. Mergers between small banks may enhance the availability of credit for small businesses. However, in urban markets, there are usually fewer links between bank mergers and local small business loans.

In most areas, commercial banks provide loans for purchases of houses, cars and entrepreneurship, and provide financing for small and medium-sized enterprises, so it brings liquidity to the economy, and the banking sector is closely related to resource allocation. The ratio of loans to total assets is often used to assess risk. If this ratio is high, the bank may face higher risks. Loans often bring benefits to banks, but if there is some inaccurate assessments or poor management, these loans often become irrecoverable loans, reducing the bank's capital, affecting its continued lending which will adversely affect bank profitability and growth. Generally speaking, the higher the risk, the higher the rate of return, so if a bank has higher ratio of net loan to total assets this bank will have a higher profit rate. But there are also a lot of studies show that they have a negative relationship. Hanzlik and Teply (2019) point out net loan to total asset indicate the percentage of assets made up from loans, thus it can be consider as a credit risk ratio. However the higher ratio indicates the lacking of liquidity, while lower ratio means lower interest income. So the impact of this ratio to banks performance is indefinite. For example Bikker and Vervliet (2017) find that net loans to total assets has a negative coefficient in the regression when taking profit as dependent variable. Therefore we don't know the actual relationship between ratio of loans to total assets with bank performance.

In addition we need to introduce some ratios can represent the quality of bank loans and assets structures. Hanzlik and Teply (2019) used loan loss reserves to gross loans ratio to measure the quality of bank assets. Fiserova et al. (2015) use loan impairment charges to average gross loans as a proxy for non-performing loans, this indicator can measure the quality of credit management by comparing the impaired loan loss to the whole loan portfolio. Bikker and Vervliet (2017) introduce credit risk proxy into their models and find the credit risk increasing leads to an increase in lending rate, in turn it promotes higher NIM. Higher net customer growth rate can bring more interest income to commercial banks, while at the same time the banks are taking more risk. Matthias (2012) discusses the impact of loan growth, he implies that if a bank has high loan growth rate does not necessarily reflect it

has high risk taking when all the other banks are holding the similar rates. But if banks have higher loan growth rate by relaxing the lending standards, the higher rate the higher risk taking.

Bikker and vervliet (2017) point out that low interest rate may increase the risk appetite of banks. In the short run, banks may profit more due to the low possibility of default loans. But in the medium run, banks might lower their lending standards therefore it could lead to a worsening of the loan portfolio quality.

2.3 Banking sector in European union

Both short term and long term interest rate have been falling to very low level even negative these years in many advanced economics around the world, European union economy is facing the high risk in financial system. Hack and Nicholls (2021) claim that market pricing indicate the low interest rates are expected to remain few years in the future.

According to the statistics of the European Banking Federation (2020) the total number of banks and credit institutions in the EU has decreased from approximately 85,000 in 2008 to around 6,000 in 2019, and the number of branches has also decreased. European Union bank branches fell to approximately 163,000 at the end of 2019. Since 2008, the number of branches has fallen by 31%. According to this trend, the increase in digital banking business is reflected. The widespread use of electronic payments and mobile banking by customers has greatly reduced the importance of bank branches. Since the global financial crisis, European banks have been undergoing a tense and slow recovery process, constantly acquiring capital to deal with possible future crises. Since 2015, banks must have at least 60% of high-quality liquid assets, and the minimum requirement is increased by at least 10% every year until reach 100% in 2019. The basic business of raising deposits from customers and providing credit to customers is vital to European commercial banks. Deposits and loans to households and non-financial companies have increased in recent years. Overall, the total assets of European banks have remained relatively stable in the past few years.

During the difficult recovery after the crisis, new changes have taken place in the global banking landscape. The European banking industry is affected by the slowdown economic development their profit level is still far

below the level before financial crisis. Some large commercial banks have suffered huge losses. In response to this, the European banking industry has proposed implementable reform and restructuring strategies which targeted about this problem in terms of regional layout, business structure, technology finance, and control of cost.

For better analysis of the commercial banks here using swot analysis to make clear of the situations of them.

Swot analysis of banking sector:

Strengths: Banking is one of the oldest industries. As long as human beings survive, there will be various banking services. At first, people lived in the barter system. Now with banks, people can use the value of money to obtain loans. Access to services such as savings bonds and credit cards has greatly improved people's living standards. Frue (2019) said that banks are leaders in economic growth. The development of the banking industry can promote economic growth and improve financial trade conditions to promote its stability and security. At the same time, the development of commercial banks can increase employment opportunities and reduce global poverty. When an economic crisis occurs, it will receive a certain amount of economic support .

Weaknesses: Lack of global coordination, because commercial banks are related to the financial industry, they are relatively fragile and are complementary to economic development. If economic development is not good, commercial banks will decline quickly and even face the crisis of bankruptcy if they do not grasp the proper measures. According to the statistics of International monetary fund (2020), the GDP of EU is estimated to be approximately US$15 trillion (nominal), accounting for approximately 1/6 of the global economy . If it faces a recession, other parts of the world will also face crises, which will have a negative impact on the European market. Exchange rate fluctuations can also cause trouble for banks. Banking is an ancient industry, and its infrastructure still relies on old technology systems. It takes a lot of time to follow the development of new technologies. And the development in rural areas is restricted.

Opportunities: Banks can develop less-touched rural markets. The development of banks should keep up with the needs of consumers. The new

generation of young people will prefer loan consumption and can provide loans to young people to expand the market.

Threatens: The biggest threat this year is the economic recession. Affected by the epidemic and the global economic recession, if a company faces a bankruptcy crisis, a large number of non-performing loans will inevitably have a huge direct or indirect impact on commercial banks. The cooperation between banks and other companies, such as PayPal, requires the bank's authorization. If these companies' information leaks or violates regulations, the bank will also be affected. More commercial banks are joining the market, the banking industry is fiercely competitive, and some financial institutions and financial technology companies that can replace commercial banks are gradually emerging. Commercial banks must continue to improve their competitiveness if they want to survive.

2.4 Current status of EU banking system

Since the outbreak of the international financial crisis, developed economies have strengthened their supervision of investment banking. Regulations such as Basel III put forward higher capital requirements for large commercial banks to carry out investment banking and trading activities, and at the same time introduced leverage ratio restrictions. A series of strict regulatory mechanisms have greatly increased the cost of the above-mentioned investment banking business, and the risk-adjusted returns are also lower than traditional retail and commercial banking businesses.

Christoph and Mariathasan (2018) found that central banks in Denmark, the Euro Area, Sweden, and Switzerland have moved their policy rates into negative territory since 2014. Based on Eurostat database we can see most of commercial banks in member states of EU are facing very low and negative interest rate. It becomes necessary to examine monetary transmission and the impact on financial stability below the ZLB.

In this context, Credit Suisse Group, Barclays Bank, Deutsche Bank, Royal Bank of Scotland and UBS have established "non-core business units" to deal with derivatives assets, specific transaction assets, credit-related investment portfolios, and specific bulk "Non-core business assets" such as commodity assets. Major European banks are trying to cut costs and liberate

regulatory capital in order to carry out financial activities with higher profit margins.

The weak European economy and Brexit have caused changes in investor risk appetite. In the previous process of selling non-core business assets, the long-term low interest rate environment in developed economies encouraged investors to seek high-yield assets, and the non-core business assets of major banks became favored by all parties. At the same time, the British referendum on Brexit and the weak economic growth in Europe in the future have greatly increased investor risk aversion and demand for hedging, and the attractiveness of banks' non-core business assets has declined.

The proportion of risky assets in the remaining non-core businesses has increased. The liquidation process in the previous years has sold highly liquid and easily priced assets. At present, among the remaining non-core business assets, there are a large number of long-term derivatives and complex structured products that are difficult to sell and handle.

The downward trend in non-core business asset prices is obvious. Due to poor liquidity or low transparency of remaining non-core business assets, the market is only willing to buy at a lower price level. At the same time, in order to increase their domestic banking capital positions, national banks such as Italy and Spain have begun to sell their non-performing assets at large discounts. This move further impacted the prices of non-core business assets.

Affected by multiple factors such as the debt crisis, the quantitative easing policy in the Euro zone and the slowdown in economic growth in emerging markets, the asset scale of European banks has declined, asset quality has deteriorated, and their capacity has declined. Many large commercial banks have experienced substantial declines in profits. As regulatory measures have become more stringent, European banks have occasionally increased their capital strength, but the pressure has also increased.

Since the global financial crisis, the current status of the banking industry has become a hot topic of public debate in Europe. A healthy and stable banking system is important in both good and bad economic conditions. Under the great economic conditions, they help companies with

financing and promote economic growth; In times of economic recession, if the banking system is unstable, it will threaten the integrity of the economic system and cause economic problems. The outbreak of the 2020 epidemic further validates this statement.

We can get inspiration from the business development models of underdeveloped banking institutions in Europe, such as UniCredito Italiano in Italy, that we should deploy overseas business reasonably and cautiously to avoid being implicated in individual countries or regions and impacting the domestic economy. In particular, we must be cautious in holding the risk positions of countries suffering from debt crises, reasonably control the risk exposure to the capital markets of emerging market countries, and establish corresponding market exit mechanisms when necessary.

2.5 Strategies adjustments of commercial banks

Many large commercial banks have begun to make strategic adjustments. First, optimize and adjust the regional layout, strategically shrink the international business network, withdraw from regions with poor profitability, and moderately shrink market operations to reduce costs. Second, promote business restructuring. Under the background of weak and slow economic growth in Europe, difficulties in running business have led to shrinking financial demand, and the scale of high-risk business in the financial market has declined. Therefore, the anti-cyclical retail business has become one of the most important way of commercial banks development. Third, the development of technology finance. With the development of technology, major banks have increased their investment in technology, strengthened the construction of information systems, developed digital finance, and reduced inefficient paper-based services. Especially affected by the epidemic currently, there are certain restrictions on people's travel and business operations. If there are convenient online financial services, the impact on the banking sector will be reduced. Fourth, continue to strengthen the ability to risks resisting. With the strengthening of economic globalization, the spread of the crisis has become faster and faster. European banks have adopted a series of measures to increase capital adequacy ratios and optimize their own assets and business structure to enhance risk resistance.

The higher capital requirements of the "Basel III" phased implementation have enabled all banking sectors to increase their capital

adequacy ratios mainly through retained earnings. Banks with poor profitability have to issue new equity or reduce the size of their balance sheets to meet higher capital adequacy requirements.People worry that banks may increase net income by widening the spread between borrowing and lending rates, or reduce assets and loans to meet increased capital adequacy requirements. If banks adopt these two strategies, they may have a negative impact on actual economic activities.The implementation of Basel III is directly related to the global financial crisis. Most banks in the EU emerging market countries have used their retained earnings to increase their capital adequacy ratios. Although the issue of leverage still exists, in better circumstances it will promote return on equity.

If there are no risks in the financial system, it will be greatly simplified, but risks are everywhere. Therefore, commercial banks should effectively manage risks to survive in this risky world. The future of the banking sector will also depend on risk management. Only banks with a sound risk management system can compete in the market. Almost all studies about the reasons for the failure of commercial banks have found that failed institutions had a large number of non-performing loans before they went bankrupt, and asset quality was a statistically significant predictor of bankruptcy. In the past few years, research on problem loans has received a lot of attention. According to the research of Hennie and Sonja (2003), credit risk is the most common cause of non-performing loans and bank failures. Therefore, almost all regulatory agencies have stipulated minimum standards for credit risk management.Almost all the failures of banks and savings institutions are due to a large number of problem loans before the bankruptcy. The asset quality of commercial banks is closely related to risks.

In addition, in the context of Internet finance, commercial banks should make appropriate transformations. With the rapid development of the Internet, Internet finance has developed rapidly through online payment and online credit, forming a competitive relationship with commercial banks. In the long run, this kind of competition will have a huge impact on commercial banks. It will not only have a direct impact on their various businesses, but will also have an impact on the management model of commercial banks. Therefore, commercial banks should closely follow the trend, develop electronic channels, complement the advantages of Internet finance, and share resources. Because this is not only convenient for data collection and risk

assessment, it can also save various costs, improve efficiency, and reduce the requirements for customers to a certain extent, thereby expanding the market.

Alexiou and Sofoklis (2009) found that macroeconomic factors such as inflation and personal consumption significantly affect the performance of banks. The establishment of appropriate screening, monitoring and forecasting mechanisms for future risk levels can reduce the default rate and greatly improve the profitability of banks. Modifying the structure of assets and liabilities and adopting cost-efficiency measures can improve the quality of the banking industry, thereby making it more profitable.

2.6 Literature review

The main purpose of this paper is to study the main factors that affect the commercial bank's NIM during the time period 2015-2020. Interest rates have continued to fall in recent years. The outbreak of the COVID pandemic has caused the global economy downturn. Therefore, the article further explores what heterogeneity of commercial banks will cause them to be more affected by negative interest rates or bad economic conditions.

Noir (2017) did a research about the NIM of Belgian banks. Considering the sample of his study is small he firstly ignored the heterogeneity of banks and the correlation among the cross sections to perform pooled OLS estimation. OLS might be efficient of these two problems are not captured. In order improve the model he introduced dummy variables to take care of the unobserved heterogeneity by using fixed effects or random effects. Cost to income ratio, liquidity, bank size, credit risk, asset structure,risk aversion and diversification were chosen as independent variables while NIM was dependent variables. However his sample is very small, most of the significance went to dummy variables which indicates banks might be very heterogeneous. Moreover, he did not take the impact of macroeconomic environment into consideration.

Fišerová et al. (2015) carried out research about the performance of foreign- hold banks in host country economics. They used the largest dataset which includes 17 countries in European region and New Zealand of seven years form 2005 to 2011. They chose Return on average assets (ROAA), Return on average equity (ROAE) and Net interest margin (NIM) as

independent variables. Explanatory variables are divided into 3 types: bank specific, banking sector specific and country specific. Although fixed effects and random effects are widely used, the characters of the dataset makes it more suitable for general method of moments. The coefficient of lagged dependent variables are highly significant which also confirmed this point. Their study suggested that banks have better performance in the environment with higher productivity and lower inflation rate. However macroeconomic conditions can not explain bank performance very well because of the heterogeneity of banks. So when comparing the results within banks they found banks that are well-capitalized and more efficient perform better. In addition, maintaining low costs of risk is also critical to the bank's profitability. When it comes to banks scale they use the number of financial institution to represent the size of the given banking sector, and this variable has a significant negative coefficient.

Shamki et al. (2016) found that The bank capital ratio of commercial banks in Jordan has a negative effect on return on equity (ROE), loans have a positive effect, but has no significant effect on return on assets (ROA). The size of the banks has no significant effect on both. They believe it is due to scarcity of data, as a result, some variables have not been well studied and therefore did not get ideal conclusions.

Bikker and vervliet (2017) studied the impact of low interest rate on bank profitability and risk taking, they use GMM estimator to illustrate the endogeneity and dynamic structure. They collected the data on the United States commercial and saving banks from 2001 to 2015. The balanced sample consists 3582 banks. In order to make the variables more comparable, they divided all level variables by total assets. They used NIM, ROA, ROA and model, total capital ratio (TCR) and credit loss provision to total loans ratio (PCL) as dependent variables for risk-taking model. Size, lending, capitalization, diversification are chosen as bank-specific explanatory variables, real GDP growth and inflation rate are macroeconomic variables, 3-month money market rate is chosen as short term interest rate while 10-year government bond yield is long term interest rate. In addition, TCR and PCL are also chosen as explanatory variables for profitability model. They found that short term interest rate is significantly positive and the relationship between NIM is concave also the long term interest rate has a slightly positive effect. Different from Fišerová et al. (2015) they used logarithm of total assets to represent the size of banks. Lager banks tend to have lower NIM and better

capitalized banks associated with higher NIM. Banks rely more on non-interest income have lower NIM. As lending size increasing NIM shows significant growth too. They also found that higher credit risk taking could lead to a higher lending rate so alternately promote the NIM. Inflation has a positive impact but real GDP growth has a slightly negative coefficient.

Hanzlik and Teply (2019) analyzed a relationship between banks NIM and interest rate under the circumstance of low interest rate. They collected the data of 629 banks in European Union countries during the time period 2011 to 2016. Their model includes bank specific variables, bank specific dummy variables and country specific variables based on a balanced dynamic panel dataset. They considered difference GMM and system GMM for dynamic panel data, but due to the dummy variables can not be used in difference GMM and the estimation would only use first differences so they choose system GMM. Comparing with Bikker and vervliet (2017) they classified banks into bank holdings & holding companies, cooperative banks, real estate & mortgage banks and savings banks according to their specialisation. Second and further lags of independent variables are introduced as instrumental variables for dealing endogenous problem. In opposition to other studies, they found significant negative coefficient of yield curve slope, but insignificant for quadratic term, so yield curve slope has a negative linear relationship with NIM. In the study of Fišerová et al. (2015), the distinguish about different banking type was not proved has significant impact on banks performance. But Hanzlik and Teply (2019) proved that bank specialized classification leads to significant difference to NIM.

In the researched of Fišerová et al. (2015) and Hanzlik and Teply (2019), results of fixed effects and pooled OLS are used for the robustness test for system GMM. Fišerová et al. (2015) mentioned fixed effects approach has three disadvantages. First, lagged dependent variables are not allowed in the from the correlation between lagged dependent variables and other regressors. Hanzlik and Teply (2019) compared the coefficient at lagged value dependent variables in pooled OLS, fixed effects and system GMM, the result of coefficient in system GMM is between the result in pooled OLS and fixed effects, which also confirmed the point of Roodman (2009).

3.Hypotheses and data

3.1 Hypotheses

As we want to study the variables related to the development of commercial banks, of course we should concentrate on their profitability. But under current conditions, we must take the risk resistance of them into consideration. A commercial bank has to make profit and reduce risk as much as possible without decreasing profit to get steady and sustainable development. And from the previous study we know that the amount of loans and banking size usually have positive effects on profitability.

We use data of European Union commercial banks in the past 6 years, from 2015 to 2020. This thesis puts growth rate of commercial banks on the left side, chooses possible variables of commercial banks and macroeconomic environments and places them on the right side of the equation. The variables are chosen based on bank size, income, liquidity and risk-taking.

Here are the hypotheses that will be tested in this thesis:

Hypothesis 1: The commercial banks specialized in offering financial services show the highest NIM.

In the study of Bikker and Vervliet (2017), banks with higher diversification (with higher total non-interest income over total income ratio) report lower NIM. So we assume that banks reliance more on interest income have higher NIM.

In this thesis commercial banks are selected by their specialized filed, in other word, their main products and services, here we roughly identify them into 9 different type of banks. The classification is based on the descriptions of each banks products and services in Orbis Bank Focus database. All the commercial banks basically have all types of commercial banks services however here we only discuss about their main services. The first one is the bank focus on individual customers and small corporations, the second is the bank mainly providing financial products and services, the third one is the bank getting main profit form deposits, the fourth is the bank preferring foreign markets and foreign commercial business, the fifth is the most basic

commercial bank, it does nor prefer any type of services, the sixth is the bank that has customers mainly from big corporations and international companies, the seventh is the bank which basically focuses on banking services, the eighth is the bank involved in treasury services, the ninth is the bank mostly lending loans.

Hypothesis 2: The NIM of small commercial banks has dropped significantly with negative interest rates.

In this thesis commercial banks are divided into 3 sizes : small banks(assets <\$ 100 million), medium banks (\$10 millions <= assets <= \$ 1 billions), big banks(assets>= \$1 billions). According to the findings of Hack and nicholls (2021) in some countries with negative interest rates, smaller banks show the most significant change in ROA, their findings indicate the small banks have seen the largest decline in profitability. Smaller banks prefer to use more funding deposit, so when interest rate decline their NIM tend to be compressed more.The finding of Hanzlik and Teply (2020) also supports our hypothesis, they point out smaller banks rely more on funding form retail deposits, so it is harder for smaller banks to control their funding costs. However large banks usually rely on institutional deposits or inter-bank lending, so they can lower their cost easily. They point out this reason may become more important under the situation of negative interest rate.

Hypothesis 3: Western European countries' NIM is affected more than the rest of EU countries by negative interest rate.

Belgium, France, Ireland, Luxembourg, Netherlands are listed as western European countries, this thesis will test if negative interest rate affects the NIM of these countries less than other countries in EU. Western European countries usually have higher economic levels, we can assume their banking sector is playing more important role in economic system, as negative interest rate theoretically would erode banks' profitability, we can consider western European countries banks' NIM would drop significantly.

In the research of Fišerová et al. (2015), they expected that foreign banks can make more profit in less developed countries, but in more developed countries they inform lower profitability.

3.2 Dataset and descriptive analysis

Table 3.1 Bank-specific variables in the dataset

Abbreviation	Variable	Description
NLTA	Net Loans / Total assets (%)	This ratio indicates how much of the company's total assets is bound by loans, and this ratio can be used as a measure of liquidity. Therefore, this ratio can be regarded as a credit risk ratio. The higher the ratio, the lower the bank's liquidity, and the higher the ratio may result in lower net interest income. The relationship between liquidity and profitability has not been clearly defined, but some studies have shown that there is a negative correlation between liquidity and profitability.
LLRGCL	Loan loss reserves / Gross customer loans & advances (%)	This variable represents the ratio of the bank's reserves which used to cover the estimated losses incurred due to defaulted loans to the total customer loans. This ratio can be used to measure the quality of bank assets.
LLGCL	Impaired loans / Gross customer loans & advances (%)	When the lender is unlikely to recover the full value of the loan, the loan will be impaired because the borrower's creditworthiness has declined. This variable enables credit assessor customers and

		investors to have a comprehensive understanding of the lender's financial situation. This indicator can measure the quality of risk management of the bank.
GCL	Growth in net customer loans & advances (%)	Usually the banks with high rates of growth in net customer loans are more risky, so this variable can show the risk banks are taking.
CI	Cost to Income Ratio (%)	The cost-to-income ratio is used to measure organizational efficiency. It is used to compare the bank's operating expenses with its income to determinate the profitability of banks. The lower the cost-to-income ratio indicates the better company's performance.
OEARA	Operating expense / Average risk-weighted assets (RWAs) (%)	Average risk-weighted assets are used to determine the minimum amount of capital that banks should hold, so this variable can show the risks tolerance of banks, the higher ratio, the lower risks tolerance.

Source: Orbis Bank Focus database.

In table 3.1 are the bank specific variables we choose for the model. Variables are selected by comparing the previous literature. Including Fišerová et al. (2015), Bikker and Vervliet (2017), Hanzlik and Teply (2019),Hanzlik and Teply (2020) and Horobet et al. (2021). Net loan to total

assets, cost to income ratio, loan loss reserves to gross customer loans are mostly chosen variables, we firstly choose these ratios. In the study of Fišerová et al. (2015), they choose Loan impairment charges to average gross loans as proxy to non-performing loans which can work as a measurement for credit quality management. Here we use impaired loans to gross customer loans as proxy for non-performing loans due to the data availability. The study of Matthias (2012) discusses implies a high loan growth rate does not necessarily mean that the bank is taking a higher risk if other banks also hold similar ratios, but if the bank raises this ratio while lowering the loan threshold, this situation represents a higher risk bear. Higher loan growth can also means higher interest income, so we add this variable to our model. Operating expense to average risk-weighted assets is another ratio represent risk tolerance.

Besides, we also need to take macroeconomics environment into consideration, Bikker and Vervliet (2017) choose real GDP growth rate, short term and long term interest rate and inflation rate as macroeconomic variables. Fišerová et al. (2015) choose real GDP growth rate, inflation rate, unemployment rate and ten-year government bond yield of each of the selected countries approximated as interest rate. In addition Hanzlik and Teply (2019)also take Herfindahl index as a measurement of market concentration. Horobet et al. (2021) found that unemployment rate has a significant impact on NIM, ROA.ROE. Unemployment rates could also affect the loan lending in banking sector.

Similar as most of the researched, in this thesis we choose real GDP growth rate, inflation rate, unemployment rate and EMU convergence criterion series interest rate. Due to the short term interest rates are only available in several countries, EMU convergence criterion series are chosen as interest rate.   Macroeconomic environment data are accessed from Eurostat database. Macroeconomic environment variables are listed in table 3.2.

Table 3.2 Macroeconomic environment

Abbreviation	Variable	Description
gdpg	Real GDP growth rate	Real GDP growth rate is used to express the growth of economic, adjusted according

		to inflation rates, it reveals the the changes of the output of a country also takes price fluctuations into account.
inf	Inflation rate	Inflation rate reflects the level of the value of money, average cost of goods increases, currency loses value, so inflation rate would affect economic growth, therefore affect commercial banks growth rate.
unem	Unemployment rate	Unemployment rate can indicate the inability of economy, when economic in a poor shape the rate tend to increase and vice versa.
ir	Interest rate	Due to the availability of short term interest rate here we use EMU convergence criterion series interest rate. Interest rate affects the profitability of banks, also affect their credit risk taking.

Source: eurostat database.

Table 3.3 Dummy variables

Abbreviation	Variable	Description
big	Big commercial banks	Big commercial banks assets>= $1 billions,if the bank is big the value equals to 1, if not equals to 0
small	Small commercial banks	Small commercial banks assets <$ 10 million,if the bank is small

		the value equals to 1, if not equals to 0
fina	financial product	If the bank main product and services are financial the value equals to 1, otherwise equals to 0
west	Western European country	If the country is western European country (Belgium, France, Ireland, Luxembourg, Netherlands) the value equals to 1, if not equals to 0
irneg	Negative interest rate	If the short term interest rate is negative the value equals to 1 if not equals to 0

Source: Author's calculation based on data in Eurostat database and Orbis Bank Focus

database

In table 3.3 dummy variables are listed. These variables are listed for testing banks heterogeneity. In this thesis we consider about bank size, specialisation and also bank's home country's economic condition (here we simply classify the countries by area).

Table 3.4 Descriptive Statistics

Variable	Mean	Std. Dev.	Min	Max
nim	2.379	1.893	.016	21.041
nlta	58.791	17.198	.984	98.226
llrgcl	4.531	4.82	.008	42.71
llgcl	7.657	9.608	.027	94.147
gcl	8.848	55.071	-96.711	1852.58

ci	64.875	101.204	-544.776	3833.488
oeara	4.514	2.762	.658	24.956
big	.028	.164	0	1
small	.833	.373	0	1
fina	.421	.494	0	1
west	.119	.324	0	1
gdp	1.426	3.776	-10.8	25.2
inf	.935	1.024	-1.5	4.1
unem	7.819	3.676	2	24.9
ir	1.298	1.837	-.51	31
irneg	.104	.306	0	1

Source: Author's calculation in stata

Dataset used in this chapter includes 252 commercial banks from 27 EU member countries which the status are active banks. We are using annual data for the examination. The main data was obtained from Orbis Bank Focus database. The data was further filtered to achieve an balanced panel data for the period 2015-2020, and there will be no shortage of observations for any bank-specific variables used in the model. The macroeconomic variables dataset was obtained from Eurostat database, and note that for the reason that interest rates of Estonia are not available, interest rates of European union was taken as replacements.

The dataset for bank specific was selected by their products and services. The further analysis will depends on their main products and services: for individual and small business or private customers, for corporation and big business, deposits, banking services, financial services, foreign currencies, loans and universal commercial banks. The description of banks NIM by main products and services is put in figure 3.1.

Figure 3.1 Average NIM by banks main products and services
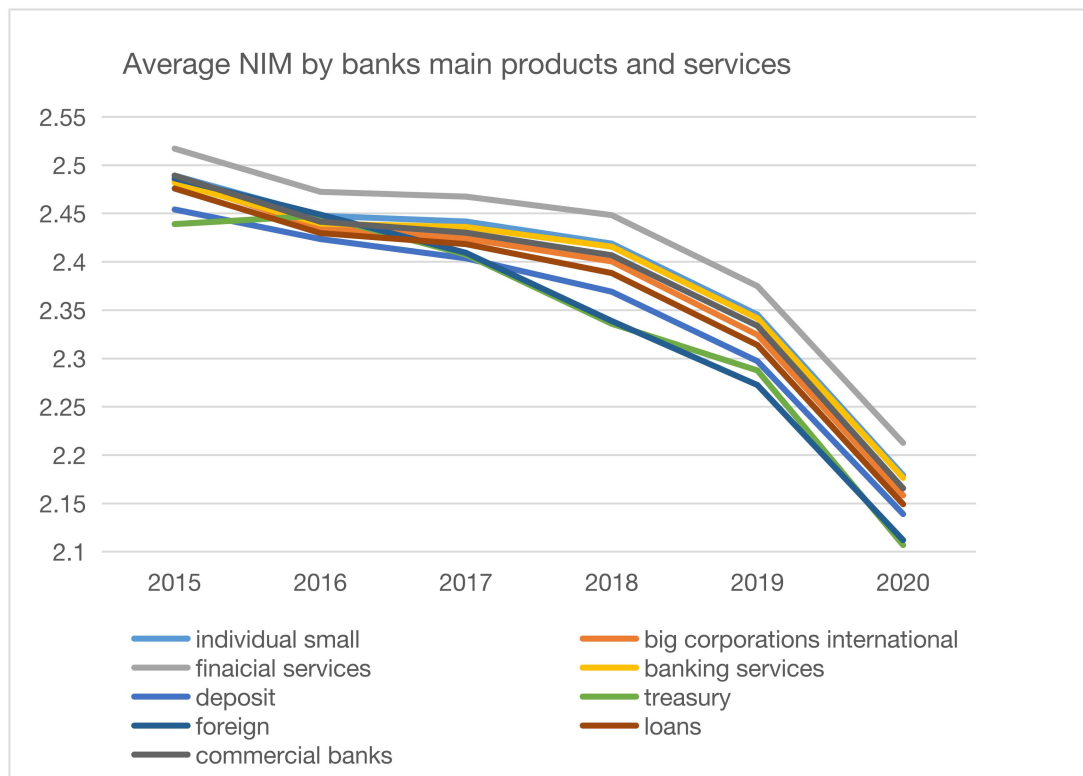
Source : author's calculation based on Orbis Bank Focus database

    Figure 3.1 shows that the average NIM of commercial banks is going down by time, and for the commercial banks focused on financial services show the highest NIM and the commercial banks focused on treasury and foreign currencies show the lowest NIM. Followed by financial services is banking services and banks for private customers or individuals and small business. Financial services usually including checking and savings accounts, certificates of deposit and individual retirement accounts, insurances, consumer and commercial loans, financing for companies, offering investment management and securities to make long term or short term financial gain, ATM services, telephone banking, online banking with bill payment functions, Visa check cards, Visa credit cards, etc. At the same time banking services refers to accepting and safeguarding the money from individual or organization then lending out the money to make profits.

Figure3.2 Average NIM of commercial banks by size
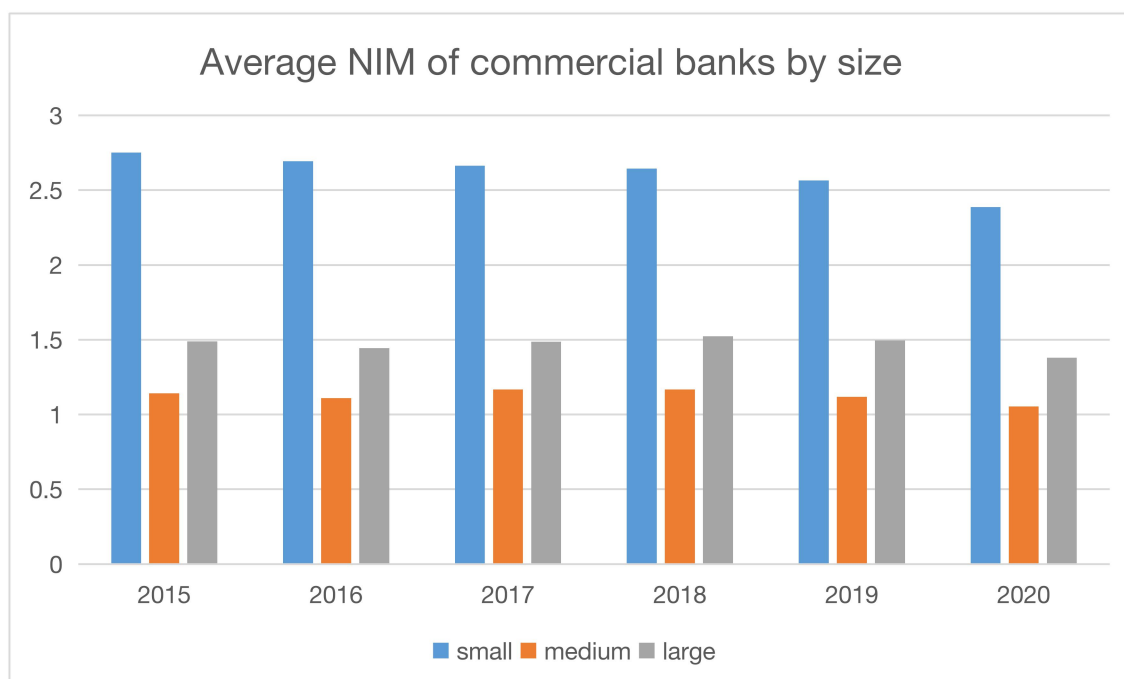
Source : Orbis Bank Focus database

Figure 3.2 indicates that highest NIM came to small size banks, followed by large size banks. Medium size banks showed the lowest NIM. The results concluded from 210 small commercial banks which total assets less than 10 millions USD, 7 large banks with more than 1 billions USD total assets and 35 medium size banks with total assets in between.

In case in our sample we only have 7 large banks , in tables 3.5, the name of the banks with their total assets are listed.

Table 3.5 List of large commercial banks

Name	country	Total assets
UNICREDIT SPA	IT	1,142,989,005
ING BANK NV	NL	1,150,257,114
INTESA SANPAOLO	IT	1,230,306,937

DEUTSCHE BANK AG	DE	1,626,224,390
SOCIETE GENERALE	FR	1,793,960,275
BANCO SANTANDER SA	ES	1,850,772,518
BNP PARIBAS	FR	3,053,625,563

Source: Based on Orbis Bank Focus database

Note: the full name of the countries are listed in appendix

In figure 3.3 the growth rates were counted by the NIM of different sizes of banks, from the data we could not tell which bank size reported the highest growth rate, because of the economic conditions most of the commercial banks showed negative growth rates, but from the figure we can see that medium size of banks had more steady growth rate. Affected by the epidemic, the growth rate of small commercial banks showed negative and continued to decline.

Figure3.3 : growth rates of commercial banks by size
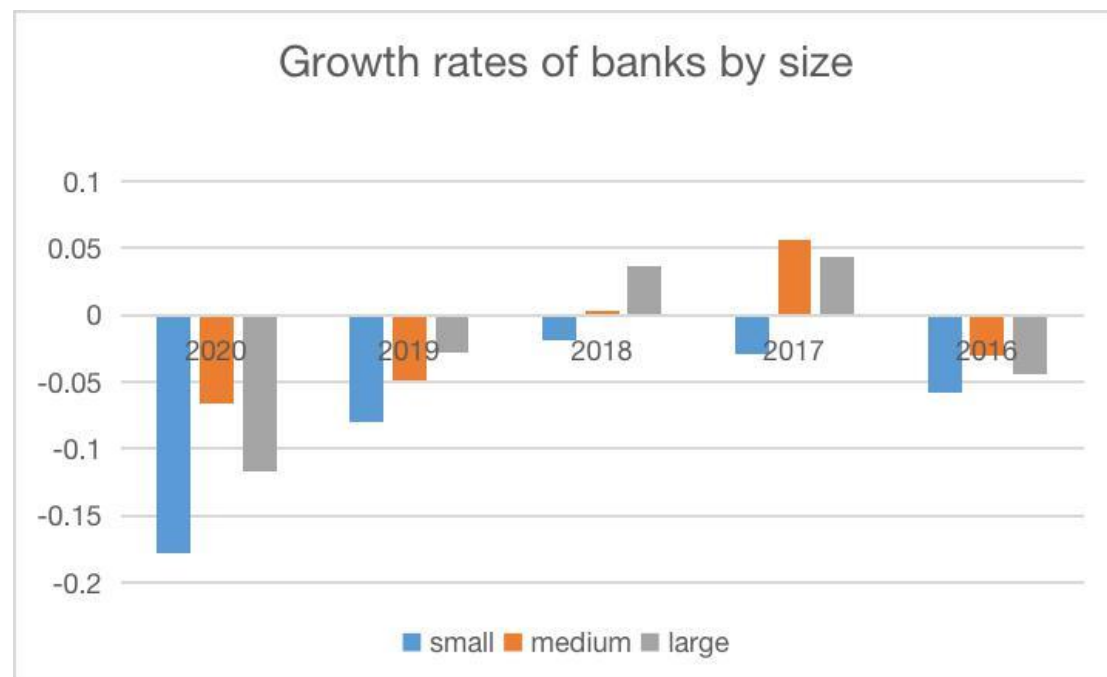
Source : author's calculation based on Orbis Bank Focus database

Bikker and Vervliet (2017) chose total assets, lending, capitalization, diversification as bank-specific variables; real GDP, inflation rate and short term and long term interest rate as macroeconomic variables. In this thesis we take net loan to total loans, loan lose reserves to gross customer loans, impaired loans to gross customer loans, growth in net customer loans, cost to income ratio and operating expense to average risk-weighed assets as bank specific variables. We take these variables from both profitability and risk taking sides. Besides, we take real GDP growth rate, inflation rate, unemployment rate and short term interest rate to indicate the macroeconomic environment which commercial banks are exposed to. Table 3.1 and table 3.2 are the summaries of both specifics of variables.

Figure 3.4 Interest rate of Euro area (19 countries)
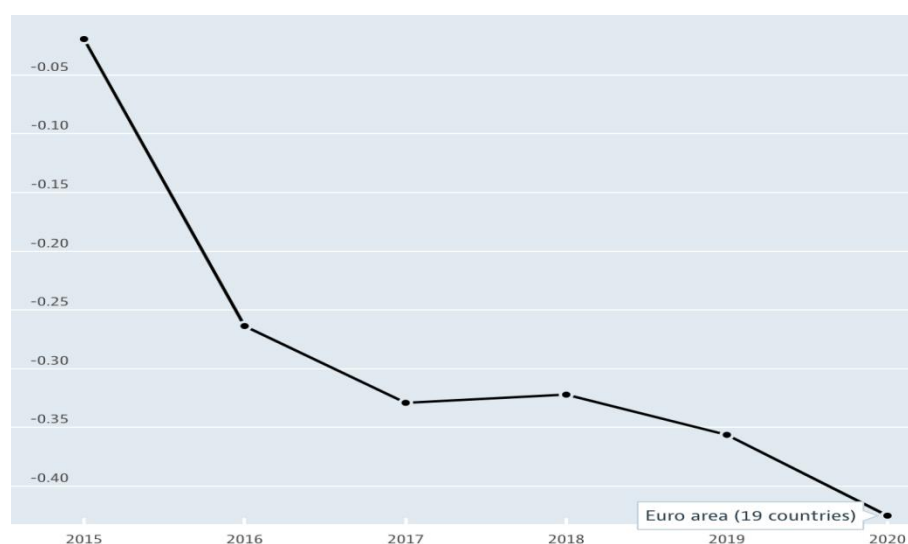
Source: Oecd database

Figure 3.5 EMU convergence criterion series interest rate of European Union countries
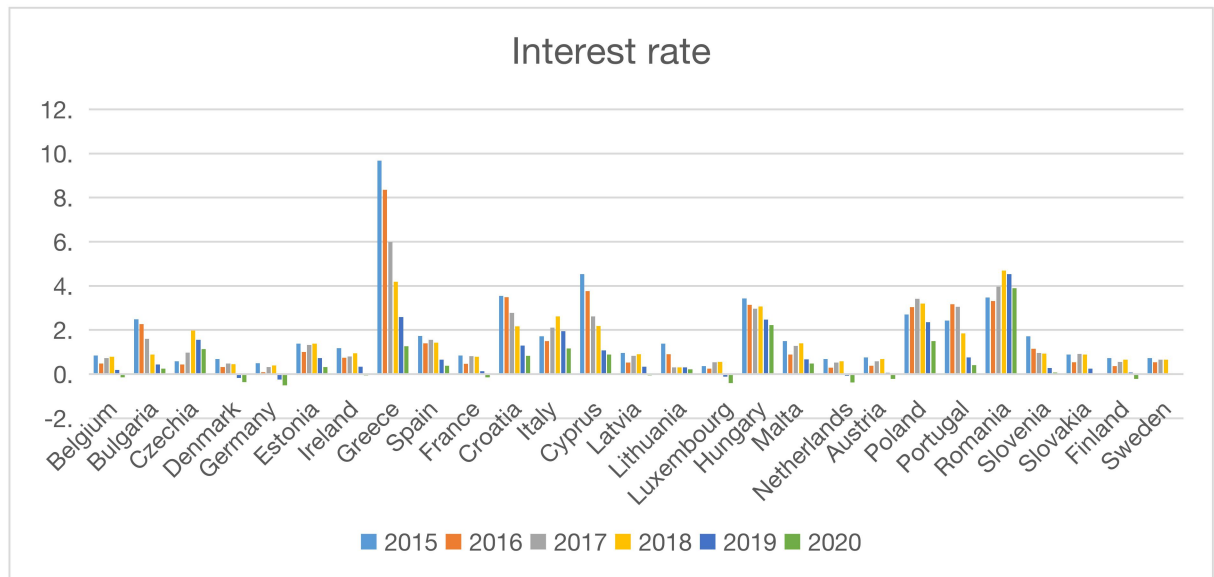
Source: Author's calculation based on Eurostat database

Figure 3.6 Average NIM of all EU commercial banks
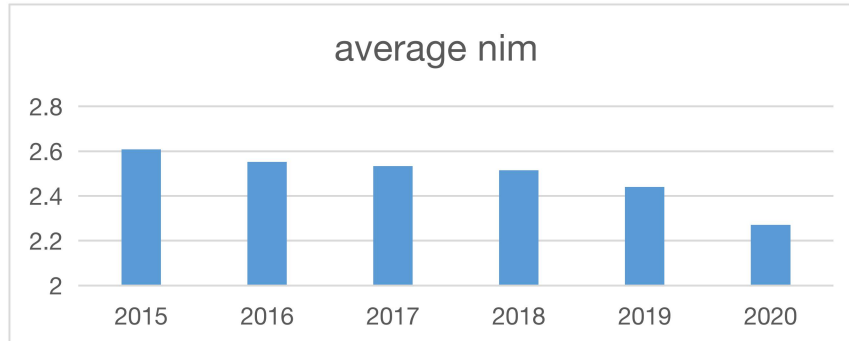
Source: Author's calculation in excel based on Orbis Bank Focus database

Figure 3.7 real GDP growth rate of all EU countries
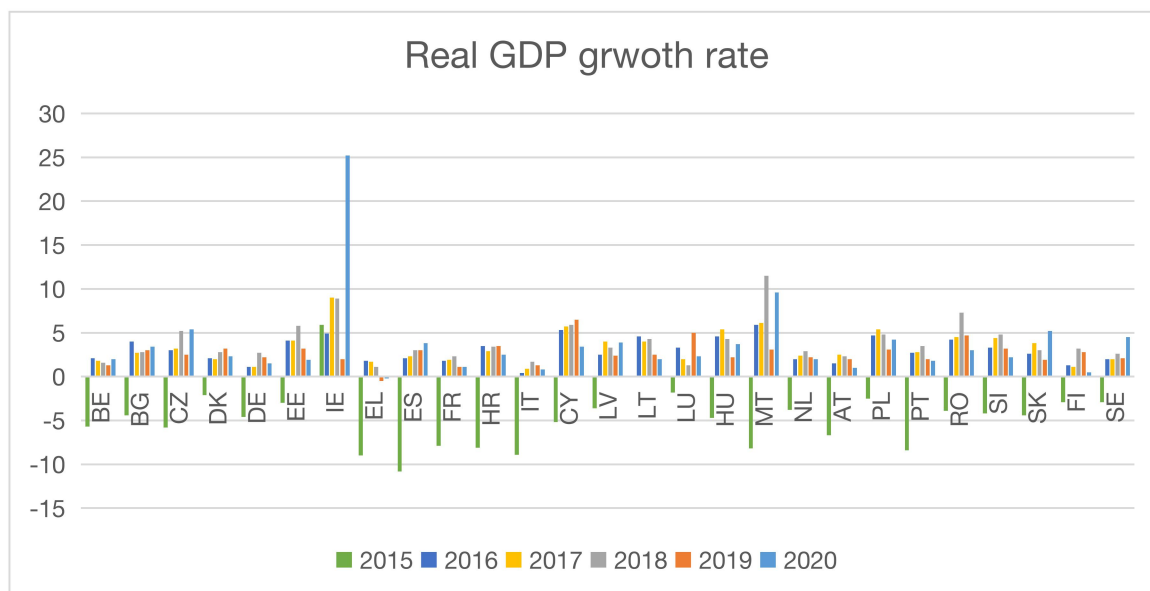
Source: author's calculation in excel based on Eurostat database

Note: The full names of the countries showed in this figure are listed in appendix

From figure 3.4 we can see that in Euro area the interest rates are all deceasing until even negative. Figure 3.5 shows the EMU convergence criterion series interest rates of all the EU countries from 2015 to 2020 and it shows show similar trend as the 3 month short term interest rate in the Euro area. Most of the countries have their interest rates all the way dropping down, since 2019, some countries started to show negative long term interest rate. From figure 3.6 we can see the average NIM of all commercial banks in EU also going down by the time. Since 2015 EU was exposed to low interest rates even negative, from figure 3.7 we can conclude that almost all the EU countries have negative real GDP growth rates except Ireland.

4. Methodology and model

When it comes to panel data set we usually consider the most common estimator like pooled ordinary least square, fixed effects or random effects. They allow us to estimate dynamic panel data in the form:

$$y_{it} = c + \alpha y_{i,t-1} + \beta X_{it}^b + \gamma X_{it}^m + \mu_i + \epsilon_{it} \qquad (4.1)$$

Yit   is individual banks' NIM in year t, and $y_{i,t-1}$ is one period lagged value of bank's NIM, Xitb is bank specific variables and Xitm is macroeconomic variables, μ_i is fixed effects or random effects. They are easier and more understandable, but they require strong assumptions.

In addition, banks have some unobserved heterogeneity, each bank has fixed effects that affect the bank's development capacity and risk-bearing ability, such as market structure and financial policies, but these fixed effects cannot be captured in the model. The dynamic structure of the model complicates the estimation. Least squares estimation methods, such as pooled ordinary least squares (OLS) estimators, first-order difference estimators, and internal estimators are also proved to be insufficient in dynamic settings because of the correlation between the lagged dependent variable and the error term.

The development of banks is sustainable, so when considering the profitability and risk-bearing factors of commercial banks, sustainability issues should also be considered. When estimating these models empirically, we should first consider the endogenous problem of these main variables, which may come from missing variable deviations or the causal loop relationship between independent variables and dependent variables (Jacob and Tobias, 2017). Jianjun Li and Shichao Jiang (2021) give an example. If a bank's performance improves, it will increase investment in financial technology, which promotes the development of financial technology and further promotes the increase in bank performance. Therefore , we need to introduce some instrument variables to estimate endogenous problem. It lead the model go to generalized method of moments framework. The first option is difference GMM in order to alleviate the endogenous problem, adjacent cross-sectional data are combined into 2015-2016, 2016-2017 and so on. The first-order difference of these cross-sectional data is used as the interpreted variable. Therefore, we can use the difference between the NIM of

adjacent years as the interpreted data under the situation in this thesis. This slightly enhances the robustness of the empirical results. However , under this framework we still can not use the dummy variables because they would still be removed by differences.

In order to deal with the above problems, there is system GMM (Blundell & Bond, 1998) which is developed for dynamic panel model. It is based on the use of instrumental variables that are not related to fixed effects to eliminate endogenous problem. It uses the lagged values of the dependent variables in the level and difference and the lag value of other important endogenous regression variables. In this way, the problems of endogenous, unobserved heterogeneity, and the persistence of dependent variables are controlled. It has been proved that the estimator can produce consistent and effective estimators if the moment conditions are satisfied. Due to all above these reasons, system GMM estimator is widely used in the studies on bank profitability and bank risk exposure. Therefore in this thesis system GMM estimator is also applied. We take bank specific variables as endogenous variables and macroeconomic variables as exogenous.

The equation of our model is:

$$y_{it} = c + \alpha y_{i,t-1} + \beta X_{it}^{b} + \gamma X_{t}^{m} + \delta X_{it}^{db} + \varepsilon X_{it}^{dm} + \mu_i + \epsilon_{it} \qquad (4.2)$$

Y_{it}:individual banks' NIM rate in year t

X_{it}^{b}: vector of individual banks' bank specific variables

X_{t}^{m}: vector of macroeconomic variables

X_{it}^{db}: vector of bank specific dummy variables

X_{it}^{dm}: vector of macroeconomic dummy variables

μ_i: unobserved banks' fixed effects

ϵ_{it}: disturbance term

In order to test the hypotheses that the NIM of small banks dropped the most dramatically under the negative interest rate and the NIM of western

European countries banks dropped significantly, we need to introduce two more interaction terms: irneg*small and irneg*west. irneg is the dummy variable when interest rate is negative it takes the value of 1 otherwise it takes 0. small is the dummy variable when the bank's total asset is smaller than 10 millions it takes the value of 1 otherwise it takes 0. And west is also the dummy variable when the countries belong to western Europe(Belgium,France, Ireland,Luxembourg, Netherlands) it takes the value of 1 otherwise it takes 0.Then the equation turns to:

$$y_{it} = c + \alpha y_{i,t-1} + \beta X_{it}^b + \gamma X_t^m + \delta X_{it}^{db} + \varepsilon X_{it}^{dm} + \theta_1 irneg_{it} * small_{it} + \theta_2 irneg_{it} *$$

$$west_{it} + \mu_i + \epsilon_{it} \qquad\qquad (4.3)$$

There regression will be performed in stata software, the xtabond2 command witch was developed by Roodman(2009) will be used.

5. Empirical results

5.1 Regression results

In this section, results from using different estimators are presented. First, we assume there is no dynamic effects, and pooled OLS, fixed effects and random effects are used, we estimate the model without lagged values of variables, and both normal and robust standard errors are used for all the estimation. The regression results of all these estimators are put in appendix. We can see some similarities from the results of each estimation. For the variables nlta, oeara, gdp they all have positive coefficient in all the estimations and they are significant under the level of $p < 0.01$,which means not loan to total assets and operating expense to average risk-weighted assets and DGP all have a positive effect to NIM. For variable small it has positive effect to NIM with significant level of $p < 0.01$, it means small banks indicate higher NIM. For variables unemployment rate and interest rate have negative coefficient but for interest rate it is not significant. These results are basically consistent with our expectation.

Besides, llrgcl, big, fina and west all have positive effects to NIM while negative interest rate has a negative but not all of them are significant, from

here we can see it result can prove the first hypothesis that banks specialized in financial services report the highest NIM, but this result is only significant in pooled OLS. The result for llgcl and inflation are not sure.

But for gcl the coefficient are all 0 in all the estimation, which are not consistent with out expectation, as the growth rate of customers loans grow banks are supposed to have more interest profits. And the coefficient for interest rate is negative which means the lower the interest rate the higher the NIM. This result are totally opposite from theoretical analysis, also against the coefficient of irneg which is negative, it means negative interest rate makes NIM getting lower but the coefficient of ir indicates the opposite conclusion.

From all above we can see these estimators are not good for the model, these estimation approaches are not the best.

The results of using system GMM estimator are presented in table 5.1, estimation are performed with xtabond2 command in Stata software.The model presented in equation 4.3 is estimated. Table 5.1 presents the results of one step GMM, two step GMM, one step GMM with robust option and two step GMM with robust option. The estimations are performed using lags value of independent variables as instrumental variables for both equations in differences and in levels.

Table 5.1 System GMM results

	(1)one-step	(2)two-step	(3)robust one-step	(4)robust two-step
VARIABLES	nim	nim	nim	nim
L.nim	0.889***	0.874***	0.889***	0.874***
	(0.006)	(0.012)	(0.028)	(0.020)
ir	-0.000	0.002	-0.000	0.002
	(0.006)	(0.002)	(0.003)	(0.002)

nlta	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
llrgcl	0.006	0.016**	0.006	0.016**
	(0.005)	(0.006)	(0.010)	(0.008)
llgcl	0.006**	-0.001	0.006	-0.001
	(0.002)	(0.004)	(0.006)	(0.005)
gcl	0.001***	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
ci	-0.000	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
oeara	0.017***	0.011**	0.017**	0.011**
	(0.004)	(0.005)	(0.007)	(0.005)
big	0.029	0.049*	0.029	0.049
	(0.059)	(0.026)	(0.034)	(0.031)
small	0.060*	0.061***	0.060**	0.061**
	(0.033)	(0.022)	(0.028)	(0.028)
fina	0.027	0.015	0.027	0.015
	(0.018)	(0.018)	(0.023)	(0.020)
west	0.074**	0.051	0.074	0.051
	(0.037)	(0.036)	(0.057)	(0.037)
gdp	0.012***	0.013***	0.012***	0.013***
	(0.003)	(0.002)	(0.003)	(0.002)
inf	0.025**	0.022**	0.025	0.022*

	(0.011)	(0.011)	(0.018)	(0.012)
unem	0.002	-0.002	0.002	-0.002
	(0.003)	(0.004)	(0.008)	(0.005)
irneg	-0.078	-0.079***	-0.078*	-0.079***
	(0.069)	(0.023)	(0.040)	(0.026)
nesmall	-0.104	-0.095***	-0.104***	-0.095***
	(0.072)	(0.027)	(0.039)	(0.029)
newest	-0.050	-0.071**	-0.050	-0.071*
	(0.076)	(0.035)	(0.042)	(0.038)
Constant	-0.231***	-0.158***	-0.231**	-0.158**
	(0.059)	(0.049)	(0.102)	(0.065)
Observations	1,260	1,260	1,260	1,260
Number of bank	252	252	252	252
AR(1)	0	0	0	0
AR(2)	0.426	0.662	0.657	0.662
Sargan/Hansen test	0	0.272	0.272	0.272

*** p<0.01, ** p<0.05, * p<0.1

From the regression results we can see we have most of the important variables with significant coefficients. We usually take the result of two step estimation with robust option as the most important one but the results of all the four estimation are reported to make comparison. We can see from the results no matter using one step or two steps with robust option or without,

the coefficients of NIM lagged by one order are all significant under the level of p<0.01, so there is strong positive correlation between the NIM of current time period and previous time period. This result report that it is correct to perform dynamic panel data model to describe the dependent variables. The coefficients of interest rate is not consistent between these four approaches, but based on Roodman(2009), robust two steps result is more reliable, in the estimation of two step with robust option the result indicate that interest rate has a positive impact of NIM. The first reason we could consider is that the data chose for this model are EMU convergence criterion series , which belong to Maastricht criterion interest rates. This long term interest rate is used as a convergence criterion for the European Monetary Union. So the impact of the change of long term interest rate on MIN is not significant as short term interest rate. There is also another reason we could consider is the strong negative correlation between ir and irneg. Besides, the interest rates of Estonia are not available so the interest rates in Estonia are replaced by interest rate of EU, system GMM is known to be very sensitive, so there may be the problem of data replacement. Both net loan to total assets and growth of customer loan variables have positive coefficient at 1% significance level, which conforms our expectation, the higher of these ratios the higher the NIM. Customer loans grow can bring more interest profits to banks, so these two variables have positive correlation to the banks' NIM confirmed this model is good. Variable llrgcl has positive impact to NIM in all four estimations and significant in two step estimation at the level 5%, indicating the loan lose reserves to gross customer loans has a positive impact of NIM. But the coefficient of impaired loans to gross customer loans is not consistent in four estimation, in the one step estimation is positive while in two step estimation is negative. This variable represent the banks' financial situation, when the lender is not possibly to cover all the value of the loan it becomes impaired loan. So this variable supposed to have a negative impact on NIM which is correlated with two step estimation result. But banks considering the loans impaired bases on the current situation and events, it means there is only some possibilities that banks will not get all the interest and principal, so there is not a significant impact on NIM. The efficient of cost to income ration it negative at 1% significant level which corresponds to our expectation. The coefficient of oeara is positive and significant at 5 % significance level. This variables is the ratio of operating expense to average risk-weighted assets, average risk-weighted assets determines the minimum capital that a bank

should hold to reduce the possibility of insolvency,the higher the ratio the lower the risk tolerance. So the results indicates that the banks with lower risk tolerance have higher NIM.

For the macroeconomic environment variables, GDP has positive impact on NIM in all estimation while the coefficient is significant at the level p<0.01, which are consistent with previous study. Inflation rate has positive coefficient being significant in except robust one step estimation which means higher inflation rate the higher NIM. For example inflation can reduce the value of saving, and when the inflation is higher banks usually pay higher interest rate, so people tend to put their money in banks so banks would receive more deposit then they can issue more loans to make more profits. It shows different results for unemployment rate, in two step estimation it shows negative coefficient while in one step being positive. However the result in two step robust estimation is more important, it is reconcilable with our expectation. With higher unemployment rate there will be greater possibility of non-performing loans therefore lower the liquidity of banks.

For the dummy variables we can test the hypotheses we set. First for the bank size, we can see the dummy variables small and big all show positive coefficient but small is more significant, so from our result we can say small banks report higher NIM. And for the dummy variable nesmall shows significant negative coefficient which means it is consistent with the second hypothesis that small banks NIM eroded the significant from negative interest rate. From figure 3.3 we can also see that small commercial banks show the most dramatically growth rate. Hazlik and Teply (2020) indicate that smaller banks rely more on retail deposits and it harder for them to reduce their operating expense. In appendix table A2 we can also see small banks relate to lower efficiency. But for the variables fina we can see the coefficient is positive but not significant so there's no clear correlation between commercial banks specialized in financial products and others. Or there can be the reason of how the dummy variable is set, it is hard to identify commercial banks by their products and services clearly, commercial banks basically offer all the services they are supposed to have, therefore, it is difficult to further classify commercial banks.so the first hypothesis is rejected here. Dummy variable west has positive coefficient but only significant in one step estimation, which suggests whether western European countries has no clear impact on NIM. Dummy variable newest reports negative coefficient and

significant in two step estimation, it means under the negative interest rate environment, the NIM of western European countries commercial banks is affected significantly. So the third hypothesis is not rejected. And for all the four estimation they have significant negative constant.

5.2 Robustness test

The results of Arellano-Bond test for AR(1) in first differences and AR(2) show that there is no autocorrelation in the residuals, we correctly choose the number of dependent variable lags. Then we use Hansen test or Sagan test to test the accuracy of our model. From the results we can see the test results are insignificant except one step GMM without robust option, so the null hypothesis of Hansen test are rejected which means the instrumental variables choosing is good and models are clearly defined. For the one step GMM without robust option the Hansen test is significant, it means the result not robust, Hansen test may be weakened by too many instruments. But we can see from table 5.1 we use only 41 instruments while the number of groups is 252. The results of AR(1), AR(2) and Hansen test are also presented in the table 5.1.

Table 5.2 Robustness test

VARIABLES	(1)fe nim	(2)sgmm nim	(3)pooled nim	(4)re nim
L.nim	0.583***	0.874***	0.918***	0.907***
	(0.087)	(0.020)	(0.017)	(0.027)
nlta	0.008***	0.003***	0.002***	0.003***
	(0.002)	(0.001)	(0.001)	(0.001)
llrgcl	0.010	0.016**	0.002	0.003
	(0.014)	(0.008)	(0.010)	(0.012)
llgcl	0.011	-0.001	0.004	0.005

	(0.008)	(0.005)	(0.006)	(0.007)
gcl	0.000	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
ci	-0.000***	-0.000***	-0.000	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)
oeara	0.070***	0.011**	0.008*	0.012**
	(0.025)	(0.005)	(0.005)	(0.006)
gdp	0.016***	0.013***	0.013***	0.033
	(0.003)	(0.002)	(0.003)	(0.031)
inf	-0.006	0.022*	0.014	0.036
	(0.018)	(0.012)	(0.015)	(0.030)
unem	-0.018	-0.002	0.005	0.027
	(0.016)	(0.005)	(0.007)	(0.023)
ir	0.001	0.002	0.005	0.062
	(0.003)	(0.002)	(0.004)	(0.050)
irneg	0.072**	0.079***	0.057	0.013***
	(0.030)	(0.026)	(0.037)	(0.003)
nesmall	-0.106**	-0.095***	-0.062	0.014
	(0.041)	(0.029)	(0.040)	(0.017)
newest	-0.008	-0.071*	-0.002	0.004
	(0.046)	(0.038)	(0.058)	(0.004)
big		0.049	0.024	-0.061*
		(0.031)	(0.028)	(0.034)

small		0.061**	0.030	-0.025
		(0.028)	(0.023)	(0.044)
fina		0.015	0.021	-0.018
		(0.020)	(0.021)	(0.040)
west		0.051	0.057	-0.026
		(0.037)	(0.038)	(0.043)
Constant	0.174	-0.158**	-0.191**	-0.213**
	(0.283)	(0.065)	(0.078)	(0.092)
Observations	1,260	1,260	1,260	1,260
R-squared	0.510		0.965	0.965
Number of bank	252	252		252

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Above all, we can see the results of pooled OLS, fixed effects and system GMM hold some similar patterns, bank specific variables nlta, llrgcl, gcl, oeara and macroeconomic variables gdp all have positive coefficient. While ci and irneg have negative coefficient. Although the other estimators are proved not good enough for the estimation we can still use the results to the robust check of system GMM with the coefficient of lagged dependent variable. The results of regressions are presented in appendix and in table 5.2 the coefficients of lagged dependent variables are showed. Roodman (2009) mentions the coefficient of lagged dependent variable estimated by pooled OLS has a upward bias while by fixed effects has a downwards bias. Table 5.2 approves this condition. Furthermore Bikker and Vervliet (2017) point out when comparing the results with pooled OLS and the within estimator, the

estimation of lagged independent variables show robustness some certain degree. Although there are still some results not consistent, system GMM still improved OLS style estimators. Wooldridge (2001) said if the number of time period is big enough, the problem of endogeneity and correlation would disappear by using OSL estimator, however, this is not the situation for our sample.

5.3 Adjusted models

However there are still some problems needed to be adjusted. Model (1) is the original system GMM two step estimation with robust option. Adjusted models will all performed with system GMM two step with robust option.The first problem is variable ir is not significant, here we consider the relation between long term interest rate and NIM may be not linear, for model (2) we add variables lir witch is Interest rate quadratic. In model (3) we leave only lir for estimate the impact of interest rate. From previous estimation and analysis we consider variable llgcl may not has an impact on NIM, so in model (4) we dropped explanation variable llgcl. The last problem is the coefficients of unemployment rate and dummy variable fina are insignificant, similar as the way we deal with the problem of ir, in model (5) we estimate unemployment rate at quadratic and simply dropped the dummy variable fina according to the way we classify commercial banks into financial products and services specialized. Table 5.3 report the results of all above the adjusted models and original model.

Table 5.3 Adjusted models regression results

VARIABLES	(1) nim	(2) nim	(3) nim	(4) nim	(5) nim	(6) nim
L.nim	0.874***	0.872***	0.874***	0.872***	0.873***	0.873***
	(0.020)	(0.022)	(0.020)	(0.023)	(0.022)	(0.022)

ir	0.002	0.036**		0.036**	0.032**	0.032**
	(0.002)	(0.015)		(0.015)	(0.014)	(0.014)
lir		-0.001**	-0.000	-0.001**	-0.001**	-0.001**
		(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
nlta	0.003***	0.003***	0.003***	0.003***	0.003***	0.003***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
llrgcl	0.016**	0.013*	0.016**	0.011***	0.013***	0.013***
	(0.008)	(0.008)	(0.008)	(0.004)	(0.004)	(0.005)
llgcl	-0.001	-0.001	-0.001			
	(0.005)	(0.004)	(0.005)			
gcl	0.001***	0.001***	0.001***	0.000***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ci	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
oeara	0.011**	0.011*	0.011**	0.010*	0.010**	0.010**
	(0.005)	(0.006)	(0.005)	(0.006)	(0.005)	(0.005)
big	0.049	0.047	0.049	0.045	0.044	0.040
	(0.031)	(0.032)	(0.030)	(0.031)	(0.030)	(0.032)
small	0.061**	0.050*	0.062**	0.047*	0.048*	0.044
	(0.028)	(0.028)	(0.029)	(0.029)	(0.027)	(0.029)
fina	0.015	0.013	0.016	0.015		0.011
	(0.020)	(0.021)	(0.020)	(0.020)		(0.020)
west	0.051	0.053	0.051	0.048	0.047	0.046

	(0.037)	(0.037)	(0.037)	(0.037)	(0.038)	(0.037)
gdp	0.013***	0.011***	0.013***	0.011***	0.010***	0.010***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
inf	0.022*	0.018	0.023*	0.018	0.026**	0.025**
	(0.012)	(0.013)	(0.012)	(0.013)	(0.012)	(0.012)
unem	-0.002	-0.006	-0.002	-0.006		
	(0.005)	(0.006)	(0.005)	(0.005)		
irneg	-0.079***	-0.090***	-0.080***	-0.088***	-0.089***	-0.088***
	(0.026)	(0.025)	(0.026)	(0.025)	(0.025)	(0.026)
nesmall	-0.095***	-0.080***	-0.096***	-0.075**	-0.079***	-0.080***
	(0.029)	(0.030)	(0.029)	(0.030)	(0.029)	(0.030)
newest	-0.071*	-0.078**	-0.071*	-0.078**	-0.071*	-0.069*
	(0.038)	(0.038)	(0.038)	(0.037)	(0.037)	(0.037)
un					-0.000	-0.000
					(0.000)	(0.000)
Constant	-0.158**	-0.127*	-0.163***	-0.123*	-0.164***	-0.166***
	(0.065)	(0.071)	(0.063)	(0.071)	(0.051)	(0.052)
Observations	1,260	1,260	1,260	1,260	1,260	1,260
Number of bank	252	252	252	252	252	252
AR(1)	0	0	0	0	0	0
AR(2)	0.662	0.696	0.667	0.686	0.700	0.698
Hansen test	0.272	0.309	0.272	0.326	0.226	0.182

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Now we compare the results with model (1). After introducing the variable interest rate quadratic, we can see the coefficients of both ir and lir turn significant but it somehow reduces the significance level of other variables, also turns the coefficient of inflation rate to insignificant in medel (2). In this section we can see that interest rate quadratic has negative coefficient so interest rate shows a positive concave relationship with NIM. This finding is consistent with Hanzlik and Teply (2019). In model (3), all the variables almost keep the same result of model (1), but the coefficient of interest rate is still insignificant. From comparing the results of model (2) and (3) we can see only keep both ir and lir the coefficients about interest rate would be significant so in model (4) we drop the variables we consider are correlated with other variables in the model or they may not have impact on NIM, after dropping llgcl the result of model (4) still can not change the significance of other variables but only interest rate. In model (5) with the unlikely important variables omitted, we change the unemployment rate into quadratic pattern, the coefficient of inflation rate turns to significant. In addition we try again to add variable fina back to check if we can test hypothesis 1, but we still could not get a pleasant result.

So far, model (5) is the best model we could get but without proving the relation between commercial banks' main products and NIM. In other word, we could not prove that commercial banks mainly offering financial product report the highest NIM. But in this model only variables big, west and unemployment rate could not get significant coefficients. From our result there is no clear relation between NIM and wether being big banks or western European countries. For model (5) the equation turns into:

$$y_{it} = c + \alpha y_{i,t-1} + \beta X_{it}^b + \gamma X_{it}^m + \delta X_{it}^{db} + \varepsilon X_{it}^{dm} + \theta_1 irneg_{it} * small_{it} + \theta_2 irneg_{it} *$$

$$west_{it} + \beta_1 ir_{it}^2 + \gamma_1 inf_{ir} + \mu_i + \epsilon_{it} \tag{5.1}$$

Where:

X_{it}^b: banks specific variables listed in table 3.1 except llgcl.

X_{it}^m: macroeconomic variables listed in table 3.2 except inflation rate.

X_{it}^{db}: bank specific dummy variables listed in table 3.3 except fina.

ir_{it}^2 : interest rate quadratic.

5.4 Summary

From the regression results above , we can obtain the following conclusion.

Hypothesis 1: not rejected. We assume that commercial banks which provide financial products and services report the highest NIM (variable fina showing significant positive coefficient). Figure 3.1 shows that the line represents financial products is the highest. Unfortunately, we could not get a significant coefficient for variable fina, but it has a positive coefficient. So for this hypothesis we have mixed evidences, we are not rejecting this hypothesis.

Hypothesis 2: no rejection. We assume small banks NIM dropped significantly with negative interest rate. We can see from figure 3.3 the growth rate of nim by bank size, the growth rate of small commercial banks always dropping or going up most dramatically. The empirical part uses irneg and small dummy variables to get the conclusion if small banks are affected significantly by negative interest rate. By multiplying irneg by small we obtain a new variable nesmall and we obtain a negative and significant coefficient of this variable, thus the second hypothesis is not rejected.

Hypothesis 3: not rejected. We assume western European countries' NIM affected more than the rest of the countries by negative interest rate. The results show that western European countries commercial banks NIM dropped more than in the rest of countries. By introducing new variable newest, which is dummy variable negative interest rate multiplied by dummy variable west, we obtain the conclusion of this hypothesis. The new variable shows a negative significant coefficient so it confirms the third hypothesis we set.

From testing hypotheses, we also have some findings about the key determinants of commercial banks NIM. For bank specific determinants, it is reported that increasing customer loans has a positive effect to commercial banks profits at the same time cost to income ratio or other factors related to operation expense would give a negative effects, furthermore, more risk taking can also erode banks' profitability, commercial banks should always evaluate their customer's quality before lending money to them to make sure there will not be great possibility that they can not cover the full value of the loans. Moreover, the result also show that small banks would show higher growth rate than big or medium size banks, but when it comes to low or even negative interest rate small commercial banks would put at worse situation. Form the results of macroeconomic environment variables, we could also take them as good indicators for banks profitability. So for better development no matter commercial banks, government or market should always pay attention to these determinants so that they can make adjustments and preparations in time.

Based on the study, we can conclude that commercial banks should adopt the following strategies. First commercial banks should increase the amount of customer loan while at the same time they should be strict about the standards of lending loans. Second, banks should reduced the operating cost therefore under the bad economic condition they would not face the high cost and high possibility of non-performing loans at the same time. They could try to expand the bank size to the operating can be more efficient. In addition as the technology developing so fast, banking sector also need to use the convenience of internet to establish a perfect information system, focus on the development of digital finance. Otherwise some other non-financial institutions would become competitive competitors. Banking sector as an old industry must keep up with the trend of the world nowadays. The epidemic can improve that future commercial banks should build their system on the internet to provide services. If a commercial bank already has a complete network system, it will be less restricted by physical conditions.

5.5 Limitations and further research opportunities

The first motivation of writing this thesis was to find out how does COVID pandemic affect commercial banks development, but there are not

enough time periods for the dynamic panel data model. So in this thesis we just find out what are changing in the macroeconomic environment and the recent 6 years data are obtained to analyze the key determinants of commercial banks' NIM, then we can see how the COVID affected commercial banks. In the future more following years data could be get for estimating a more more robust result. But there is still some limitation of it, the best exogenous instrumental variables still needed to be found and the heterogeneity of commercial banks remains to be studied more. In this thesis we only obtain the results about banks scale and banks in different countries. For the specific of banks specialisation we did not get clear result. We could still furthermore identify commercial banks in more reasonable way. For example using new way to classify commercial banks, we can get the data in their balance sheets to identify what the income made of, but the progress may be complicated. Or more clearly classify commercial banks by private and public sector banks or urban and rural banks.

More shortcoming about our estimation is that the data about bank size, there are not so many large commercial banks in our sample, most of the observations contain big banks and medium size banks were deleted due the missing data of other variables. The results about bank size needed to be used carefully because of the limited amounts of observations.

Both short term interest rate and long term interest rate can be both taken into consideration as the key determinants of banks' NIM. The previous researches (including Bikker and Vervliet, 2017) take both interest rate into their model, and short term interest rate seems more important.

For countries specific, we could classify them by economic characters rather than simply by area.

6. Conclusion

Nowadays commercial banks play a very important role in financial system. However the situation of interest rates these years is not an easy issue for commercial banks. From the data of the past years we can see they keep decreasing and even dropped to negative. So it is necessary to find the key determinants of banks profitability. Then we could know how to plan a

good development strategy of commercial banks. So when big breakout of financial crisis or some worldwide pandemic happen we could know which variables are important to take control of. The aim of this thesis is to find out the proper development strategies of commercial banks under the condition of recent years which is low or even negative interest rate.

The data of 252 commercial banks in European Union are obtained from Orbis Bank Focus database. Macroeconomic environment variables data are obtained from Eurostat database and OECD database. The data from 2015-2020 are collected therefore we have a dynamic panel dataset.

Because of the characters of dynamic panel data and the heterogeneity of banks and also the endogenous variables, it leads us to system GMM. The models are based on bank specific variables, macroeconomic variables and dummy variables from both bank-specific and macroeconomics sides. We also introduce lagged independent variable on the right hand side and instrumental variables to deal with endogeneity problem. From the regression results we can see that interest rate, GDP and inflation rate have positive impact on commercial banks NIM, while negative interest rate has significant negative impact on it. From bank specific variables we get the conclusion that the customer loans growth related variables have positive impact and risk related variables or expenses would decrease the NIM. In addition we also find that small banks report the highest NIM but also their NIM dropped the most during negative interest rate time period. And how much the commercial banks are affected also depends on the economic level of the countries. By comparing the coefficient of lagged independent variables the result is between Pooled OLS and Fixed Effects. This shows that system GMM is robust.

According to our regression results we can get conclusion about our hypotheses.

Hypothesis 1: not rejected. Our hypothesis is The commercial banks specialized in offering financial services show the highest NIM (variable fina showing significant positive coefficient). Although figure 3.1 shows that commercial banks specialized in financial products and services reports the highest NIM, from our regression model we did not get significant result about it. Variable fina only shows a positive coefficient but not significant. There are few reasons can explain it. Firstly the classification of commercial banks is not

strict enough, we obtain this dummy variable based on the description on banks main products and services. As one branch of the whole banking sector, most of the commercial banks would have financial products we could not identify them very clearly. In a word, evidences for this hypothesis are mixed, we can not reject this hypothesis.

Hypothesis 2: not rejected. The hypothesis is that the NIM of small commercial banks has dropped significantly with negative interest rates (variable nesmall showing significant negative coefficient). Based on the system GMM results except one step without robust option, nesmall variables all show a significant negative coefficient. It means small commercial banks' NIM dropped significantly. Figure 3.3 also supports this point.

Hypothesis 3: not rejected. We assume commercial banks in Western Europe are suffering more from negative interest rate (variable newest showing significant negative coefficient). By the result of introduced variable newest we can prove this point. Variables newest equals irneg times west, it shows a significant negative coefficient. So Western European countries' NIM is affected more than the rest of EU countries by negative interest rate.

From our result we can obtain the conclusion that banks performance is related to income, cost and risk taking and also to bank scale, at the same time real GDP growth rate, interest rate and inflation rate can also give NIM a positive impact. So if commercial banks want to have steady development even during the the economically difficult times, they should always take control of these bank specific variables. The results tell us that greater growth rate on customer loans has positive impact on profitability, at the same time the banks should also know more about customer's financial situation so that when interest rate is changing or inflation rate is changing they will not be facing high risk of losing values of the loans.

However, there are still some problems that have not been solved, we did not find out significant relation between impaired loans to gross customer loans & advances and NIM. We also did not find out the impact from bank specialization. The future researches could use more recent data to test hypotheses about these variables.

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Appendix

Table A1

Belgium	(BE)	Greece	(EL)	Lithuania	(LT)	Portugal	(PT)
Bulgaria	(BG)	Spain	(ES)	Luxembourg	(LU)	Romania	(RO)
Czechia	(CZ)	France	(FR)	Hungary	(HU)	Slovenia	(SI)
Denmark	(DK)	Croatia	(HR)	Malta	(MT)	Slovakia	(SK)
Germany	(DE)	Italy	(IT)	Netherlands	(NL)	Finland	(FI)
Estonia	(EE)	Cyprus	(CY)	Austria	(AT)	Sweden	(SE)
Ireland	(IE)	Latvia	(LV)	Poland	(PL)		

Table A2 Correlation of variables

```
             |      nim      nlta     llrgcl     llgcl       gcl        ci      oeara
-------------+---------------------------------------------------------------
       nim |    1.0000

      nlta |    0.2333     1.0000

     llrgcl |    0.2956    -0.0903     1.0000

      llgcl |    0.2180    -0.0722     0.8928     1.0000

       gcl |    0.0235     0.0797    -0.0744    -0.0418     1.0000

        ci |   -0.0436    -0.0152     0.0122     0.0518     0.0407     1.0000
```

oeara	0.1350	-0.2513	-0.0188	-0.0420	0.0727	0.1333	1.0000
gdp	0.1110	0.0318	0.0662	0.0428	0.0159	-0.0203	-0.0583
inf	0.0536	0.0820	-0.2216	-0.2390	0.0625	-0.0164	-0.0038
unem	-0.0308	-0.0698	0.3963	0.4158	0.0131	0.0386	0.0258
ir	0.0754	0.0135	0.3200	0.2837	0.0251	0.0084	-0.0341
irneg	-0.0639	-0.0582	-0.1011	-0.0933	-0.0455	0.0021	0.0076
big	-0.0812	-0.1260	-0.0408	-0.0369	-0.0168	0.0048	0.0031
small	0.2855	0.1856	0.1770	0.1550	0.0554	0.0217	0.1069
fina	0.0659	-0.0531	-0.0038	-0.0231	-0.0276	-0.0123	0.0206
west	-0.0905	-0.1109	-0.1797	-0.1334	-0.0356	-0.0102	0.0252

	gdp	inf	unem	ir	irneg	big	small

	gdp	inf	unem	ir	irneg	big	small
gdp	1.0000						
inf	0.1593	1.0000					
unem	-0.0931	-0.4467	1.0000				
ir	0.1543	0.0514	0.3217	1.0000			
irneg	-0.3118	-0.0505	-0.1676	-0.2785	1.0000		
big	-0.0552	-0.0215	0.0752	-0.0381	0.0212	1.0000	
small	0.0471	0.0305	-0.0165	0.1555	-0.1025	-0.3780	1.0000
fina	0.0303	0.0395	0.0373	0.0393	0.0067	0.0516	0.0791
west	0.0760	-0.0022	-0.0712	-0.1752	0.1481	0.1616	-0.3617

	fina	west

fina | 1.0000

west | 0.0839   1.0000

Table A3 Regression result of pooled OLS, fixed effects and random effects

VARIABLES	(1)pooled nim	(2)fe nim	(3)re nim	(4)pooled nim	(5)fe nim	(6)re nim
nlta	0.031***	0.012***	0.013***	0.031***	0.012***	0.013***
	(0.003)	(0.003)	(0.003)	(0.004)	(0.003)	(0.003)
llrgcl	0.197***	0.032	0.039*	0.197***	0.032	0.039*
	(0.020)	(0.021)	(0.022)	(0.034)	(0.021)	(0.022)
llgcl	-0.030***	0.016**	0.015**	-0.030**	0.016**	0.015**
	(0.010)	(0.007)	(0.007)	(0.015)	(0.007)	(0.007)
gcl	0.000	0.000	0.000	0.000	0.000	0.000
	(0.001)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
ci	-0.001***	-0.000***	-0.000***	-0.001	-0.000***	-0.000***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.000)	(0.000)
oeara	0.138***	0.095***	0.098***	0.138***	0.095***	0.098***
	(0.016)	(0.036)	(0.036)	(0.030)	(0.036)	(0.036)
big	0.406		0.348	0.406***		0.348
	(0.278)		(0.270)	(0.125)		(0.270)
small	0.850***		1.148***	0.850***		1.148***
	(0.136)		(0.233)	(0.099)		(0.233)

fina	0.227***		0.210	0.227**		0.210
	(0.087)		(0.227)	(0.090)		(0.227)
west	0.222		0.073	0.222		0.073
	(0.145)		(0.511)	(0.203)		(0.511)
gdp	0.030**	0.018***	0.018***	0.030**	0.018***	0.018***
	(0.012)	(0.004)	(0.004)	(0.012)	(0.004)	(0.004)
inf	0.068	-0.055**	-0.054**	0.068	-0.055**	-0.054**
	(0.048)	(0.021)	(0.022)	(0.057)	(0.021)	(0.022)
unem	-0.060***	-0.045**	-0.049***	-0.060***	-0.045**	-0.049***
	(0.015)	(0.018)	(0.016)	(0.020)	(0.018)	(0.016)
ir	-0.037	-0.001	-0.001	-0.037	-0.001	-0.001
	(0.026)	(0.005)	(0.005)	(0.024)	(0.005)	(0.005)
irneg	-0.062	-0.125***	-0.121***	-0.062	-0.125***	-0.121***
	(0.152)	(0.043)	(0.042)	(0.151)	(0.043)	(0.042)
o.big		-			-	
o.small		-			-	
o.fina		-			-	
o.west		-			-	
Constant	-1.099***	1.396***	0.244	-1.099***	1.396***	0.244

	(0.251)	(0.270)	(0.335)	(0.386)	(0.270)	(0.335)
Observations	1,512	1,512	1,512	1,512	1,512	1,512
R-squared	0.267	0.163		0.267	0.163	
Number of bank		252	252		252	252

*** p<0.01, ** p<0.05, * p<0.1

Table A4 comparison of regressions

VARIABLES	(1)fe	(2)sgmm	(3)pooled	(4)re
	nim	nim	nim	nim
L.nim	0.583***	0.874***	0.918***	0.907***
	(0.087)	(0.020)	(0.017)	(0.027)
nlta	0.008***	0.003***	0.002***	0.003***
	(0.002)	(0.001)	(0.001)	(0.001)
llrgcl	0.010	0.016**	0.002	0.003
	(0.014)	(0.008)	(0.010)	(0.012)
llgcl	0.011	-0.001	0.004	0.005
	(0.008)	(0.005)	(0.006)	(0.007)
gcl	0.000	0.001***	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
ci	-0.000***	-0.000***	-0.000	-0.000***

	(0.000)	(0.000)	(0.000)	(0.000)
oeara	0.070***	0.011**	0.008*	0.012**
	(0.025)	(0.005)	(0.005)	(0.006)
gdp	0.016***	0.013***	0.013***	0.033
	(0.003)	(0.002)	(0.003)	(0.031)
inf	-0.006	0.022*	0.014	0.036
	(0.018)	(0.012)	(0.015)	(0.030)
unem	-0.018	-0.002	0.005	0.027
	(0.016)	(0.005)	(0.007)	(0.023)
ir	0.001	0.002	0.005	0.062
	(0.003)	(0.002)	(0.004)	(0.050)
irneg	0.072**	0.079***	0.057	0.013***
	(0.030)	(0.026)	(0.037)	(0.003)
nesmall	-0.106**	-0.095***	-0.062	0.014
	(0.041)	(0.029)	(0.040)	(0.017)
nebig	-0.027		-0.021	0.003
	(0.043)		(0.053)	(0.008)
newest	-0.008	-0.071*	-0.002	0.004
	(0.046)	(0.038)	(0.058)	(0.004)
nefina	-0.006		-0.011	0.069**
	(0.050)		(0.046)	(0.032)
big		0.049	0.024	-0.061*
		(0.031)	(0.028)	(0.034)

small		0.061**	0.030	-0.025
		(0.028)	(0.023)	(0.044)
fina		0.015	0.021	-0.018
		(0.020)	(0.021)	(0.040)
west		0.051	0.057	-0.026
		(0.037)	(0.038)	(0.043)
Constant	0.174	-0.158**	-0.191**	-0.213**
	(0.283)	(0.065)	(0.078)	(0.092)
Observations	1,260	1,260	1,260	1,260
R-squared	0.510		0.965	0.965
Number of bank	252	252		252

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1