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**The impact of the macroeconomic and the parent
bank on the credit risk of subsidiaries of foreign
banks: Evidence from CEE countries**

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Abstract

This thesis aims to study the banking characteristics of the parent bank of foreign banks and the influence of the economic environment of the home country on the credit risk of subsidiaries. The study collected a data set of 32 foreign banks in eight CEE countries (joining the EU in 2004) from 2009 to 2020 and conducted an empirical analysis using a fixed-effect panel regression model. Credit risk (NPL) is used as the dependent variable, and the explanatory variable is divided into four groups according to the home country and host country, the bank level and the macroeconomic level. The regression results show that the profitability of the parent bank has a negative impact, while the liquidity, size, capital and credit risk of the parent bank has a positive impact on the credit risk of the subsidiary. Moreover, the inflation in the country where the parent bank is located has a negative influence on the credit risk of the subsidiary, while the GDP growth and unemployment rate in the country where the parent bank is located leads to an increase in credit risk. These results show that international risk is transferred from the parent country to the host country through a new channel for foreign banks.

Abstrakt

Účelem tohoto článku je studovat bankovní charakteristiky mateřské banky zahraničních bank a vliv ekonomického prostředí domovské země na úvěrové riziko dceřiných společností. Studie shromáždila soubor dat 32 zahraničních bank v 8 zemích střední a východní Evropy (vstup do EU v roce 2004) od roku 2009 do roku 2020 a provedla empirickou analýzu pomocí regresního modelu panelu s fixním efektem. Jako závislá proměnná se používá kreditní riziko (NPL) a vysvětlující proměnná je rozdělena do čtyř skupin podle domovské země a hostitelské země, úrovně banky a makroekonomické úrovně. Výsledky regrese ukazují, že ziskovost mateřské banky má negativní dopad, zatímco likvidita mateřské banky, kapitál mateřské banky, velikost mateřské banky a úvěrové riziko mají pozitivní dopad na úvěrové riziko dceřinou společností. Inflace v zemi, kde se nachází mateřská banka, má navíc negativní dopad na úvěrové riziko dceřiné společnosti, zatímco růst HDP a míra nezaměstnanosti v zemi, kde se nachází mateřská banka, vede ke zvýšení úvěrového rizika. Tyto výsledky ukazují, že mezinárodní riziko se přenáší z mateřské země do hostitelské země prostřednictvím nového kanálu pro zahraniční banky.

.Bibliographic note

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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, July 27, 2021

Jiamin Cheng

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Acronyms

CEE Central and Eastern Europe

SMEs Small and medium-sized enterprises

1 Introduction

Since the emergence of financial liberalization reforms in the 1970s, more and more countries have begun to accelerate the reform and opening of their financial sectors, and the rapid growth of foreign banks in emerging market countries has become an irreversible trend. As a typical representative of countries in transition, Central and Eastern European (CEE) countries have begun banking reforms since the early 1990s, which favor using new investors, especially good at using foreign banks to realize the privatization reform of the domestic banking sector, thereby improving efficiency and competitiveness. At the same time, the international activities of multinational banks in developed countries have experienced a large-scale expansion, including the establishment of subsidiaries and branches of foreign banks except for cross-border credit flows. In that context, multinational banks began to expand rapidly in CEE countries, which make the jump in foreign banks' share of CEE national banks from 27% (1995) to 70% (2008, before the crisis) (Arakelyan, 2018). This situation shows that foreign banks dominate CEE countries (Arakelyan, 2018; Babin, 2015; Poghosyan and Poghosyan, 2010; De Haas and Van Lelyveld, 2006).

However, the financial crisis that originated in the United States in 2008, raging across the world, inevitably caused CEE countries to be affected. Due to the global liquidity crisis, international capital has withdrawn from emerging markets one after another, which is a heavy blow to the CEE banking industry dominated by foreign banks. The full-blown outbreak of the European debt crisis in 2009 further accelerated the escape of funds from CEE countries' banking sector deepened the banking crisis. The European banking industry reached the "Vienna Initiative" in 2009 to prevent Western European banks from withdrawing capital from CEE, urging central Western European banks to maintain their loan business in Central and Eastern Europe. In 2012, the "New Vienna Initiative" issued a proclamation which stated: "The result of lack of collaboration will be excessive and disorderly deleveraging and a credit crisis," requiring Western European parent banks to pay special attention to the possible negative impact on the bank credit of the host country banks when formulating capital restructuring plans. Thus, it can be seen how the supply of credit is significant to CEE countries. At the same time, the importance of credit supply has caused scholars to pay

attention to the influence of the transmission mechanism between multinational banks and their subsidiaries on credit supply. Scholars are interested in how the supply of credit is affected. Will the conductivity of the shock cause the credit supply of the host country's subsidiary banks to be affected by the parent bank of the multinational bank and its macro economy of the host country? Many works of literature have examined this question (Cetorelli and Goldberg, 2012; de Haas et al., 2012; de Haas and Horen, 2013; Ongena, Peydro, van Horen, 2013; de Haas and van Lelyveld, 2014; de Haas et al., 2014; Allen et al., 2013, 2014; Arakelyan, 2018). Summarize the conclusions drawn from the above literature that exists a transmission relationship between the parent banks and subsidiaries or branches. The driving factors of the credit supply of foreign banks' subsidiary banks are the profitability and liquidity of the parent bank and the macroeconomic indicator GDP growth of the parent bank.

And in the aftermath of the crisis, the non-performing loans on the balance sheets of many national banks showed an upward trend. Scholars began to study the determinants that caused the increase in non-performing loans (credit risk). Most empirical studies mainly use three aspects to study what drives the increase in non-performing loans, including the macroeconomic level, the bank-specific level, and the banking industry level (Ghosh, 2015; Jakubík and Reininger, 2013; Louzis et al. al., 2012; Makri et al., 2014; Messai, and Jouini, 2013; Vogiazas and Nikolaidou, 2011; Yüksel, 2017). However, only a few studies on credit risk exist in CEE countries (Glogowski, 2008; Jakubík and Reininger, 2013; Škarica, 2014; Vogiazas and Nikolaidou, 2011). Exploring the determinants of credit risk after the crisis is a critical issue for financial stability and bank regulatory agencies, and it is even more critical for Central and Eastern Europe, which is so dependent on foreign capital.

Although there has been more and more analysis on the role of foreign banks in the credit supply of CEE countries and the determinants of non-performing loans in recent years, few researchers discuss the credit risk of foreign banks and fewer studies concentrating on CEE countries. However, Will the credit risk is affected by the potential transmission mechanism of the credit supply between the parent bank and the subsidiary bank and the potential utilization of the internal capital market in the same way as the credit supply? From these contexts, this thesis will focus on the impact of the role of foreign banks on credit risk. Therefore, the research question of the thesis

is whether the bank characteristics and macroeconomic characteristics of the parent bank of a foreign bank will be transmitted to its subsidiaries, which will have a negative impact on its credit risk?

This paper selected 32 foreign banks in 8 CEE countries and their corresponding parent banks to examine the above research questions. The eight CEE countries include the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovenia, and Slovakia. The reason for choosing these countries is that the eight countries joined the European Union at the same time in 2004, and their banking reforms were comparable. The data collected the period from 2009 to 2020, as the previous literature mainly focused on the time during and before the financial crisis; after the financial crisis, many new regulatory measures were issued (Vienna Initiative I, II, etc.), and the government and regulatory agencies began to intervene to control the risk. Moreover, multinational banks gradually changed their credit policies after the outbreak of the crisis. Therefore, the impact of foreign banks on credit risk after 2009 may differ before the crisis and supplement the gaps in credit risk research after the crisis. This dissertation will use quantitative analysis to investigate the research question, and the model will use the fixed-effects model.

This thesis aims to contribute to the credit risk literature through three channels. First, this thesis adds empirical evidence on the determinants of the credit risk of foreign bank subsidiaries in CEE countries. Secondly, based on studying the determinants of credit risk, added the role of foreign banks, including the parent bank characteristic variables and the macroeconomic variables of the home country. This step proves that multinational banks are conducive and sets of variables significantly impact credit risk. Therefore, the results supported that the bank-level indicators of the parent bank and the home country's macroeconomic characteristics impact credit risk. Moreover, this thesis provides research evidence that the parent bank's liquidity declines credit risk, while the parent bank's credit risk, profitability, and capital increase credit risk. At the macro level, the real GDP growth and the unemployment rate of the home country will raise the credit risk of foreign banks' subsidiaries in CEE countries. The growth in the inflation rate of the home country cause reduces the credit risk of the host country's subsidiary banks. Third, different entry modes may have different connections to the parent bank; thus, this thesis will divide 32 foreign banks into subsidiaries and branches

according to the entry mode. The results verify that the different entry modes of the parent bank will cause different credit risks to the subsidiary banks. The credit risk of the parent bank has a significant impact on the credit risk of the subsidiary, while insignificant for the branches. And the profitability of the parent bank will enhance the subsidiary's credit risk while reducing the branch's credit risk. Finally, it provides further empirical evidence for establishing a more effective non-performing loan disposal mechanism for continuous supervision and cooperation.

The structure of this thesis is arranged as follows: From the second part, the second part provides the economic and financial background of the sample countries, focusing on the the historical development, model and motivation of foreign banks, the origin of foreign banks, and the status quo of the relevance of foreign banks to the financial market. The third chapter is the literature review, which systematically sorts out the relevant research status, mainly from the determinants of credit risk and the role of foreign banks. The next chapter describes the data and methods, elaborates on the data source, sample selection, variable definition and methodology, and then performs descriptive statistical analysis on subsequent regression analysis. In the fifth chapter, the empirical analysis is discussed. By constructing a panel data model for 32 banks of 8 CEE countries from 2009 to 2020, the characteristics of the parent bank and the impact of the macroeconomy of the home country on the credit risk of foreign subsidiaries are studied, the regression is discussed. The final chapter draws the conclusion of the results, the limitations of the research and significant findings.

2 Overview of foreign banks in CEE

Before the literature review, this thesis first provides an overview of the foreign banks' system in the CEE countries that are the subject of this thesis.

The banking system of CEE countries has roughly gone through four periods, including the reform of the banking system, the opening of the banking industry, and the crisis in 2008 and the period of post-crisis credit growth. During the banking system reform period, from the late 1980s to the early 1990s, before the collapse of the Soviet Union, the banks in Central and Eastern Europe adopted the primary banking system, which is the National Bank must simultaneously undertake the functions of the central bank and the business of commercial banks. This banking system is inherently not conducive to the development of the market economy and the construction of a modern financial system. Following the 1980s, CEE countries separated the commercial bank from the national central bank, secondary banking reforms. Poland and Hungary were first established secondary banking systems in CEE countries. In the 1990s, some countries in the CEE region experienced high inflation and sovereign crises due to macroeconomic imbalances and policy dilemmas. The reform has led to many corporate bankruptcies, non-performing loans have overwhelmed commercial banks and the government; however, reconstructed or newly built state-owned commercial banks are still monopolists in the domestic financial sector and have inherited problems. Thus, bank privatization reform is imminent. The privatization reform of the Polish banking industry began with the "Twinning Program," which is through the pairing of foreign banks and domestic banks to achieve technology transfer and experience exchange. At the beginning of the plan, Poland adopted a form of privatization of mixed ownership, that is, through a public listing of new shares (IPO), the government (holding approximately 30% of the shares) and domestic investors (holding approximately 20% of the shares), bank employees (holding approximately 20% of the shares) and the rest bank equity for foreign investors to obtain. Wielkopolski Bank Kredytowy (Bank Zachodni WBK for now) and BSK (ING BSK for now) adopted a related model. However, Hungary's government mainly selects a form that introduces foreign investors to purchase state-owned equity. The Czech Republic focuses on selling bank warrants by establishing investment property funds (IPF) to purchase bank

shares and reach rapid or nominal privatization. Subsequently, the Czech government began a second round of privatization reforms to reduce IPF's equity concentration.

Then CEE banks system opened a period of stable development from the late 1990s to 2004. Since the previous privatization reforms are not productive, Hungary, the Czech Republic, Poland and other CEE countries began the second round of reforms in 1996, and the main characteristic of this reform is intensify opening up to the foreign investor, foreign banks are beginning to develop in CEE. Hungary is one of the first CEE countries to loosen control on foreign banks. Hungary further amended the Banking Law that no more restrictions the proportion of foreign bank holdings, allowing foreign investors to have a voice and control in 1996. Thus, the foreign bank entered rapid development in Hungary. Poland adopted a form like Hungary that sells equity to foreign investors after 1996. By the late 1990s, the banking transformation had been finished in CEE countries. Foreign banks accounted for an average of about 75% of the total assets of the banking industry. The number of institutions, holdings, and market share of foreign banks has stabilized. In May 2004, the 10 CEE countries joined the European Union (EU). The 8 sample countries selected in this thesis are based on this condition. Joining the EU has brought the banking industry in CEE into a new stage of development, bringing both opportunities and challenges. On the one hand, economies of scale can be obtained through mergers and acquisitions of EU banks, and financial innovation, regulatory strengthening, and disciplinary constraints can be obtained in the long term; on the other hand, the "three major principles" of the EU banking facilitates division, mergers, and acquisitions of multinational banks within the EU internal. Meanwhile, multinational banks' development could increase the possibility of mutual penetration and contagion of financial risks.

There are three main methods for foreign banks to engage in the privatization reform of the banking industry in CEE countries. One is the IPO of bank equity represented by Poland, where the government dominates approximately 30%-40% of the bank's controlling rights; the second is the purchase method of foreign investors represented by Hungary, which has a relatively high degree of openness. Related countries include Estonia and Latvia; the third is issuing warrants represented by the Czech Republic, and the government puts out a small part of the bank's equity for foreign investors to subscribe. There are two main trails for foreign banks to enter the banking industry in CEE countries: the first one is to set up branches in the CEE region. Foreign banks that apply this method to expand into CEE are mainly affiliated with Austria, the

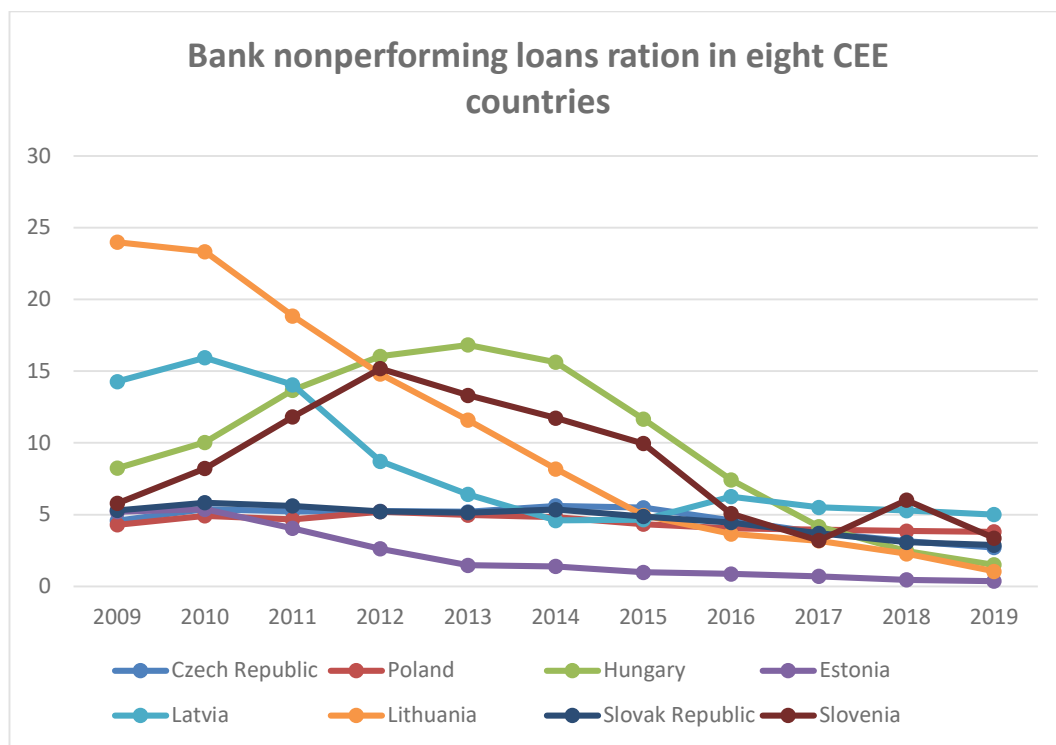
Netherlands, Italy and Belgium, such as KBC Bank in Belgium, Italy's UniCredit Bank and ABN AMRO Bank. The second is to acquire commercial banks in the CEE region. For example, AIB Bank of Ireland acquired 80% of the shares of WBK Bank of Poland. In 2001, Societe Generale acquired Komerčni Bank, the largest commercial bank in the Czech Republic.

At the beginning of the 2008 crisis, CEE countries' financial markets were relatively stable. However, at the end of 2008 and 2009, the crisis began to spread from Western Europe to Central and Eastern Europe. As mentioned above, foreign banks participated extensively in the CEE banking industry, especially Western European developed countries; when the Western European financial system has happened into systemic risks, most foreign banks affiliated with Western Europe began to withdraw funds to supplement the liquid capital of their home country banks, which caused a massive influence on the CEE banking industry. At the same time, substantial foreign currency loans further aggravated the pressure on the banking sector. Foreign currency loans are among the leading financing methods for enterprises and consumers in CEE countries. Before the financial crisis, foreign banks provided a wide range of cheap foreign currency loans to CEE consumers. Affected by the financial crisis, the global credit crunch and banks generally demanded recovery debt, while the macroeconomy has deteriorated, corporate and household incomes have decreased, a large number of debts are facing default risks, and the depreciation of the local currency has further increased the cost of debt servicing. The superposition of these unfavorable factors has caused the non-performing rate of the banking industry in CEE to accelerate sharply. Therefore, between 2008 and 2012, the CEE countries deleveraged substantially, and most of the capital outflow resulted from the decrease in bank loans. As this thesis studies the impact of foreign banks on credit risk after 2009, the post-2009 period will be described in detail. The following is an overview of the post-crisis banking systems of several representative sample countries selected in this thesis. The foreign banks selected in my thesis roughly originate from these countries.

The Czech banking system proliferated before the 2008 global financial crisis while it has slowed since 2009. The Czech banking system is mainly controlled by five multinational banks, which account for 70%, and these five groups are wholly-owned or controlled subsidiaries of large multinational banks or financial groups in Western Europe (IMF, 2012b). The unique feature of the Czech banking industry is that the balance sheet is relatively conservative, and most of the Czech resident's deposits and

loans are denominated in local currency. The loan-to-deposit ratio is 70%, and only one-fifth of loans are denominated in foreign currencies. Therefore, its credit growth is mainly driven by domestic deposits. With these characteristics, the Czech banking industry did not need to take any special measures during the 2008 financial crisis. After 2012, the capital, liquidity and profitability of Czech banks have gradually become more robust, with a non-performing loan ratio of about 5% (Figure 1), equivalent to non-performing loans in advanced economies.

Figure 1: Bank nonperforming loans ratio in 8 CEE countries



Source: *World Development Indicators*

Slovakia and the Czech Republic have comparable characteristics that foreign bank subsidiaries dominate its banking industry, but the banking system has limited reliance on external funds because domestic retail deposits mainly finance loans. The NPL ratio has steadily declined after reaching a peak of 5.83% in 2010 (Figure 1).

The global financial crisis has severely harmed the Hungarian banking system and financial stability. After the slowdown in economic activity, the Hungarian government was forced to implement some somewhat non-standard measures to balance the budget-such as bank taxes. In this challenging environment, banks will naturally reduce their business. After the crisis, its non-performing loan ratio exceeded

16% in the second quarter of 2012, which is related to the high level of Swiss franc-denominated loans and the weakening of forints, which prompted the Hungarian monetary authority to take various remedial measures. However, due to the impact of its remedial measures, its non-performing loan ratio continued to rise in the next few years.

Finally, the lowest non-performing loan levels in the sample are in Estonia, the Czech Republic, Poland and Slovakia, and the non-performing loan ratio in 2010 peaked slightly higher than 5%. In the same quarter, Lithuania's non-performing loan ratio reached the highest level (23.99%). Interestingly, as mentioned earlier, the Czech Republic and Slovakia have the lowest foreign currency loan levels among the countries studied in this study. The overall debt growth rate was also the lowest during the post-2009.

3 Literature Review

As mentioned above, CEE countries have begun banking reforms since the early 1990s. CEE countries represented by Poland, the Czech Republic, and Hungary tend to use new investors, especially foreign banks, to achieve private ownership of their banking sector reform. Since this period, foreign capital has gradually poured into the CEE country's banking system, and foreign banks have begun to play an essential role in the financial systems of CEE countries. Therefore, many scholars will focus their research on foreign banks on the market access of foreign banks (Althammer & Haselmann, 2011; Cull and Martinez-Peria, 2013; Hryckiewicz & Kowalewski, 2010; Lensink et al., 2008; Poghosyan & Poghosyan, 2010), the difference between foreign banks and domestic banks (Bonin et al., 2005; Degryse et al., 2012; Havrylchuk and Jurzyk, 2011) and the role of foreign ownership in CEE countries (Bonin et al., 2005; Havrylchuk and Jurzyk, 2011; Lensink et al., 2008; Drakos et al., 2016). Simultaneously with the inflow of foreign capital, the proportion of domestic credit in the GDP of CEE countries has been rising sharply. As a result, the credit activities of foreign banks have attracted the attention of some scholars. The 2008 global financial crisis made scholars begin to study this issue more in-depth. In the study of credit activities, the literature tried to explain the causes for the dominance of foreign banks before the crisis. After the crisis, scholars tried to investigate the influence of foreign banks on credit. For example, foreign banks' credit growth, credit supply stability, and the role of shock transmission channels (Cetorelli & Goldberg, 2012; De Haas & Horen, 2013; Ongena, Peydro, van Horen, 2013; De Haas & van Lelyveld, 2014; De Haas, Korniyenko, Pivovarsky & Tsankova, 2014). However, in the credit and economic growth process in CEE countries, credit risk is not the center of empirical research. Only a few scholars analyzed national credit risk (Uiboupin, 2005; Glogowski, 2008; Jakubík and Reininger, 2013;). The overall outcome of these articles is that various macroeconomic variables significantly affect the rise of non-performing loans. The primary determinant in all papers is GDP growth. Other macroeconomic determinants, such as unemployment rate, interest rates, inflation, and exchange rates, can influence non-performing loans as well. Some works of literature have discovered that bank financial indicators such as profitability, capital ratio, and bank size also significantly influence.

In this context, there seems to be little research on the influence of foreign banks on credit risk, and only a few pieces of literature consolidate the ownership of foreign banks into the credit risk model. Therefore, this thesis concentrates on investigating the extent to which the credit risk of the subsidiaries of foreign banks in CEE countries depends on the development of the parent bank, whether it is positive or negative. The literature studies the credit risk of CEE countries from two aspects:

1. Investigated what factors affect credit risk.
2. The impact of foreign banks on credit risk. Banks control the financial systems of CEE countries, and most of these banks are foreign capital. Therefore, credit risk considerably depends on the behavior of these foreign banks. Then, it investigates the extent to which the credit risk of foreign bank subsidiaries in CEE countries depends on the development of their parent bank.

3.1 Factors affecting credit risk

Before the global financial crisis, a few pieces of literature investigated the credit risk of CEE countries (Uiboupin, 2005; Glogowski, 2008; Jakubík and Reininger, 2013; Škarica, 2014), and the consequences of these scholars on the CEE countries concluded that GDP growth is a determinant of credit risk in CEE countries at the macro level. Besides, interest rates and unemployment rates are the essential macroeconomic driving factor. The bank size will affect credit risk at the bank-specific level, and bank liquidity and profitability are not significant. Judging from the specific conditions of the banking industry, national credit to the individual sector has increased credit risk, while the proportion of foreign bank assets in total bank assets has reduced credit risk. After the crash of the financial crisis, credit risk attracted the attention of scholars, and many scholars began to explore the credit risk of Central and Eastern Europe deeply. Previous research proposes four indicators to measure credit risk, including expected default frequency (EDF), loan loss reserve (LLP), default loss (LGD) and non-performing loan (NPL). However, most of the literature applies non-performing loans to represent credit risk. Scholars consider credit risk based on the driving factors of non-performing loans. The literature uses two different groups of factors to describe credit risk: cyclical macroeconomic factors that affect systemic credit risk and bank-

specific or institutional factors that affect non-systemic risk (Castro, 2013; Louzis et al., 2012).

On the one hand, the cyclical macroeconomic factors affect the probability of borrowers to repay liabilities. These determinants include:

First, macroeconomic circumstances, such as GDP growth, employment rate, unemployment, stock market index, inflation rate, exchange rate. GDP growth will increase income, which means that borrowers have more money in their pockets, and their ability to repay loans will increase, leading to a reduction in non-performing loans. Therefore, there is a negative correlation between non-performing loans and GDP growth. Beck et al. (2015) investigated the impact of credit risk through employ cross-country panel analysis and selected data from 2000 to 2010. The empirical results pointed out that the real GDP growth rate has an opposite inhibitory effect on credit risk. In another analysis, De Bock and Demynanets (2012) showed the same result with Beck et al. (2015), which is a significant negative correlation between credit risk and real GDP growth rate. Similarly, Fofack (2005) selected 16 South African countries and adopted a fixed-effects model. The empirical consequences demonstrated a significant negative correlation between credit risk and per capita GDP. Although Warue (2012) analyzed both real GDP and per capita GDP, the outcomes showed a significant negative correlation. However, Fofack's (2005) research indicated that inflation, real GDP growth rates, and domestic credit to the private sector are insignificant. At the same time, the impact of employment on credit risk may be consistent with GDP because an increase in the employment rate means that individuals have a stronger ability to repay debts (Messai and Jouini, 2013). However, unemployment should be the opposite of employment. Unemployment will reduce the ability of individuals to repay debts, which will cause a positive impact on credit risk (Chaibi and Ftiti, 2015). Klein (2013) and Nkusu (2011) confirmed a significant positive correlation between non-performing loans and the unemployment rate. Castro (2013) also came to a similar conclusion. Moreover, many kinds of literature also consider the interest rate, inflation rate and exchange rate when studying the impact of credit risk. High interest rates mean that borrowers need to pay higher debt; therefore, interest rates positively affect increasing credit risk (Nkusu, 2011). The same study by Beck et al. (2015) examined that loan interest rates are positively correlated with credit growth. However, De Bock and Demynanets (2012) found that loan interest rates are not significant for non-performing loans. Fofack (2005) investigated the data from 16

African countries from 1993 to 2002 and concluded a positive relationship between the non-performing loans and real interest rates. In the study of Warue (2012), who distinguished the size of banks and indicated that interest rates only significantly positively influence the credit risk of small banks. As for the inflation rate, its impact on credit risk is not consistent. Castro demonstrated in a 2013 study that by lowering the actual value of outstanding loans, a higher inflation rate could make debt repayment easier. By comparison, in countries where interest rates are variable, banks modify interest rates to keep their actual returns. Therefore, customers with reduced income make debt repayment more difficult and have to pay higher interest rates. In this regard, the correlation between inflation and non-performing loans can be positive or negative. Klein (2013) indicated that a positive correlation between inflation rate and non-performing loans, and other scholars had conducted research on the inflation rate and non-performing loans, and their conclusions are similar to the above results. Louzis et al. (2012) and Nikolaidou and Vogiazas (2014) used a time series method or a single country panel model to analyze the problem. In the study of Warue (2012), large banks and small banks were screened according to the size of banks, and the results showed that inflation only harms the credit risk of large banks. The same uncertainty is observed in the impact of exchange rates on non-performing loans. Based on Fofack's (2005) research, currency appreciation may immediately influence the solvency of people by raising the price of local products, while the decline in profit in export-oriented industries may restrict their ability to fulfill their credit commitments. However, foreign currency loans are assisted by the appreciation of the national currency, which makes them cheaper for borrowers (Mishkin, 1996; Nkusu, 2011). This effect is more significant in countries with the biggest proportion of foreign currency loans. Therefore, depending on the debt currency, exchange rates on non-performing loans may be positive or negative. Fofack (2005) examined the correlation between non-performing loans and the appreciation of the real exchange rate and found that the relationship is positive. Castro (2013) also analyzed that the relationship between exchange rate and credit risk is positive and demonstrated that credit risk would increase with exchange rate appreciation and decrease with exchange rate risk depreciation.

Following are economic policies, such as currency and taxation policies, changes in economic legislation, import restrictions, and export stimulus.

Third, political reforms or modifications in the purposes of the leading party. However, it is difficult to analyze the economic policies and political reforms of factors quantitatively, so most studies focus on macroeconomic factors.

On the other hand, bank-specific or institutional factors refer to specific factors that affect individuals (such as financial solvency and capital, credit insurance) and corporations (i.e., administration, financial status, funding sources and financial reports, and solvency). During the economic boom, people have more money to repay debts, and banks have adopted looser credit standards. However, during this period, people and banks are keen to participate in hazardous projects, which is easy to underestimate the services they provide or recover the ability to lend (Jimenez and Saurina, 2006). So when the economy is in recession, credit risk will appear. Therefore, credit risk is accumulated during the economic boom. According to the above literature, the unique characteristics of banks are also regarded as essential factors of credit risk. Warue (2012) collected Kenya's data from 1995 to 2009 and conducted a single-country panel analysis, which results showed that bank-specific determinants have a higher degree of impact on credit risk than macroeconomic determinants.

Furthermore, bank-specific or institutional factors are usually reflected by bank size, bank liquidity, bank profitability, and credit growth. As the size of the bank rises, the possible credit risk becomes higher. According to the moral hazard assumption, in the case of high bank liquidity, managers can obtain the expected rate of return by expanding loans. Thus, in this case, the bank's credit criteria may be lowered, bringing additional risks to the bank (Vogiazas and Nikolaidou, 2011). The impact of bank profitability indicators on credit risk is unclear. Louzis et al. (2012) provided a clear explanation using poor management and procyclical credit policy assumptions. Based on the hypothesis of bad management, poor management by managers means poor monitoring skills, which will lead to low credit scores, which means a high risk of default. Consequently, the profitability of banks is negatively correlated with future non-performing loans. However, the procyclical credit policy hypothesis considers that excellent achievement is positively correlated with the increase in non-performing loans in the future because bank managers are usually not only interested in maximizing profits but also in gaining fame. Specifically, bank managers may try to increase the bank's profitability in the market by reducing loan maturity to expand market share, thereby leading to increased credit risk. Therefore, current earnings may

help create a more extensive stock of non-performing loans in the future. The rapid increase of credit is often accompanied by a parallel growth of impaired loans (Castro, 2013). The moral hazard theory shows that banks with insufficient capital often suffer higher risks due to excessive lending and suffer higher loan losses (Gavin and Hausmann, 1996; Berger and DeYoung, 1997). Nevertheless, Makri et al. (2014) believe that both theoretical and practical evidence indicate that the capital-credit risk relationship is vague. Precisely, even banks with sufficient capital adequacy ratios may generate small but high-risk investment portfolios and hence report large non-performing loans.

According to the above literature, the literature on credit risk (NPL) varies according to the country surveyed, the methods applied, and the variables considered. Most research focuses on credit risk, and most of these countries are developed countries. Some of these documents only consider macroeconomic variables or consider specific indicators such as banks or macro and microeconomic indicators for accurate credit risk modeling. The following research combines and contrasts macroeconomic indicators and bank-specific indicators and introduces some indicators that do not appear in the literature. Nikolaidou and Vogiazas (2017) adopted the ARDL cointegration estimation and found that in the long term, non-performing loans in all countries except Uganda are principally generated by macroeconomic determinants rather than bank-specific determinants. In a 2010 study, Ali and Daly pointed out that the correlation between the macroeconomic environment and credit risk is significantly based on Australian and the United States data. At the same time, the results indicated that GDP growth and short-term interest rates are critical to credit risk, although the size of each country is different. Kakvler and Festic (2012) revealed the importance of current account deficits to non-performing loans when they investigated Romania from 1997 to 2008. As the author claims, the enormous current account deficit generated by the structural dependence on external financing may trigger economic uncertainty. Demirguc-Kunt and Detragiache (1997) argue that a weak macroeconomic environment characterized by slow GDP growth and high inflation rates, low bank liquidity and a high proportion of credit to the private sector is the core of the banking crisis. Some advanced economies and emerging economies experienced it during 1980-94. Gavin and Hausmann (1995) conclude the excessive credit growth was at the core of the Latin American banking crisis because loan limitations and contract fluctuations

accompanied it. Makri et al. (2014) surveyed 14 Euro area countries in the pre-crisis period of 2000-2008, which found that non-performing loans are associated with various macroeconomics (public debt, unemployment, GDP growth) and bank-specific (capital adequacy ratio and return on equity). There is a strong correlation between the factors. Mesai and Jouini (2013) obtained similar results when analyzing a group of Greek banks in Greece, Italy, and Spain, and Louzis et al. (2012) analyzed the data from banks of Greece and concluded similar results. Warue (2013) analyzed a panel data study from 1995 to 2009 and compared with macroeconomic factors, bank-specific factors contributed to a higher degree of non-performing loans, consistent with Fofack (2005).

3.2 The role of foreign banks

The above literature has investigated the influencing factors of credit risk. However, from the existing research on credit risk in the CEE, the role of foreign banks is not fully explored. Only a few studies include the ownership of foreign banks in the impact on credit risk (Uiboupin, 2005; Agoraki et al., 2011). However, many scholars have studied the impact of foreign banks on credit supply; thus, the next part reviews the role of foreign banks in credit. The literature mainly discusses four representative perspectives. At the same time, many empirical studies have explored the influence of foreign banks on credit and verified the above qualitative analysis.

First, from the perspective of foreign banks' independence, foreign bank subsidiaries are not fully autonomous organizations but constitute part of a more extensive bank holding company (the parent bank) with an international diversified asset portfolio. Therefore, the policy of the subsidiary bank will be influenced to a certain extent by the decision of the parent bank or holding corporation (De Haas and van Lelyveld, 2014; Cull and Martinez Peria, 2010; Althammer and Haselmann, 2011). Because of this, it is inferred that the credit risk of the subsidiary bank will also be affected by the parent bank to a certain extent. On the bright side, the parent bank of a foreign bank can play as the lender of last resort during the crisis and allocate capital and liquidity among branches at home and abroad (Stein, 1997). Therefore, subsidiaries of a foreign

bank will have a relatively stable supply of credit, and the possibility of their credit risks will also be reduced. More specifically, the parent bank will maintain its foreign affiliates through the internal capital market (De Haas and Van Lelyveld 2006, 2014, Navaretti et al., 2010), which may make it difficult for foreign bank subsidiaries affected by the adverse impact of the host country's bank capital crash, foreign bank subsidiaries may be able to recover relatively quickly from shock and maintain relatively stable credit levels. On the contrary, some scholars believe that foreign banks are not conducive to the stability of the host country's subsidiaries. The reason is that the head office usually allocates capital between different regions according to the expected risks and returns. When a particular region's economy is in recession, the head office will reduce local business and switch to support other regions (Morgan and Strahan, 2004), then the credit level of the subsidiary may become unstable, and it can be inferred that the credit risk of the subsidiary will increase instead. A recent study by Anginer et al. (2017) found a transmission relationship between the default risk of the parent company of a foreign bank and its subsidiary. Babin (2015) found confirmation that the monetary policy of the parent bank of a foreign bank has an impact on the bank's risk in the balance sheet of a subsidiary of a multinational bank in CEE countries. A study demonstrated by De Haas and Naaborg (2006) among parent banks and subsidiaries (from the Baltic States and Central Europe) shows that subsidiaries are closely integrated with their parent companies through capital allocation and credit diversion. In addition, they distinguished between the "internal equity market" and the "internal debt market," illustrating how the parent company affects the operations of its subsidiaries. Due to regulatory restrictions, the rise in equity capital is critical to granting new credit. On the other hand, in the case of inadequate liquidity, the subsidiary can obtain from the parent bank to promote loans and stabilize the credit supply. Houston et al. (1997) surveyed the overseas branches of the U.S. banking industry and found that the parent bank mainly influences the credit growth of foreign banks, and the parent bank's credit rationing to branches shows a clear tendency to choose the best (Winner-picking Behavior), Some overseas branches have good performance, the credit growth in this area, and the poor performance in other areas, the bank credit will decrease accordingly. Cetorelli and Goldberg (2012) selected the data from U.S. banks that have foreign subsidiaries and branches. The study found that as a response to the parent company's capital shock, the degree of redistribution of funds in the network of foreign entities was different.

Secondly, based on the perspectives of "domestic pull factors" and "international push factors," on the one hand, when the home country's economy is in recession, the head office has to reduce its business under capital constraints, while overseas branches often bear the brunt of the brunt, the parent bank may transfer funds and capital from the subsidiary and weaken the financial health of the subsidiary in the process, leading to an increase in its credit risk. In contrast, other scholars believe that when the home country's economy is in a recession, foreign banks see such problematic economic circumstances as a chance for expansion through new acquisitions or expansion of existing credit lines. Specifically, due to fewer investment opportunities in the home country, the head office will strive to expand overseas business, thereby increasing the supply of credit in the host country (De Haas and van Lelyveld, 2004), encouraging higher risks to earn higher profits, which may have a negative influence on the level of credit risk. Morgan and Strahan (2004) conducted a survey of banks in various states in the United States and found that if instability occurs in certain regions, bankers' risk-return factors may suddenly transform, making foreign banks transfer business. Foreign banks may "suspend production and run" at the first sign of economic weakness, thereby accelerating capital flight during the crisis. In contrast, Cetorelli and Goldberg (2012) and Martinez Peria et al. (2002), Althammer and Haselmann (2011) found that foreign banks did not decrease credit supply during the host country's economic recession and even regarded the economic crisis as an opportunity for business expansion. At the same time, the credit risk of its subsidiaries will also increase. Bruno and Hauswald (2009) showed that foreign banks used to loosen external financial restraints to offset the negative impact of the local banking crisis on growth. De Haas and van Lelyveld (2014) conducted a study on the data of the 48 largest multinational banking groups and found that the growth of credit of foreign banks slowed down nearly twice that of domestic banks during the global financial crisis which made credit unstable. Among them, the parent bank group relies more on wholesale financing to reduce loans through its subsidiaries, which increases the vulnerability of its subsidiaries and increases the possibility of credit risk.

Third, based on the perspective of relational credit, many scholars believe that foreign banks are prone to cherry-picking. Due to the asymmetry of information between

foreign and domestic banks and local companies and the consideration of economies of scale, foreign banks will provide loans for large companies with transparent information and healthy finances, especially multinational companies and high-net-worth customers from their home countries and ignoring the financing needs of small and medium-sized enterprises (SMEs). Therefore, this is not conducive to the stability of the host country's bank credit (Dell'Ariccia and Marquez, 2004). Companies with opaque information may be left to domestic banks. If domestic banks encounter opaque companies with low creditworthiness and their information advantages cannot fully protect themselves from the borrower's default, the asset quality of domestic banks will deteriorate, thereby increasing the possibility of credit risk. On the other hand, some scholars hold different views. They believe that because foreign banks have mature risk identification technology and management methods when foreign banks enter the host country, they can improve the competitiveness of the host country's banking system and improve the screening and selection of SMEs by domestic banks, thereby conducive to the growth of the country's credit scale. Nevertheless, as foreign banks operate in the host country's market, competition may intensify simultaneously (Claessens and Laeven, 2004). The traditional theory believes that higher franchise value will restrict banks' incentives to take immoderate risks (Keeley, 1990, Demsetz et al., 1996). However, if the entry of foreign banks is associated with higher market competition, due to lower profitability, the franchise value of the bank will be reduced, thereby weakening the constraints on bank risk betting (Claessens and Laeven, 2004; Jiménez et al., 2013). As suggested by the "competitive vulnerability" hypothesis (Beck et al., 2006), fiercer competition leads to a decline in the net interest margin, which erodes the primary source of bank profits and induces higher-risk behaviors of "seeking gains." Intensified competition from foreign banks has led existing domestic banks to loosen their review of loan applications to maintain their market share, thereby reducing the quality of their asset portfolios and inducing credit risk (Dell'Ariccia and Marquez, 2006). This point is confirmed in the study of Degryse et al. (2012), the consequence found that domestic banks have more non-performing loans because of the lower customer transparency of domestic banks. De Haas, Ferreira, and Taci (2010) conducted a study of transformation countries that ownership structure and scale are essential for the structure of credit portfolios. Foreign banks attach great importance to providing loans and mortgages to subsidiaries of international companies, while state-

owned banks provide financing for state-owned enterprises to a greater extent than private banks. Claessens and Van Horen (2014) studied the influence of foreign bank entry on private credit in developing countries. The research results prove that there is a phenomenon of picking foreign banks in developing countries, so foreign banks have a negative impact on the credit of the host country. Lensink, Meesters, and Naaborg (2008) used the Hotelling model of spatial competition to analyze the spillover effects on domestic banks after foreign banks with superior screening techniques entered. The study found that the entry of foreign banks would have a negative influence on bank credit efficiency.

Furthermore, the impact of foreign bank subsidiaries on credit risk will also be affected by their establishment methods. Generally speaking, there are two ways for foreign bank groups to enter the host country: Greenfield, which means setting up a new branch of a foreign bank, and Take-over, which means taking over an existing local bank. The latter's management personnel, financial status, business strategy and risk appetite are mostly inherited from the former bank that was acquired. Therefore, its connection with the head office is weaker than that of Greenland Investment. The credit policies of foreign banks established through Greenland Investment will be more. The land is affected by the policy of the head office. According to international standards, a subsidiary bank (generally established through mergers and acquisitions) is an independent legal entity with independent capital established following the host country's laws. It has the same legal rights and obligations as domestic banks. Therefore, the assets of the parent bank are segregated, and the liabilities of the subsidiary are not supported (separated liabilities). On the contrary, branches (generally through greenfield investment) do not have independent legal status; then, all their liabilities are backed by the assets of the parent bank (joint liabilities). Branches are neither individually capitalized nor evaluated by rating agencies, nor do they issue individual financial reports. Therefore, branches with the parent bank as the backing may have a more vital ability to deal with credit risks, while the subsidiary banks may be more affected by credit risks. Degryse et al. (2012) found in their research that greenfield banks have more tremendous efficiency advantages and more significant information disadvantages than parallel banks. Sub-banks formed by combining banks have low efficiency and opaque organizational structure, so there

have more non-performing loans. De Haas and van Lelyveld (2006) analyzed 250 banks (domestic banks and subsidiaries, divided into "greenfields" and "takeovers") from Central and Eastern Europe from 1993 to 2000; therefore, the analysis covers transition and pre-EU accession Period.

It should be noted that many CEE countries were affected by the so-called "transition crisis." The author simulated credit growth within a year and percentage changes in domestic credit market share. The results indicated that domestic banks lessened their credit during the crisis, while Greenfield foreign banks stabilized the credit base. In the case of economic problems in the home country, both foreign banks reduced their loans; however, the decline was even more remarkable for Greenland.

Several studies investigated the exposure of foreign subsidiaries, which consider some other aspects of the exposure of banks. For instance, Ongena et al. (2013) examined the impact of banking supervision in the domestic market on the lending criteria of multinational banks in CEE countries. Ashraf and Arshad (2017) investigated the impact of home country and host country culture on bank risk-taking. Anginer et al. (2017) studied the relationship between the default risk of foreign subsidiaries and the parent bank during the global crisis. All these studies have some variables that do not change from year to year. We are considering that non-performing loans have undergone significant changes during the period while culture or regulation has not undergone significant changes. Therefore, our model cannot capture the influence of these unchangeable groups of variables each year.

Based on the above literature, first of all, from the perspective of the determinants of credit risk, the literature has researched credit risk from macroeconomic cycle factors, bank-specific factors and institutional factors. Most of the determinants of credit risk will be concentrated in one country or one aspect of the above three factors. However, there is minor literature on credit risk in the CEE region. In addition, the three factors are all based on the banks of the country in question, and the role of foreign banks has not been fully discussed. Secondly, from the relationship between foreign banks and the parent bank, there is a transmission relationship between the parent company of a foreign bank and its subsidiaries. The situation of the parent company will affect credit growth, credit supply or bank risks. However, the determinants of credit growth, supply or bank risk and credit risk are different and not the same. Moreover, none of the above

reports provide theoretical or empirical explanations on how credit risk is transferred through the internal capital market of foreign banks. This paper will comprehensively consider the determinants of credit risk and the influence of foreign banks on the credit risk of foreign banks in CEE countries and research them. The characteristics of the parent bank and the macroeconomic environment of the parent bank are included in the credit risk model. It is hoped that this method can be used to conduct a more detailed investigation of the role of foreign bank ownership in subsidiary credit risk, especially the consequences of international credit risk transmission through subsidiary credit supply. This is where innovation is expected in this thesis. Secondly, from the perspective of the research period, most of the current research is before 2008, and there is a lack of quantitative analysis under the significant reversal of many financial indicators after the financial crisis. The sample period of this thesis is 2009-2020, which can compare and analyze the credit risk situation of countries in Central and Eastern Europe after the 2008 financial crisis.

4 Data and Methodology

4.1 Data source

This thesis studies the characteristics of the parent bank and the impact of the macroeconomics of its home country on the credit risk of subsidiaries. Therefore, the empirical part uses data from bank-specific indicators and macroeconomic indicators at the national level. The bank-specific data is mainly obtained from Bureau van Dijk's Orbis Bank Focus database. In the literature, scholars generally use the Bankscope database of Bureau van Dijk, but the database was discontinued in January 2017 and officially revised to become the Orbis Bank Focus database of BVD. The two databases are similar, but there are differences. The Bankscope database includes data on approximately 29,000 public and private banks worldwide. The revised Orbis Bank Focus database covers detailed and standardized reports and ratio data on the operations and credit analysis of more than 44,000 banks and important financial institutions and organizations globally; however, the time frame of this database is shorter. Although the Orbis Bank Focus database has a relatively short time frame, the data after the crisis is relatively complete. The timeline of my thesis is after the crisis (i.e., 2009-2020), so the data used in this thesis is taken from the BvD Orbis Bank Focus database. Since this paper needs to measure the characteristics of foreign banks and their parent banks, such as bank scale indicators, liquidity ratio, profitability, loan quality and other indicators, so this thesis will use the financial data of foreign banks and their parent banks, but each indicator can be measured using different variables; therefore this paper will detail the definition of variables to introduce the definition and selection of variables. Moreover, the database can use the search function filter to create a specified data set. For example, the screening of foreign banks can be selected by ownership. Besides, the database also has the tool function. The tool function tab can be accessed for various analyses, such as pivot analysis, peer analysis and compare groups. "Report" data is linked to the source file to see how the data is derived. It has been widely used in academic research circles and is unparalleled in the scope and data coverage of bank-level data. Nevertheless, there is still a lack of observations among

the foreign banks selected in this round, and several banks do not have any data entries at all, but listed banks have relatively complete data, which may have something to do with the national banking system. The Czech Republic, Slovakia, Poland and Hungary have relatively complete data.

As for the macro characteristics of foreign banks and their parent bank countries, this thesis mainly collected the macroeconomic variables of the host country and the home country from World Bank Development Indicators and Global Economic Monitor (GEM). The World Development Indicators provide countries worldwide with annual data on various economic, environmental, political and social factors. Data coverage starts in 1960 and ends in 2021 and is usually renewed every quarter. The World Bank database also gives measures at the national, regional and global levels. It is one of the most extensive databases in the area, and its data comes from officially recognized international sources. This paper uses the national economic growth, inflation rate, unemployment rate, and real effective exchange rate of the host country and the foreign bank's home country to capture the macroeconomic development of the host country and the home country. Compared with bank-level data, the macro data obtained from the World Bank Development Indicators is complete for the sample countries, except for the real effective exchange rate, and there are no missing observations. The data obtained from the World Bank and Orbis Bank Focus are all denominated in U.S. dollars to compare banks in different countries and currencies.

4.2 Sample selection

The sample collected data on foreign banks in 8 countries in Central and Eastern Europe from 2009 to 2020. First, CEE countries (CEE) is a geographical division formed by 16 countries, including Albania, Bulgaria, Croatia, Czech Republic, Hungary, Poland, Romania, Slovak Republic, Slovenia, Estonia, Latvia and Lithuania. In this thesis, the 8 CEE countries selected are the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Slovakia, and Slovenia. The reason for choosing these eight countries is that they were the first to join the European Union(EU) during the eastward expansion of the EU in 2004. Compared with the CEE countries that later joined the European Union or are joining the European Union, there may be variations in the stages of economic transformation and the development of the banking industry

reforms. Secondly, the data of these eight countries are relatively easy to obtain, especially the four countries of Czech Republic, Hungary, Poland and Slovakia are representative. Hence, this thesis selects these eight CEE countries with the first waves of joining the EU as the main ones. There are two reasons for the selection of the sample from 2009 to 2020. First, most of the literature on credit risk research focuses on the influence of the global financial crisis before and during the crisis. Only a few scholars have studied the influence of foreign banks' credit risk after the crisis. The 2008 global financial crisis transmitted financial shocks through multinational banks. Since then, the CEE countries where foreign banks dominate the banking system have begun to strengthen and improve the regulatory system of foreign banks to keep the countries' credit stability where bank subsidiaries are located, which reveals that there are differences in credit risk after the crisis and before the crisis. Therefore, post-crisis investigations are used to make up for the gaps that the period does. Secondly, due to the severe lack of data in the Orbis Bank Focus database before the crisis, the data will be more inaccurate if using missing data to be investigated. The data survey to 2020 means that the data is updated to 2020, and the literature is updated. Next, we will explain in detail how to prepare and clean up the data.

4.3 Data preparation and Variable Definition

4.3.1 Data preparation

Open the Orbis Bank Focus Database and first set the conditions through the filter. The conditions include still operating banks, and banks that are no longer operating are automatically excluded from the data set. The region is set in 8 sample countries, and the selected banks are all set as commercial banks. Finally, the foreign banks are selected by setting the ownership options; that is, the owner is ultimately held in other countries except for the 8 sample countries (min . path of 50.01%, known or unknown shareholder). Filtered results include the foreign bank subsidiaries and the branches of foreign banks. Foreign bank dummy variables are used to divide the data set into two subsets of foreign bank subsidiaries and branches. In order to match the data of the parent bank with that of its subsidiaries, the variable "Global Ultimate Owner" is used to identify the name, country and type of the parent bank. Following Orbis Bank Focus, the indicators for selecting the relevant characteristics of the parent bank, including

bank scale indicators, liquidity ratios, profitability, bank capital, were downloaded and matched with their respective subsidiaries. The results show that a total of 51 foreign banks meet the requirements. Due to the lack of many observations in several banks (such as COMMERZBANK ZRTTOYOTA BANK in Hungary and POLSKA SA in Poland). Therefore, the first step after downloading the data is to delete the bank with no data for two consecutive years. This step significantly reduced the original data set from 51 banks to 37 banks. The above identification of the type of the parent bank of the subsidiary bank of a foreign bank found that the ultimate owners of five foreign banks are corporate or government, so need to drop the data sets of these five banks (LUMINOR BANK AS, NOVA KREDITNA BANKA MARIBOR DD, PRIMA BANKA SLOVENSKO AS, EQUA BANK AS and BANK BPH SA), in the end, there are only 32 data sets of foreign banks left. In the next step, the bank-level data and the macro-level data obtained from the world data bank are merged and reshaped to obtain a format suitable for panel analysis in Stata. Finally, it is necessary to check for outliers because they may affect the regression results. In the end, we got the complete data set

Pivot analysis is performed on these 32 foreign banks. Table 1 summarizes the distribution of foreign banks in the data set. The data is concentrated on the Czech and Poland foreign banks in the selected bank sample, 9 and 7, respectively. Then there are Hungary and Slovakia, each of which has four banks selected from these two countries. However, Poland has the most significant banking industry in the selected eight countries, while foreign banks in the Czech Republic have more data available than Poland, and Poland has to eliminate more foreign banks. In addition, three of the remaining four countries are all Baltic states. They seem to have less penetration of foreign banks than other countries.

Table 1: Country distribution of selected foreign banks

Location	Number of entities
Czech Republic (CZ)	9
Estonia (EE)	1
Hungary (HU)	4
Latvia (LV)	2
Lithuania (LT)	2
Poland (PL)	7
Slovakia (SK)	4

Slovenia (SI)	3
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Source: *Bankfocus*

Finally, according to data screening, it was found that the 32 foreign bank parent banks matched to 15 parent banks, which came from 10 developed countries: Austria, Belgium, France, Germany, Italy, the Netherlands, Portugal, Spain, Sweden and the United States, of which Western European countries accounted for the majority. It can be seen that except for one parent bank from the United States, the other parent banks are from developed countries in Western Europe, which demonstrated the EU's three principles would help multinational banks to enter CEE countries after joining the EU..

4.3.2 Variable definition

1) Dependent variable

Previous credit-related literature mainly studied credit activities, or credit supply and other issues. Scholars mostly took credit growth as a dependent variable in their research (Arakelyan, 2018; De Haas and Van Lelyveld, 2006), but this paper examines the impact of the macroeconomic environment and the characteristics of the parent bank on the credit risk of foreign banks subsidiaries. Therefore, the dependent variable of the model should be determined based on credit risk. First of all, credit risk is the possibility that the borrower defaults to repay the money or bank loan in time due to various reasons. In the event of a default, the lender or the bank will necessarily bear economic losses due to the inability to obtain the expected return. Then in previous literature studies, four indicators have been used to measure credit risk: Expected Default Frequency (EDF), Loan Loss Reserve (LLP), Default Loss (LGD) and Non-Performing Loan (NPL). However, most of the literature uses the non-performing loan ratio and loan loss allowance to represent credit risk. The loan loss reserve is the reserve fund drawn by the bank to compensate the bank's unrecoverable loan loss reserve to prevent credit risk. It is the bank's early prediction of the loss caused by the credit risk. The non-performing loan ratio can directly reflect the bank's credit risk. When the non-performing loan ratio is high, the proportion of loans that may not be recovered is more significant; the low non-performing loan ratio indicates that the smaller the loan ratio, the financial institution cannot recover. In an analysis by Škarica (2014) which analyzed the factors of changes in the non-performing loan rate of some European

emerging markets and used the non-performing loan rate to measure credit risk. Tanasković and Jandrić (2015) used the rate of non-performing loans as an indicator to measure credit risk when studying the growth of credit risk and macroeconomic and institutional experience. Many documents confirm that the NPL ratio is a more appropriate indicator for measuring credit risk (Castro, 2013; Jakubík and Reininger, 2013; Yüksel, 2017). Therefore, this thesis will use the non-performing loan ratio as an indicator to measure bank credit risk.

2) Independent variable

The independent variables are mainly divided into the bank-specific indicator and the macroeconomic level according to the relevant literature into credit risk factors and then divided into the host country and the home country from these two levels. Therefore, the variables will be divided into four groups.

The first group is about the bank-specific indicators of the host country bank, which selects the bank size, bank liquidity, bank profitability and bank capital.

For the size of the bank (size), this thesis selects the bank's total assets for measurement. The data for this indicator may be relatively large; therefore, consider using the natural logarithm of the total assets. There is a long-term relationship between the size of a bank and its risk-taking behavior. On the one hand, as the size of a bank increases, it will encourage them to pursue higher-risk projects, thereby increasing risky loans. On the other hand, as the scale of banks increases, their influence may influence policymakers and management authorities. The larger the bank, the higher the possible credit risk. Agoraki et al. (2011) found a negative correlation between bank size and non-performing loans, while Louzis et al. (2012) find a positive influence. Therefore, it is predicted that the size of the bank may have a positive correlation with the credit risk.

As for measuring the liquidity of banks (liquidity), the ratio of liquid assets to total assets is selected. Generally speaking, a bank's liquidity assets account for a small proportion of total assets, indicating that the bank's liquidity assets utilization rate is relatively high and the company's operational capabilities are not insufficient. If the proportion of current assets is relatively large, the proportion of accounts receivable or inventory may be too large, resulting in low efficiency in the use of assets. If the proportion of fixed assets is too large, it will also affect the use efficiency of assets. In

the case of high bank liquidity, managers achieve the expected rate of return by expanding loans. Therefore, in this case, the bank's credit standards may be lowered, bringing additional risks to the bank. Therefore, it is predicted that the bank's liquidity may have a positive correlation with the credit risk. Arakelyan (2018) investigated foreign banks and credit dynamics that measure bank liquidity by the ratio of current assets to total assets, but it is not significant. At the same time, Zheng et al. (2020) found that bank liquidity and lending rates significantly positively affect NPLs.

Bank profitability this thesis uses return on average assets (ROAA). The average return on assets can reflect the ability of banks to use assets to create profits. The higher the indicator, the better the bank's asset utilization effect, indicating that the bank has achieved good results in increasing income and saving funds; otherwise, the opposite is true. Loans are one of the primary means for banks to make profits. Banks can expand market share and win loans by reducing loan terms, which leads to increased credit risk. Ghosh (2015) believes that high-profit banks have fewer incentives to engage in high-risk activities. This argument is also supported by the "bad management" hypothesis initially proposed by Berger and DeYoung (1997), which explains that unprofitable banks generate more bad loans and are more susceptible to default risks. Therefore, predicted profitability might be negatively correlated with credit risk.

The equity of total assets measures the capital of the bank (capital), which reflects the long-term financial status and long-term solvency of banks from another aspect. The higher the indicator, it indicates that the debt in the operation process must be too small, which may affect the number of funds occupied, affect the expansion of the business and increase the profitability. The indicator is too low. The financial risks of banks are increasing, and once they encounter a downturn, a debt crisis will occur, which will cause severe obstacles to the development prospects of banks. Due to moral hazard, low-capital bank managers may increase risky loans, which means betting with customers' money. However, managers of adequately capitalized banks may face pressure to ensure capital returns and therefore may increase risky loans. Data provided by Dell'Ariccia et al. (2017) shows that during periods of low Fed interest rates, U.S. banks with sufficient capital are at higher risk. Therefore, it is predicted that there is a positive correlation between bank capital and credit risk.

The second set of variables are the bank-specific indicators of the parent bank. The same indicators as those of foreign bank subsidiary banks were also selected.

The bank scale of the parent bank (*p*size), this paper selects the total assets of the parent bank to which foreign banks belong to measure. Most parent banks are large multinational banks, which are vital to domestic and international financial stability. Therefore, such large banks may be protected by the policy of "Too big to fail." Therefore, it is predicted that the size of the parent bank may have a positive correlation with the credit risk of the subsidiary.

The liquidity of the variable parent bank is also measured by the ratio of liquidity assets to total assets (*p*liquidity). It is possible to provide additional liquidity to its subsidiaries in CEE countries to realize additional profits through internal capital markets. The prediction sign is positive.

The profitability of the parent bank is measured by the average return on assets of the parent bank (*p*profitability). If the parent bank's profitability in the home country declines, they will make up for lost profits by targeting more dangerous projects in the host country. Therefore, the laundering coefficient of the predictive variable of the parent bank's profitability may be negatively correlated.

The capital of the parent bank is the capital that measures the total assets of the parent bank. The forecast is the same as the subsidiaries.

The parent bank's non-performing loans measure (*p*creditrisk) the credit risk of the parent bank. Based on the relationship between the parent bank and its subsidiaries and the credit risk management at the international bank group level. As the credit risk of the parent bank increases, it is expected that the credit risk of the subsidiary will also increase. It is predicted that the parent bank will have a positive impact on foreign banks.

The third and fourth sets of variables are the country's macroeconomic indicators where the parent bank of the eight CEE countries and their subsidiary banks are located. Real GDP growth is an indicator of economic activity (*GDP* and *pGDP* representing the subsidiary and parent bank, respectively). Countries with faster growth can bring higher income levels, thereby improving the solvency of the economy. Improvements in debt service have led to a reduction in non-performing loans. In the event of any economic recession, the situation is just the opposite. Therefore, this thesis assumes a

negative relationship between the real GDP growth rate and credit risk. Beck et al. (2013) and Castro (2013) broadly confirmed that the banking credit risk rises when GDP growth declines. In addition, inflation estimated by the consumer price index indicates the annual rate change in the cost to the average consumer of acquiring a box of goods and services that may be fixed or changed at specified intervals (inflation and pinflation). In rising inflation expectations, borrowers' actual income and solvency are reduced, which leads to an increased risk of non-performing loans. Castro (2013) also confirmed the above view, while Louzis et al. (2012) found a negative relationship between credit risk and Inflation. Therefore, the sign of the inflation rate coefficient is also uncertain. Moreover, the real effective exchange rate (REER and pREER) is used to measure the exchange rate. In the literature, REER is often used to reflect the transmission of external currency shocks to the credit quality of the domestic economy. There are two sources of literature that establish the link between REER and credit risk. One view is that the local currency's appreciation will lead to a decline in exports, thereby reducing the solvency of enterprises in export-oriented sectors. Therefore, an increase in international competitiveness will increase bank defaults (Beck et al., 2013). The other part attempts to simulate the impact of currency depreciation on asset quality. Castro (2013) believes that in the case of a weak foreign currency exchange rate, when a company borrows in a foreign currency without hedging currency risks, banks will face serious credit risks. Because the real effective exchange rate in the literature does not have a unifying influence on credit risk, this thesis predicts whether the sign of the exchange rate coefficient is positive or negative. The last is the unemployment rate (unemployment and punemployment), measured by the share of the labor force without work but available for and seeking employment. The unemployment rate can reflect its ability to pay debts, so the prediction sign is positive. As the home country's liquidity increases, the parent bank can transfer it to a subsidiary in CEE countries, which may lower credit standards. The macroeconomic environment of the home country may also affect its branches or subsidiaries. Therefore, the above indicators are divided into the host country and the home country corresponding to the foreign bank.

3) Dummy variable

The dummy variables defined in this article are the type variables of foreign banks. Due to the different entry modes of foreign banks in Central and Eastern Europe, foreign banks are divided into branches and subsidiaries (subsidiaries). In theory, the

structure of sub-banks allows the host country to protect them from banking groups better, and in the absence of actual international cooperation, the cost of resolving subsidiary bankruptcies may be lower (Fiechter et al., 2011). On the other hand, in the event of a crisis in the host country, the parent bank's assets are legally separated, the parent bank may find it easier to downsize or sell its subsidiary banks. Besides, the establishment of branches can support economies of scale and corporate efficiency because banks can conduct the same business in different countries or regions without repeating reports. Operating in a branch structure can reduce operational risks because it will be under the responsibility of one jurisdiction. When branches are not subject to capital requirements, the parent bank can avoid expensive capital transfers. Banks with many wholesale businesses are more inclined to choose a branch structure to provide greater flexibility in managing global liquidity and credit risk (Fiechter et al., 2011). In contrast, the structure of subsidiaries is also conducive to reducing distortions related to risk transfer and is generally more conducive to benefiting from national tax and regulatory incentives. Subsidiaries and branch structures may have different impacts due to different entry modes. Therefore, when the bank is a subsidiary bank, this article sets the dummy variable to 1 and vice versa, which allows us to distinguish foreign banks based on different entry modes. However, the proportion of foreign bank branches in many CEE countries is not significant.

Table 2 summarizes the definitions and sources of the above variables and their hypothetical symbols.

Table 2: Variable's definition and Data source

Variables	Symbol	Definition	Hypotheses	Data source
Dependent variable				
Credit risk		Impaired loans / Gross loans (%)		Bankfocus
Independent variable				
Size		Logarithm of Total assets (in thousand USD)	+	Bankfocus
Liquidity		Liquid assets / Total assets (%)	+	Bankfocus
Profitability		Return on average assets (ROAA) (%)	-	Bankfocus
Capital		Total equity / Total assets (%)	+	Bankfocus
GDP		Real GDP growth (annual %)	-	World Development Indicators

Inflation		Inflation, consumer prices (annual %)	-	International Monetary Fund, IFS
Exchange rate		Real effective exchange rate index (2010 = 100)		International Monetary Fund, IFS
Unemployment		Unemployment / total labor force (%)	+	International Labour Organization
Parent Creditrisk	pcreditrisk	Impaired loans / Gross customer loans (%)	+	Bankfocus
Parent Size	ln_psize	Logarithm of Total assets (in thousand USD)	+	Bankfocus
Parent Liquidity	pliquidity	Liquid assets / Total assets (%)	+	Bankfocus
Parent Profitability	pprofitability	Return on average assets (ROAA) (%)	-	Bankfocus
Parent Capital	pcpital	Total equity / Total assets (%)	+	Bankfocus
Parent GDP	pGDP	Real GDP growth (annual %)	-	World Development Indicators
Parent Inflation	pinflation	Inflation, consumer prices (annual %)	-	International Monetary Fund, IFS
Parent Exchange rate	pREER	Real effective exchange rate index (2010 = 100)	+	International Monetary Fund, IFS
Parent Unemployment	punemployment	Unemployment / total labor force (%)	+	International Labour Organization

4.4 Hypothesis

The potential contagion or diversification impact faced by foreign subsidiaries through their parent banks means that the parent bank plays an essential role in determining its subsidiaries' credit stability and growth. The existence of the bank's internal capital market plays a central role. It can transfer additional funds from the parent company to the subsidiary or can transmit financial shocks in any bank. At the same time, based on the above literature research and the definition of variables, the following assumptions are made for this thesis:

H1: Bank size, liquidity and capital have a positive impact on credit risk.

H2: Bank profitability has a negative impact on credit risk.

H3: Parent bank credit risk, parent bank size, parent bank liquidity and parent capital have a positive impact on the credit risk of the subsidiary bank.

H4: Parent bank profitability has a negative impact on the credit risk of the subsidiary bank.

H5: GDP growth and Inflation interest rates have a negative impact on credit risk.

H6: Unemployment has a positive impact on credit risk.

H7: Home countries' GDP growth and inflation rate have a negative impact on the credit risk of the subsidiary banks.

H8: Home countries' real effective exchange rate and the unemployment rate positively impact the credit risk of the subsidiary bank.

4.5 Description

Table 3 presents fundamental descriptive statistics on bank-specific variables and macroeconomic variables of foreign banks in Central and Eastern Europe and their parent banks, excluding dummy variables. The second column in the table describes the data availability for each variable during the sample period. The data summarizes 384 observations of 32 foreign banks in Central and Eastern Europe from 2009 to 2020. From the perspective of data types, the data availability of bank characteristic variables is better than that of macroeconomic variables. Excluding the REER variable, this variable is in Slovenia, Estonia, and the Republic of Lithuania lack many observations. Since manually deleted the vacant variables, thus the observed values of the macroeconomic variables and the observed values of the characteristic variables are complete. However, except for the variable REER in CEE countries, the observed values of other variables are complete. Therefore, in the subsequent regression analysis, the REER of CEE countries is not included in the regression, which may significantly impact the regression results.

Table 3: Descriptive Statistics of all variables

Variable	Obs	Mean	Std.Dev.	Min	Max
Creditrisk	384	7.409	9.596	.47	83.7
ln_size	384	16.099	.933	14.215	18.224
liquidity	384	25.932	13.417	1.04	85.13
profitabil~y	384	.809	1.423	-7.41	4.27
capital	384	10.313	3.243	4.05	22.41
GDP	384	1.614	3.69	-14.839	7.427
inflation	384	116.325	28.077	85.617	182.531
REER	312	96.435	4.503	85.45	108.002
unemployment	384	7.585	3.563	2.01	19.48
pcreditrisk	384	6.268	4.367	.36	25.07
pliquidity	384	29.38	8.127	10.54	54.78
pprofitabi~y	384	.463	.777	-8.74	2.15
pcapital	384	6.674	2.146	2.53	17.62
ln_psize	384	19.944	1.091	15.737	21.753
pGDP	384	.343	2.953	-10.839	5.952
pinflation	384	107.955	25.21	89.993	258.844
pREER	384	98.73	4.46	85.651	117.802
punemploym~t	384	8.328	3.869	3.14	26.09

Source: Bankfocus

Firstly, the first line presents the descriptive statistics of the dependent variable credit risk of foreign bank subsidiaries. The mean value of non-performing loans in the total loan is 7.409%. The standard deviation is 9.596%. The minimal non-performing rate was 0.47, while the maximal non-performing rate reached 83.7, which means that the credit risk fluctuates wildly, and there may exist outliers. At the same time, the 32 banks or maybe indifferent. There are significant differences in the non-performing loan ratio between Eastern European countries. Compared with foreign banks in Central and Eastern Europe, the average non-performing loan ratio of its parent bank is lower (6.268), and its standard deviation is 4.367. These data reflect that the volatility of credit risk is low, and the possibility of outliers is slight. The minimal non-performing rate was 0.36, while the maximal non-performing rate reached 25.07. Overall, the non-performing loan ratio of the subsidiary bank is higher than the parent bank from the comparison of the mean, and as far as the selected sample is concerned, the NPL ratio of the parent bank is relatively stable. Thus, the subsidiary bank may have a higher credit risk.

Secondly, as for the variables of bank characteristics, the average logarithm of the size of foreign bank subsidiaries is 16.099, while the average logarithm of the parent bank's asset size is 19.944. There is no doubt that the asset size of the parent bank is more significant than that of its subsidiaries. Besides, the mean value of the parent bank's liquidity ratio is 29.38%, which is also more significant than the subsidiary's 25.932%. The minimum liquidity ratio of the subsidiary is 1.04%, and the maximum is 85.13%, which is quite volatile. Therefore, the parent bank may provide additional liquidity to its subsidiaries in CEE countries to realize additional profits through the internal capital market. However, the data in table 3 shows that the profitability of the host countries' bank is significantly higher than the profitability of the parent bank. The mean return on assets of the subsidiary is 0.809%, while the mean return on assets of the parent company is only 0.463%. It is assumed that if the parent bank's profitability in the home country declines, they will make up for the loss of profit by targeting more dangerous projects in the host country. As for capital, the equity to assets ratio of the subsidiary bank is 10.313%, while that of the parent bank is 6.674%, indicating that the financing structure of the subsidiary and the parent bank's control over the subsidiary is relatively stable.

Finally, a sample at the macroeconomic level found that the mean GDP growth rate of CEE countries was significantly higher than that of the parent bank countries. The average GDP growth rate of banks in CEE countries is 1.614%, and 0.343% of the country's parent bank is located. It can be seen from the above that the country where the parent bank is located is generally a developed country in Western Europe. The average inflation rate of foreign bank subsidiaries (116.325%) is also slightly higher than the average inflation rate of the parent bank (107.955). The minimal inflation rate of the home country was 89.993%, while the maximal inflation rate reached 258.844%. This means the inflation rate of the home country fluctuates wildly. A high inflation rate may reduce borrowers' actual income and solvency, thereby increasing the risk of non-payment of loans. In addition, the average effective real exchange rate unemployment rate of the parent bank is higher than that of the subsidiary. Therefore, it is expected that foreign banks will increase loans to subsidiaries in CEE countries to seek higher yields.

Table 4: Correlations Matrix: CEE Banks

Variables	Creditrisk	ln_size	liquidity	profitability	capital	GDP	inflation	REER	unemployment
Creditrisk	1.000								
ln_size	-0.200*	1.000							
liquidity	-0.142*	0.168*	1.000						
profitability	-0.413*	0.158*	0.185*	1.000					
capital	-0.063	0.053	0.176*	0.403*	1.000				
GDP	-0.163*	-0.008	0.104*	0.397*	0.208*	1.000			
inflation	-0.121*	0.258*	0.216*	0.206*	0.286*	0.218*	1.000		
REER	0.020	-0.110	-0.281*	-0.097	-0.105	-0.367*	-0.375*	1.000	
unemployment	0.297*	-0.178*	-0.148*	-0.206*	0.100*	-0.120*	-0.200*	0.468*	1.000

* shows significance at the 0.05 level

Source: owner calculation

This paper analyzes the correlation between the dependent variable credit risk and its explanatory variables. Table 4 lists the correlation coefficients between the credit risk of foreign banks in CEE countries and the explanatory variables of the host country, including bank-level and macroeconomic-level. The three bank characteristic variables logarithm of bank size, liquidity and capital are negatively correlated with subsidiary credit risk, contrary to those predicted when the variables were set in the previous period. Only profitability and credit risk are negatively correlated with expectations. The variables at the macroeconomic level (GDP and inflation) have a negative correlation with credit risk, which is consistent with the signs predicted above and

supports the expectation hypothesis. In addition, credit risk will increase with the increase of REER and the unemployment rate, which is also in line with the forecast. Considering the problem of multicollinearity, the correlation coefficient between endogenous variables needs to be tested. It is significant between liquidity and other variables in the table, but the coefficient is not significant. Based on the principle of prudence, it has been tested for multicollinearity, and the result is mean vif=1.36, which is less than 10. Therefore, this paper predicts that the estimated model will not have serious multicollinearity problems.

Table 5: Correlation matrix of parent bank specific indicator and home country macroeconomic

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) Creditrisk	1.000									
(2) pcreditrisk	0.351*	1.000								
(3) pliquidity	-0.173*	0.125*	1.000							
(4) pprofitability	0.132*	-0.204*	-0.242*	1.000						
(5) pcapital	0.402*	0.296*	0.013	0.182*	1.000					
(6) ln_psize	-0.216*	-0.189*	0.348*	-0.013	-0.563*	1.000				
(7) pGDP	-0.000	-0.009	0.017	0.167*	0.027	-0.122*	1.000			
(8) pinflation	-0.047	-0.137*	0.415*	0.020	0.490*	0.015	0.058	1.000		
(9) pREER	0.107*	0.015	0.110*	0.065	0.221*	-0.086	-0.109*	0.340*	1.000	
(10) punemployment	0.070	0.148*	0.015	-0.083	-0.120*	0.394*	-0.091	-0.221*	-0.166*	1.000

* shows significance at the 0.05 level

Source: owner calculation

Table 5 lists the explanatory variables related to the home country with the credit risk of foreign bank subsidiaries. Through the correlation coefficient, the credit risk, profitability, capital, real effective exchange rate, and the unemployment rate of the home country are all positively correlated with the credit risk of foreign bank subsidiaries. Among them, only the profitability is not in line with the above assumptions, and the remaining variables are negatively correlated with the credit risk of foreign bank subsidiaries (the liquidity and the size of the parent bank are contrary to the standard assumptions, and the impact of the remaining variables on credit risk is in line with expectations). This is to observe the impact of a single charge, and the specific results will depend on the regression results. Based on the correlation coefficients between the endogenous variables and the comparison with the previous table, we predict that the estimation model will not have serious multicollinearity problems.

4.6 Methodology

My thesis data has 32 banks from 2009 to 2020 for 12 years, and 32 banks come from 8 CEE countries. Therefore, this paper will use cross-border panel regression to analyze the influence of the parent bank characteristic indicators and the macroeconomic indicators of the home country on the credit risk of foreign banks' subsidiaries. This thesis uses software Stata 15.0 to analyze. The estimation technique used is a fixed-effects model, which allows controlling the unobserved heterogeneity of time constants across countries. If the equation of the fixed effects model is:

$$y_{i,t} = \beta x'_{i,t} + \mu_i + \varepsilon_{i,t}$$

The fixed effects method uses μ_i as a group-specific constant term in the regression model (usually, β represents the parameter vector to be estimated, and $\varepsilon_{i,t}$ is the interference term). When using fixed-effect estimators, it is assumed that certain factors within a single entity (foreign banks in this thesis) may influence or bias the predictor variables or outcome variables, so it is necessary to control this. This is the basic principle behind the assumption of the correlation between the entity error term and the predictor variable. The fixed effect estimator removes the influence of those time-invariant features from the predictor variable, so the net effect of the predictor variable can be evaluated. Another critical assumption of the fixed effects model is that these characteristics that do not change over time are unique to each entity and should not be associated with other individual characteristics. Each entity is different, so the error terms and constants (capture individual characteristics) of the entity should not be related to other entities. It seems reasonable to use a fixed-effects model because there may be time-constant differences between banks and countries. The unobserved effects that describe the differences between banks and countries are likely to be non-random. The fixed-effects model allows control of this time-invariant bank and country-specific characteristics; otherwise, these characteristics may not be considered. In this way, fixed effects can help avoid unobserved heterogeneity bias restrictions. Comparable previous studies have frequently observed that fixed effects are the most fitting model. Nonetheless, this thesis conducted a formal Hausman test to verify that fixed effects are more suitable than random-effects models and select the most

powerful model with consistent results. The Hausman test is a generally accepted formal test used to choose between fixed effects and random effects. A significant p-value ($0.000 < 0.05$) means that the coefficient of the effective random effect estimator is different from the coefficient of the consistent fixed effect estimator. Therefore, the fixed effects model is more appropriate. Therefore, we can use the fixed-effect command `xtreg` in Stata. In addition, this thesis runs a GMM estimation in the robust test to confirm the results and compare the model results.

Then analyze the question in three steps. First, this thesis runs three regressions to analyze in more detail the factors that affect credit risk-whether it is the macroeconomy or the specific characteristics of the bank. The first step is to use the characteristics of the subsidiaries of foreign banks and the macroeconomics of the eight CEE countries to determine the drivers of bank credit risk. The second step is to add the characteristics of the parent bank and the macroeconomic variables of the home country and explore the relationship between the subsidiary's credit risk and the parent bank. The third step is to divide the data into two parts, the subsidiary bank, and the branch, to determine whether the characteristics of the parent bank and the macroeconomic variables of the home country will impact different entry modes.

5 Empirical analysis

5.1 Design of the model

According to the methodology, this thesis begins our analysis by constructing a basic model that includes two variables: bank-specific characteristics and macroeconomic variables in CEE countries. Therefore, in the first step, we tested a basic model, which can be written as the following equation (1):

$$Credit\ Risk_{i,t} = \alpha + \beta_1 Bank_{i,t} + \beta_2 Macroeconomic\ Host_{i,t} + \mu_i + \varepsilon_{i,t} \quad , \quad i = 1, \dots, N, t = 1, \dots, T, \quad (1)$$

The following equation (2) adds the characteristics of the parent bank and the macroeconomic characteristics of the home country, which can be written as:

$$Credit\ Risk_{i,t} = \alpha + \beta_1 Bank_{i,t} + \beta_2 Macroeconomic\ Host_{i,t} + \beta_3 Macroeconomic\ Home_{i,t} + \beta_4 Parent_{i,t} + \mu_i + \varepsilon_{i,t} \quad , \quad i = 1, \dots, N, t = 1, \dots, T, \quad (2)$$

The annual credit risk (NPL) i at time t is used as the dependent variable in the model. Bank refers to a vector of bank-specific variables, including bank size, liquidity, profitability, and capital, while macroeconomic is a variable at the macroeconomic level, including real GDP growth, inflation, and unemployment rate. Host and Home refer to the host country and home country, respectively. Since the home country's real effective exchange rate data is relatively complete, the macroeconomic characteristics of the home country include the real effective exchange rate. α describes a constant, μ_i indicates a fixed effect, and $\varepsilon_{i,t}$ describes an error term. N is the number of banks, and T is the number of periods.

5.2 Empirical results

In the following part, the empirical results of panel regression will be introduced and discussed. First of all, this thesis analyzes the bank-level characteristics of foreign bank subsidiary banks and the impact of macroeconomic variables on credit risk. Foreign

banks are regarded as separate entities from their parent banks and do not consider the characteristics of the parent company and the macroeconomic conditions of the home country.

Before the first round of regression, the Hausman test is performed on the first round of regression models. The test result p value=0.000, which means that rejecting the null hypothesis. The effective random effect estimator coefficient is different from the coefficient of the consistent fixed effect estimator. Therefore, the fixed effects model is more appropriate. Table 6 is the Hausman test result.

Table 6: Hausman (1978) specification test

	Coef.
Chi-square test value	26.481
P-value	.001

Source: owner calculation

The first round of regression is mainly aimed at the driving factors of foreign bank credit risk. Since the REER variable has severely missing data in three countries in Central and Eastern Europe (Slovenia, Lithuania and Estonia), adding this variable may significantly impact the regression results; thus, this variable will not be considered the following regressions.

Table 7: Regression results of basic model

Creditrisk	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]	Sig
ln_size	3.258	1.747	1.86	0.063	-0.179 6.694	*
liquidity	-0.095	0.046	-2.07	0.039	-0.184 -0.005	**
profitability	-1.431	0.394	-3.63	0.000	-2.207 -0.656	***
capital	0.212	0.260	0.82	0.415	-0.299 0.723	
GDP	0.020	0.117	0.17	0.864	-0.210 0.250	
inflation	-0.212	0.086	-2.47	0.014	-0.381 -0.043	**
unemployment	0.640	0.199	3.22	0.001	0.249 1.031	***
Constant	-23.854	29.090	-0.82	0.413	-81.071 33.363	
Mean dependent var		7.409	SD dependent var		9.596	
R-squared		0.251	Number of obs		384.000	
F-test		16.491	Prob > F		0.000	
Akaike crit. (AIC)		2568.434	Bayesian crit. (BIC)		2600.039	

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ F test that all $u_i = 0$: $F(31, 345) = 6.19$

Prob > F = 0.0000

Source: owner calculation

Table 7 is the first round of regression, which only considers the banking characteristics of foreign banks in the host country and the macroeconomic variables of the host

country. First, the F statistic measures the overall significance shown by the multiple regression model. The P-value of F is 0.00, which is less than 0.01, indicating that the overall model is significant at the 0.01 level. The coefficient of determination (R-squared) is 0.251, indicating that the model explains 25% of the variability of credit risk, and there may be missing explanatory variables. There is also an F test at the bottom, which is a comparison between the fixed effects model and the mixed-effects model. The table shows that the p-value is equal to 0; thus, the null hypothesis is rejected, the fixed effects model is adopted. The fixed effects regression results of the complete data set show that among all the selected explanatory variables, only the logarithm of bank size, liquidity, inflation rate and unemployment rate are important determinants of credit risk. Among the explanatory variables at the bank level, the model results show that controlling other variables is unchanged. The profitability coefficient is -1.431, which is significant at the 1% level, indicating that the subsidiary's profitability has a significant reverse inhibitory effect on credit risk. Profitability rises every time One unit; Credit risk is reduced by 1.431 units, which means that it will reduce the credit risk when the subsidiary's profitability increases. The predictable signs are consistent. There is no reason for a bank with high profitability to engage in high-risk credit activities, thereby increasing the bank's credit risk. In addition, the liquidity of the subsidiary bank has a significant negative influence on the credit risk of the subsidiary bank at the level of 5%, with a coefficient of -0.095. When the liquidity of the subsidiary bank increases by one unit, the credit risk of the subsidiary bank will be reduced. 0.095 units. This result is contrary to the previous assumption. Expectation management may adopt aggressive investment strategies to expand credit when liquidity is strong, leading to credit risks. However, this ultimately depends on the manager's risk appetite. The logarithm of the total assets, that is, the size of the bank, has a positive effect on the credit risk of the subsidiary bank, and its coefficient is 3.258, which means that when the total assets of the bank increase by 0.0325%, the credit risk of the bank will add 1 unit. This result shows that the larger the bank, the greater the credit risk it faces, which also confirms the theory of "too big to fail." On the one hand, the ability to bear risks is strong, and on the other hand, with the government's support, this will inevitably increase the credit risk. The result is in line with the previous expectations. Finally, the influence of bank capital on credit risk is not significant.

At the macroeconomic level, only the variable inflation and unemployment rate affect the credit risk of foreign banks' subsidiaries. Among them, inflation has a negative correlation with credit risk, and it is significant at the level of 5%. This means that when the inflation rate of the host country increases, it will reduce the solvency of borrowers in that country to a certain extent because the same thing will cost more money. This is also in line with expectations. The unemployment rate showed a vital positive sign (at 1% level). The coefficient is 0.640. When the unemployment rate increases by 1 unit, the credit risk of the subsidiary bank will increase by 0.640 units. An increase in the country's unemployment rate will result in a lack of sources of income, which will affect the solvency of borrowers and increase the possibility of loan impairment. However, GDP growth is not significant in this model.

Before the second round of regression, the Hausman test is performed on the second round of regression models. The test result of p value=0.000, which means that rejecting the null hypothesis. Therefore, the fixed effects model is more appropriate. Table 8 is the Hausman test result.

Table 8: Hausman (1978) specification test

	Coef.
Chi-square test value	83.131
P-value	0

Next is the second round of regression. The regression of the fixed effect model is the same as the first round, but the bank-specific indicators of the parent bank and the macroeconomic indicators of the home country are added. The bank-specific indicators of the host country bank and the host country's macroeconomic indicators are added. The indicators are controlled to study the relationship between the parent bank and the subsidiary bank of a foreign bank. The regression results are listed in Table 9 below, describing each variable's regression coefficient, standard error, and significance level. The parent bank variable is indicated by adding a lowercase letter "p" to the variable. After excluding variables about the actual effective exchange rate of the host country, the rest of the data is relatively complete, especially the parent bank's data is remarkably complete. It may be that many parent banks are listed companies, so the data disclosure is relatively complete. Since the total number of parent banks we observe is 384, including the parent banks corresponding to 32 foreign subsidiary

banks, it should be remembered that some parent banks have more than one subsidiary in the sample country. After screening, it was found that there were only 15 parent banks in 32 multi-pair pairs.

Table 9: Regression results of parent bank characteristic and home country macroeconomic

Creditrisk	Coef.	St.Err.	t-value	p-value	[95% Conf Interval]	Sig
pcreditrisk	0.827	0.164	5.05	0.000	0.505 1.150	***
pliquidity	-0.353	0.073	-4.86	0.000	-0.496 -0.210	***
pprofitability	1.210	0.519	2.33	0.020	0.189 2.230	**
pcapital	2.894	0.445	6.50	0.000	2.018 3.769	***
ln_psize	17.487	2.181	8.02	0.000	13.196 21.777	***
pGDP	0.409	0.187	2.19	0.029	0.042 0.776	**
pinflation	-0.368	0.140	-2.63	0.009	-0.643 -0.093	***
pREER	0.148	0.099	1.49	0.137	-0.047 0.343	
punemployment	0.677	0.241	2.81	0.005	0.203 1.150	***
ln_size	0.222	1.543	0.14	0.886	-2.814 3.258	
liquidity	-0.104	0.039	-2.67	0.008	-0.181 -0.027	***
profitability	-1.450	0.334	-4.34	0.000	-2.108 -0.793	***
capital	0.061	0.226	0.27	0.789	-0.384 0.505	
GDP	-0.229	0.150	-1.52	0.129	-0.524 0.067	
inflation	0.107	0.132	0.81	0.417	-0.152 0.366	
unemployment	0.104	0.203	0.51	0.611	-0.296 0.503	
Constant	-349.889	50.178	-6.97	0.000	-448.593 -251.186	***
Mean dependent var		7.409	SD dependent var			9.596
R-squared		0.550	Number of obs			384.000
F-test		25.694	Prob > F			0.000
Akaike crit. (AIC)		2390.419	Bayesian crit. (BIC)			2457.580

*** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$ F test that all $u_i = 0$: $F(31, 336) = 6.67$

Prob > F = 0.0000

Source: owner calculation

First, the F statistic measures the overall significance shown by the fixed-effects model. The P-value of F is 0.00, which is less than 0.01, indicating that the overall model is significant at the 0.01 level. The coefficient of determination (R-squared) is 0.55. The high probability is that the relevant variables of the parent bank are added, indicating that the model can explain the variability of credit risk. There is also an F test at the bottom, which compares the fixed effects model and the mixed-effects model. The table shows that the p-value is equal to 0, so the null hypothesis is rejected, and the fixed effects model is adopted.

Secondly, from the perspective of the bank-specific indicators of the parent bank, the model results confirm that each parent bank-specific indicator has a significant impact on the credit risk of the subsidiary. The first one is to control other variables unchanged. The coefficient of Parent bank credit risk is 0.827, which is significant at the 1% level,

indicating that the credit risk of the parent bank will significantly positively promote the credit risk of the subsidiary banks in CEE countries. When the credit risk of the parent company rises by one unit, the credit risk of the subsidiary will also increase by 0.827 units. Based on the transmission mechanism of multinational banks and the potential role of the internal market, the credit risk of the parent bank may have spillover effects, which may spread to its subsidiary banks. It is consistent with the symbol predicted in the previous thesis. On the contrary, the liquidity of the parent bank has a reverse inhibitory effect on the credit risk of the subsidiary bank. The coefficient is -0.353, which means that the subsidiary's credit risk may decrease when the parent bank's flow increases, which is significant at the 1% level. Interestingly, this indicator contradicts the hypothesis, indicating that a more liquid parent company may also be more inclined to avoid risks, so a more conservative strategy is to increase its credit portfolio in foreign subsidiaries. In addition, the profitability of the parent bank is directly proportional to the credit risk of the subsidiary bank, which is significant at the 1% level. The coefficient is 1.210, which means that when the parent company's ROAA increases by one unit, the bank credit risk of CEE countries will also grow by 1.210 units. Besides, the parent bank's capital and the logarithm of the bank's size both have a significant (10%, 5%, respectively) positive impact on the credit risk of the subsidiary bank, and their coefficients are 2.894 and 17.487, respectively. For every increase in capital by one unit, the credit risk of the subsidiary bank will increase by 2.894 units. This result may indicate that the well-capitalized parent bank prefers risks and, therefore, will adopt aggressive strategies for the credit of its foreign subsidiaries and may also result from a slowdown in credit growth in the domestic market, which is obtained through subsidiary banks. On the other hand, for every increase of 0.17487% in the asset size of the parent bank, the credit risk of the subsidiary bank will increase by 1 unit. The above two indicators are in line with the hypothesis. The bank characteristics of the parent bank have a significant impact on the credit risk of the subsidiary bank. The macro-level variables of the foreign bank's home country, including home countries' real GDP growth, inflation and unemployment rate, are all sensitive to the credit risk of the subsidiary bank. Among them, the sign of the coefficient of home countries' real GDP growth is opposite to the previous prediction, and it has a positive correlation with the credit risk of the subsidiary bank. For every unit increase in the real GDP growth of the home country, the non-performing loans of the subsidiary banks grow by 1 unit. It is expected that since the home country is

generally a developed country, with the slower GDP growth rate of the home country, the possibility of making a profit in the home country is reduced. Therefore, the parent bank will transfer resources to the subsidiary, but because the subsidiary's regulatory agency has carried out Corresponding supervision, its credit risk will not increase. The inflation rate and unemployment rate of the home country are consistent with expectations.

After adding the bank characteristics of the parent bank and the macroeconomic variables of the home country, the significance of the variables in the host country has slightly changed, but the liquidity and profitability of the subsidiary banks are still solid and significant. The remaining variables become insignificant after adding the home country variable.

In general, the parent bank is conducive to the subsidiary bank. Variables at the parent bank's specific indicator level can have a significant relationship with the credit risk of the subsidiary bank, and the macroeconomic characteristics of the home country can also affect the dependent variables.

Table 10: Regression result of Subsidiaries and Branches

VARIABLES	Subsidiary (dummy=1)	Branch (dummy=0)
pcreditrisk	0.297*** (0.084)	0.624 (0.580)
pliquidity	-0.065 (0.048)	-0.012 (0.203)
pprofitability	0.920*** (0.304)	-2.891** (1.198)
pcapital	-0.282 (0.233)	9.218*** (1.407)
ln_psize	1.758 (1.539)	14.593** (6.456)
pGDP	0.237** (0.106)	0.206 (0.435)
pinflation	0.124* (0.072)	-1.334** (0.646)
pREER	-0.230*** (0.071)	-0.085 (0.237)
punemployment	0.033 (0.117)	-0.416 (1.205)
ln_size	-0.962 (0.820)	1.282 (3.998)
liquidity	-0.006 (0.022)	-0.050 (0.104)
Profitability	-3.166*** (0.197)	2.190*** (0.753)
capital	0.509*** (0.140)	-0.526 (0.475)

GDP	-0.278*** (0.094)	-0.688* (0.354)
inflation	-0.216*** (0.072)	0.011 (0.375)
unemployment	0.398*** (0.124)	0.728 (0.493)
Constant	17.648 (32.085)	-212.108 (153.372)
Observations	252	60
Groups	21	5

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

Source: owner calculation

According to the literature research in Chapter 3, it is known that foreign banks in Central and Eastern Europe can be divided into subsidiary banks and branches according to the way foreign capital enters. There may be differences in conductivity between the two (subsidiary banks and branches) and the parent bank. Therefore, this thesis also searched the database to browse the financial statements of each bank and the nature of the establishment of the bank and investigated whether the selected foreign bank is a subsidiary or a branch. At the same time, dummy variables are set in the above thesis, but due to the fixed-effects model, all variables in all models that do not change over time will be dropped. Therefore, this thesis abandons the use of dummy variables, divides the selected 32 banks into two groups, and does not bring them into a fixed-effect model to compare whether the different entry methods of foreign banks have different effects on their credit risk. Table 10 records the results of subsidiaries and branches. First of all, from the perspective of the bank's specific indicators, the profitability of the parent bank has a significant impact on the credit risk of the branch and the subsidiary. However, the two coefficients have opposite signs, and there may be differences in their attitudes towards credit risk. For subsidiaries, the relationship between the parent bank's credit risk and subsidiaries credit risk is significant at 1%, and its coefficient is 0.387, which positively promotes the subsidiary bank's credit risk, while the branch's coefficient is negative and insignificant, which reveals that there is a big difference in how they deal with credit risk in different entry modes. The liquidity theory is an essential driving factor for the determinants of credit risk, but it is not significant for all foreign banks or subsidiaries and branches. The parent bank's capital is prominent in the subsidiary column, and the branch is not sensitive, but the branch is more sensitive to the size of the parent bank.

From a macroeconomic perspective, the macroeconomic characteristics of the parent bank have a significant impact on the credit risk of foreign banks. The coefficients of real GDP growth, inflation and real effective exchange rate in the home country are all positive, and they are at a significant 10%, 1%, 1% level, which means that by increasing the GDP of the home country, inflation and the real effective exchange rate, the credit risk of the branch will also increase, which is a positive promotion. As for the credit risk of the subsidiary, it is only sensitive to the REER of the home country, and it has a reverse inhibitory effect.

5.3 Robust test

Table 11:Regression result of GMM estimation

VARIABLES	(1) System GMM
L.Creditrisk	0.110*** (0.0378)
pcreditrisk	0.225** (0.0955)
pliquidity	-0.0627 (0.0406)
pprofitability	-0.627** (0.271)
pcapital	0.153 (0.200)
ln_psize	1.423** (0.611)
ln_size	-0.00670 (1.578)
liquidity	-0.0942** (0.0376)
capital	-0.394** (0.164)
pGDP	0.423*** (0.117)
pinflation	0.0121 (0.0115)
pREER	0.133*** (0.0370)
punemployment	0.137 (0.0949)
GDP	-0.315** (0.133)
inflation	0.00923 (0.0116)
unemployment	0.543*** (0.0920)
Constant	-36.31** (17.08)
Observations	352
Groups	32
AR1	0.0326
AR2	0.240
Hansen	0.770

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

Source: owner calculation

In order to test the robustness of the above evaluation methods and variables, this paper adopts the systematic generalized moment method (GMM) as an alternative estimation method to review the impact of the bank characteristic variables of the parent bank and the macroeconomic characteristics of the home country on the credit risk of foreign banks' subsidiary banks. Introduce the lag items of the explained variables, construct a dynamic panel, and use bank-specific financial variables and credit risk lag items as endogenous variables and pre-variables. According to the theory of the model, the lag order of endogenous variables or pre-variables is used as their instrumental variables, and the remaining macroeconomic variables are regarded as exogenous variables. This thesis chooses the collapse option in the `xtabon2` command for lagging dependent variables and endogenous bank-specific variables. This option can eliminate too many instrumental variables, and the minimum number of instrumental variables can be used to ensure more accurate results. At the same time, GMM can solve the problem of autocorrelation of credit risk and the potential endogeneity of bank-specific variables, using the over-restricted Hansen test and the Arellano-Bond test report for sequence correlation to support the effectiveness of the tool.

After continuous attempts, a lag order that can pass both the autocorrelation test and the Hansen test was selected. Table 11 demonstrated the results of the system GMM estimation. First, in the autocorrelation test of the model, AR (1) is less than 0.05, and AR(2) is more significant than 0.05, which means that the results of the two models meet the setting, which means that the model has the first-order autocorrelation. There is a second-order autocorrelation, indicating that the model is set up correctly. The function of the Hansen test is to test the validity of instrumental variables (the original hypothesis is that all instrumental variables are valid). If the p-value is less than 0.05, it means that the instrumental variable is unreasonable, and there is an over-identification problem. Suppose the p-value is more significant than 0.05. In that case, it means accepting the original hypothesis, or the original hypothesis that "all instrumental variables are valid" cannot be rejected, and that all instrumental variables are valid, and the endogeneity problem is dealt with. The Hansen test of the system GMM estimation in this paper is more significant than 0.1, indicating that the

endogeneity of the model has been dealt with, and the instrumental variables are all valid.

Controlling other variables unchanged, the lagged term (L. Creditrisk) of the explained variable is significantly positive at the 1% level, indicating that Credit risk has a significant positive lagged effect on itself. The model results show that controlling for other variables unchanged, the coefficient of credit risk is 0.225, which is significant at the 5% level, indicating that parent bank credit risk has a significant positive effect on foreign bank subsidiaries' credit risk. Each unit of parent bank credit risk increases foreign bank subsidiaries' credit risk by 0.225 units as well. The parent bank size coefficients are positive, consistent with the symbols in the fixed-effects model. Although the parent bank's profitability is significant, the relationship is the opposite, inconsistent with the symbols in the fixed-effects model. Nevertheless, our results are robust to the GMM estimation method to a certain extent, at least two key variables are consistent with the fixed-effects model.

5.4 Discussion

All in all, as far as Central and Eastern European countries are concerned, the impact caused by non-performing loan variables has long-term effects on the entire banking system; the proportion of non-performing loans in total loans is an essential index in the field of analysis and has a long-term impact on the situation of the entire industry. As far as the examined country is concerned, preventing shocks in non-performing loans and immediately alleviating emerging shocks are particularly important from the perspective of the entire banking system. Comparing the bank-level characteristics of the four host countries, bank asset scale, bank liquidity, bank profitability and bank capital, we find that the bank's asset scale and bank liquidity's impact on foreign bank subsidiaries' credit risk are consistent with the assumptions made in this thesis. The results are similar to those reviewed by scholars in the literature. In addition, after adding the variables of the parent bank characteristics, the liquidity and profitability of the host country's subsidiary banks are still significant, indicating that these two indicators have a substantial influence on credit risk. Comparing the three principal macroeconomic variables: the unemployment rate and credit risk are significantly positively correlated, while inflation is significantly negatively correlated, which are

consistent with the hypothesis. The above-obtained results are similar to those obtained by scholars in the literature. Therefore, it can be revealed that the influence of these macroeconomic variables on credit risk is stable, regardless of the research period used, even if the regulatory agencies and the government conduct supervision after 2009, similar results can be obtained. Secondly, comparing the five indicators in the bank-level characteristics of the parent bank, we obtain that the credit risk of the parent bank, the size of the parent bank, the liquidity of the parent bank, the profitability of the parent bank and the capital of the parent bank all have significant forces on the credit risk of the foreign bank subsidiaries. From a macro perspective, the home country's GDP growth, home country inflation, and home country's unemployment rate also have significant effects, and most of the signs are consistent with the hypothesis and are similar to the results proposed by scholars in previous literature studies. Therefore, it can be concluded that the characteristics of the parent bank and the home country's macroeconomic characteristics will influence the credit risk of the subsidiary bank. This result also confirms the potential penetration between foreign subsidiaries and their parent banks, and the existence of banks' internal capital markets may play an important role.

6 Conclusion

This thesis aims to clarify whether the parent bank's bank-specific characteristics and the home country's macro-economy have a negative impact on the credit risk of its subsidiaries in CEE countries. However, the large proportion of foreign banks in Central and Eastern Europe has attracted many scholars to study foreign banks in Central and Eastern Europe. Nevertheless, in these studies, only some scholars have investigated the impact of foreign banks on credit risk, and in these studies, they have less to explain the impact of the characteristics of the parent bank and the macroeconomic environment of the home country on the credit risk of the banking industry in Central and Eastern Europe. In order to study this problem, this thesis adds the role of foreign banks to the decisive factors of credit risk, that is, the specific financial indicators of the parent bank and the macroeconomic characteristics of the home country are added. At the same time, the research of this thesis is based on the assumption of the transmission mechanism of multinational banks and the existence of internal capital markets. This thesis confirms that the parent bank's influence on subsidiary credit risk is also indirectly a consequence of the credit distribution of multinational banks through its conductivity and internal capital markets. Therefore, this paper analyzes the research problem through the panel data regression model. The first step is to analyze the determinants of bank credit risk. The second step is to add relevant variables to evaluate the impact of the financial characteristics of the international parent bank and the macroeconomic characteristics of the home country on the credit risk of its subsidiaries to investigate potential contagious effects. In the second part, foreign subsidiaries are divided into two groups, namely subsidiaries and branches, which are used to explore whether the different entry modes of foreign banks will have different effects on their conductivity.

The research results of this paper have four main points: First, this paper discovers the driving factors of the credit risk of foreign banks in CEE countries. As far as the financial characteristics of banks are concerned, the credit risk of foreign bank subsidiaries is more sensitive to bank liquidity and profitability, and the increase in

both can have a reverse inhibitory effect on non-performing loans. The larger the bank's assets, the stronger the growth of the subsidiary's non-performing loans. From a macroeconomic perspective, the host country's inflation rate and unemployment rate have a more significant impact on the non-performing loan ratio of foreign banks, while GDP is less sensitive.

Secondly, according to the empirical research results of this thesis, the credit risk of foreign subsidiaries is affected by the status of the parent bank. The higher the liquidity of the parent bank, the more risk-averse the attitude will be, and the non-performing loans of the subsidiary will be reduced accordingly. Parent banks with high non-performing loan ratios, strong profitability, adequate capital, and large banks will adopt more aggressive strategies for the credit of subsidiaries, which leads to the possibility of the increased credit risk of foreign bank subsidiaries. The bank-specific variables of the parent bank selected in this paper are all significant in the empirical study. Therefore, it is confirmed that the parent bank will adopt different credit strategies for its subsidiaries according to its bank characteristics, which affects the credit risk of CEE countries.

On the other hand, the macroeconomic characteristics of the country where the parent bank is located also have a significant impact on the credit risk of its foreign bank subsidiaries in Central and Eastern Europe. The empirical results of this thesis show that the improvement in real GDP growth and unemployment in the home country will strengthen the credit risk of foreign banks subsidiary in CEE countries. On the contrary, an increase in the inflation rate of the home country will reduce the credit risk of the host country's subsidiary banks.

Fourth, the empirical research results of this thesis explain that the different entry modes of the parent bank will cause different credit risks to the subsidiary banks. The credit risk of the parent bank has a significant impact on the credit risk of the subsidiary, but it is not significant for the branch. The profitability of the parent bank is significant whether it is a subsidiary or a branch, but the coefficient is the opposite. The parent bank may adopt different strategies due to the different regulatory measures (such as capital requirements, loan restrictions) that the subsidiaries and branches are subject to. Finally, this paper conducts a robust test. This paper uses a GMM estimation method that is different from fixed effects to test the impact of the parent bank's specific level and the parent country's macroeconomics on the credit risk of the subsidiary. The subsidiary's credit risk lagging trend is also used as an explanatory variable to form

dynamic panel data. The results show that the credit risk and scale of the parent bank positively affect the subsidiary's non-performing loans, which is consistent with the sign of the fixed effects model and has a significant impact. The actual GDP growth of the parent bank's home country is also related to the subsidiary's credit risk, which is positively correlated. However, the empirical results estimated by the GMM model are not as significant as the fixed effects, but they are still robust to a certain extent. The above research conclusions support the theory that multinational banks have international transmission of shocks.

Furthermore, the research in this paper has many limitations—first, the limitations of the data. Although the bank focus database provides bank-level data, there are many gaps in banks' data in Central and Eastern Europe (especially Slovenia, Lithuania and Estonia). From the original 51 banks to 32, it is impossible to analyze a single country. In terms of sample size, the larger the sample size, the more accurate the estimated result may be. Another limitation of the data lies in the choice of variables. This thesis selects the overall level of non-performing loans. Since the data in Bankfocus does not provide more detailed data, the data covers a broader range and may not accurately predict the fluctuation of credit risk. Secondly, from a methodological point of view, the fixed-effects model estimation may not estimate the impact of credit risk reasonably, and a more complex model GMM should be used as the primary research tool. At the same time, there is no in-depth study of the problems of the model. Therefore, the empirical results may be biased. In addition, although this thesis uses the U.S. dollar uniformly for the data unit, it seems more appropriate to use the euro for the study of countries in Central and Eastern Europe.

Finally, the research results of this paper are possible to contribute. The first is evidence that multinational banks have increased conductivity. Foreign banks that rely on internal capital markets will enhance their credit risk in CEE countries due to changes in their domestic macroeconomic and parent bank conditions, which means that national regulators must monitor the risk appetite of foreign banks in terms of credit growth more extensively. This provides further empirical evidence for the continued supervision and cooperation to establish a more effective non-performing loan resolution mechanism. Given the extensive reforms of the regulatory environment after the crisis and the rise in non-performing loan rates in many EU countries, CEE decision-makers should not only understand the domestic business of foreign banks

but also need to have a broader perspective, including the international regulatory environment and the parent company of foreign banks. Potential (coming) regulatory changes in your jurisdiction.

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