The impact of banking regulations, institutional environment, and negative interest rates on bank risk-taking

Mandeep Kaur

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Abstract

This thesis makes three contributions to the literature. First, in Chapter 2, we add to the inconclusive literature on creditor rights and banking regulations regarding bank risk-taking. By using a panel dataset of commercial banks from 2004 to 2014, we find the risk-inducing impact of creditor rights and three regulatory measures (activity restrictions, capital stringency and official supervisory powers) from 2004-2014. These results propose that none of these measures by governments and regulators are sufficient to manage bank risk over the long run. we perform some post-crisis analysis and find that while the risk-inducing impact of creditor rights weakens after the crisis, bank regulations help mitigate banks' excessive risk-taking behaviour. These findings suggest that either bank became more risk-averse after the crisis or bank regulations became more effective around this time.

Second, in Chapter 3, we contribute by addressing the scant literature on institutional environment and bank risk. In this area, we also contribute by using more advanced econometric methodologies (fixed effects and two-step system generalized method of moments) compared to existing literature (Ordinary Least Squares and Generalized Least Squares. We find that most of the WGIs (Voice & Accountability, Government Effectiveness, Regulatory Quality, Rule of Law and Control of Corruption) are helpful in reducing risk-taking behavior of banks. However, the magnitude is different for each of them. The only exception is political stability (PS), for which we find the opposing effect. These results suggest that paying attention to individual components of WGIs is important while improving the overall institutional quality of the country.

Finally, in Chapter 4, we investigate banks' risk-taking behaviour in a negative interest rate environment. First, we contribute to the literature by employing only countries that adopted negative policy rates in 2014, while existing studies examined all countries that adopted negative rates in different years. Using a homogenous treatment year can provide a better analysis of heterogeneous treatment. We find that banks have not increased their risk-taking across European countries since their implementation. These findings suggest that negative rate policies serve the purpose they were designed for. In addition, we contribute by exploring this relationship based on types of banks such as commercial banks, cooperative banks, and savings banks. We find that while commercial banks tend to take more risks, savings banks exhibit more prudent behaviour. The behaviour of cooperative banks is unclear since they show the characteristics of both risk avoidance and risk-seeking.

Key words: bank risk-taking, banking regulations, institutional environment, negative interest rates, NIPR, bank risk-determinants.

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List of Abbreviations

ASEAN	Association of Southeast Asian Nations
BCBS	Basel Committee on Banking Supervision
BIS	Bank for International Settlements
BR	Banking Regulations
CAR	Capital Adequacy Ratio
DID	Difference in Differences
DMS	Djankov McLeish and Shleifer
ECB	European Central Bank
EU	European Union
FDI	Foreign Direct Investment
FE	Fixed Effects
FGLS	Feasible Generalised Least Squares
GDP	Gross Domestic Product
GE	Government Effectiveness
GFC	Global Financial Crisis
GLS	Generalised Least Squares
GMM	Generalised Method of Moments
IMF	International Monetary Funds
MENA	Middle East and North Africa
NATO	North Atlantic Treaty Organization
NIM	Net Interest Margin
NIPR	Negative Interest Policy Rates
NIRP	Negative Interest Rate Policies
NPL	Non-Performing Loans
OECD	Organization for Economic Co-operation and Development
OLS	Ordinary Least Squares

PS	Political Stability
RL	Rule of Law
ROA	Return on Assets
ROE	Return On Equity
RQ	Regulatory Quality
SNB	Swiss National Bank
TARP	Troubled Asset Relief Programs
UK	United Kingdom
US	United States
USA	United States of America
V&A	Voice & Accountability
WGI	World Governance Indicators
WTO	World Trade Organization

Chapter 1 Introduction

In this thesis, we investigate the determinants of bank risk-taking behaviour by using a global sample of banks. The thesis sequentially focuses on banking regulations, institutional environment and negative monetary policy rates as the focal points of bank-risk determinants in the empirical chapters. This chapter discusses the motivation behind the study, provides a brief literature review, research aims and objectives, a quick overview of data and methodologies, a summary of our empirical findings, contribution to the empirical literature and thesis layout.

1.1 Motivation for the study

The global financial crisis (2007-08) raised concerns regarding the risk-management practices of banks across the globe. Banks' poor performance and commercial banks' failure during the crisis agitated the confidence in the financial and banking structure. Before the crisis, the bank's profits and assets grew much higher than the economic growth rate (Acharya and Richardson, 2009). Banks followed liberal risk-assessment strategies, such as neglecting risk to increase compensation and financial incentives by investing in high-risk projects (Hellwig, 2009). These high-risk investments did help bank managers to achieve their short-term rewards, but the long-term sustainable income of banks was compromised (Acharya and Schnabl, 2010). Banks were following the relaxed lending standards, had thin capital and were relying mostly on short-term wholesale markets for liquidity. (Ely, 2009). The crisis exposed liquidity buffers, insufficient capital, increased non-performing loans and a pattern of excessive risk-taking by banks (Westermeier, 2018).

Banks are important institutions for an economy as they channel the surplus funds to the areas where the funds are in deficit. Banks aid in capital and saving generation in an economy by taking deposits from savers and lending money to individuals and businesses. This allocation of resources is crucial for the economic growth of a country. Banks are considered to display excessive risk-taking when less efficient banks are not carefully scrutinizing the risk profiles of their debtors and display greater volatility in revenue generation (Agur and Demertzis, 2012). Bad asset decisions result in bad loans and other losses. Over the last two decades, the banking sector has thoroughly transformed in terms of global reach, size, technology, new financial instruments, and diversity of activities. All these changes have intensified the risk profile of banks. Banks are motivated to adopt complex and risky financial tools to maximize their profits. The banking industry is different from other industries in the economy because they have to manage various forms of risk together, such as interest rate risk, operations risk, credit risk, market risk, liquidity risk and reputation risk.

Many studies have shown that excessive risk-taking by banks before the crisis was the root cause behind the failure of the banking system (Beltratti and Stulz, 2012; Hoque et al., 2015). The literature has put forward the significance of identifying the early indicators of high-risk banks because this can help them improve their position at a low cost in a reasonable time (Davis and Karim, 2010; Fortin et al., 2010). Immoderate risk-taking by banks is usually associated with bank defaults and high-cost government-funded bank bailouts. The cost of bank bailouts gets transferred to the entire economy, and the failure of some major banks can lead to contagious banking sector failure (Fernandez and Gonzalez, 2005). Consecutively, such banking disasters cause a plunge in asset prices, an abrupt recession, a rise in government debt and prolonged recovery periods (Reinhart and Rogoff, 2009). Overall, the issue of excessive risk-taking is crucial for the banking sector and the entire economy, and therefore, a better understanding of bank risk-taking determinants is required.

The determinants of bank risk-taking behaviour have been attracting increased attention from policymakers and academics. Supervisors and policymakers must evaluate their current policies designed to prevent excessive risk-taking by banks. The literature has addressed bank risk-taking in various contexts: from the impact of bank-level characteristics such as bank size, bank capitalization, balance sheet and income statement items (Afonso et al., 2014; Drakos et al., 2016; Stiroh, 2006) banking regulation (Agoraki et al., 2011; Barth et al., 2004; Fernandez and Gonzalez, 2005; Laeven and Levine, 2009), legal environments such as investor protection and creditor rights (Fang et al., 2014; Houston et al., 2010), institutional environment (Ashraf et al., 2017; Uddin et al., 2020), monetary policy (Altunbas et al., 2010; Chen et al., 2017; De Nicolo et al., 2010), macroeconomic factors (Bohachova, 2008; Mileris, 2014) and banking industry competition (Agoraki et al., 2011; Boyd and De Nicolo, 2005; Jiang et al., 2018; Jimenez et al., 2013). Some researchers have investigated the impact of internal corporate governance factors on bank risk-taking: board characteristics (Berger et al., 2014; Srivastav et al., 2016); ownership structure (Laeven and Levine, 2009; Shehzad et al., 2010); CEO and management compensation setting (Chen et al., 2006; Francis et al., 2015). This thesis examines the impact of banking regulations, the institutional environment, and negative interest rates on bank risk-taking. Most other risk-determining factors are applied as control measures in the empirical analysis.

1.2 Research Aim and Objectives

This research aims to evaluate the impact of banking regulations, institutional environment, and negative policy rates on bank risk-taking.

To achieve this aim, we divide the research into three research objectives/questions as follows:

1.2.1 Research Objective 1

What is the impact of various bank regulatory measures and creditor rights on risk-taking in banks?

The existing literature considering the impact of banking regulations on bank risk-taking presents mixed findings. For instance, while Agoraki et al. (2011) and Ashraf (2017) find the risk-reducing effect of strict restrictions, Laeven and Levine (2009) support the risk-inducing effect of activity restrictions. Notably, the recent literature is scant in terms of establishing the relationship creditor rights and bank risk-taking. The only available study is by Houston et al. (2010), who find that stronger creditor rights encourage risk-taking in banks. Therefore, we contribute to the empirical literature by addressing this inconclusive stance and scant literature. In addition to this, we contribute by examining the effect of bank regulations and creditor rights after the crisis. Such work is vital because there is a belief/consensus that prior to the crisis, banks were not always following sound risk management strategies, and there were imperfections in the regulatory and supervisory frameworks of the banking sector (Ashraf et al., 2017; Beltratti and Stulz, 2012). Regulations have been tightened after the crisis. Therefore, the expectation is that banks should take less risk after the crisis. No study in our knowledge have evaluated the after-crisis effect of creditor rights and all these regulatory variables.

To examine our research objective 1, we have used a global sample of commercial banks that are purely in the business of deposit-taking and loan-making from the period 2004 to 2014. Our panel dataset is unbalanced in nature. We use the fixed effects estimation method. We have some interesting findings from our empirical analysis. First, we find that both creditor rights and three banking regulation measures increase banks' risk-taking. The findings are in line with the findings of Houston et al., (2010) and Hoque et al. (2015). These results propose that none of these measures put in place by governments and regulators are sufficient to manage bank risk over long run. Further, we find that while the risk-taking impact of creditor rights weakens after the crisis, bank regulations help mitigate banks' excessive risk-taking behaviour. These findings suggest that either bank became more risk-averse after the crisis or bank regulations became more effective around this time.

1.2.2 Research Objective 2

What is the relationship between the different measures of the institutional environment and the risk-taking behaviour of banks?

The literature suggests that a stable political system (Bordo and Rousseau, 2006; Voghouei et al., 2011), the existence of corruption (Aidt, 2009) and the rule of law (Boudriga et al., 2010) determine the degree of financial development of a country. Subsequently, institutional quality also matters for the banking stability of a country. Most studies have used the aggregate index of institutional quality while studying the impact on risk-taking (Fang et al., 2014; Klomp and De Haan, 2012). They find that better institutional quality helps reduce banks' non-performing loans and capital-asset risk in transition and OECD countries. A few studies have analysed the impact of individual governance indicators (Bui and Bui, 2019; Houston et al., 2010; Toader et al., 2018; Uddin et al., 2020), but their findings are mixed. These studies support that all WGI measures influence bank risk differently. Therefore, we investigate the individual measure of WGIs on bank risk-taking.

We contribute to the empirical literature by addressing the scant literature on institutional environment and bank risk. Only a few studies have examined the relationship between the two on a global level (Bui and Bui, 2019; Houston et al., 2010). Therefore, we have employed a global sample of commercial banks. Further, we are contributing by using more advanced econometric methodologies compared to existing literature. While we have employed fixed effects and two-step system GMM methods, which can address potential endogeneity and heterogeneity issues within a risk-taking model, existing papers have used OLS and GLS, which are ineffective in controlling those issues. We also contribute by investigating the varying impact of different institutional environment measures. We employed various subsamples from the primary sample based on countries and economic events such as the global crisis. None of the existing studies has explored further why different institutional quality measures influence risk-taking differently when we know they are highly correlated.

For the second research objective, we analysed how six World Governance Indicators (WGIs) influence banks' risk-taking behaviour. We find that most of the WGIs are helpful in reducing risk-taking behaviour of banks, but the magnitude is different for each of them. The only exception is political stability (PS), for which we find the opposing effect. These results suggest that paying attention to individual components of WGIs is important while improving the overall institutional quality of the country. In our in-depth further analysis, we find that the relationship between WGIs and bank risk is quite dynamic (time-varying) and depends on specific countries. Although PS reduces risk-taking before and after the global crisis, we find that PS led to high volatility in banks' share prices. Our study is quite similar to Houston et al. 2010 and Bui and Bui (2019) regarding data set and period; we find some significant differences in our findings because of differences in estimation techniques.

1.2.3 Research Objective 3

What is the relationship between negative monetary policy rates and bank risk-taking?

Monetary policy is another crucial aspect that can influence bank risk. We study this aspect by analysing the relationship between negative rates and bank risk-taking. Before the beginning of the 2000s, it was commonly believed that interest rates should not drop below zero. Economists also admit that a negative rate policy is not a good idea as lenders tend to hoard up the funds instead of lending. However, the global financial crisis transformed how central banks use monetary policies to regulate economies. Following the crisis, the CB of most of the developed economies continued dropping the interest rates till short-term policy rates reached nearly zero. Some CB adopted unconventional monetary policies in response to deflation and economic downturn.

The empirical evidence on risk-taking is scant and mixed. Some empirical literature studies the impact of negative rates on bank profitability and interest margins (Borio et al., 2017; Brei et al., 2020). Some studies evaluate the effect of NIPR on economic growth and inflation rates (Molyneux et al., 2019). Most of the others examine these policies' direct effect on lending and inflation (Heider et al., 2019; Michail, 2019). Some limited papers have explored the relationship between negative interest rates and bank risk (Florian, 2018, Bongiovanni et al., 2021 Bubeck et al., 2020). While a few papers find that negative policy rates help minimise bank risk (Florian, 2018; Boungou, 2020), Bubeck et al. (2020) find that negative rates encourage risk-taking behaviour in banks in search of yield. Therefore, due to limited and mixed evidence, we explore the impact of negative rates on bank risk-taking.

We contribute to empirical literature first by employing only countries that adopted negative policy rates in 2014, while existing studies examined all countries together that adopted negative rates in different years (Boungou, 2020; Bongiovanni et al., 2021; Carbo-Valverde et al., 2021). Examining a sample with different adoption dates makes it challenging to identify which year had a significant impact. Therefore, using a homogenous treatment year can provide a better analysis. Further, we contribute by exploring the relationship between negative rates and bank risk-taking based on the type of banks, such as commercial banks, cooperative banks, and savings banks. We are the first study to perform such an investigation. Different types of banks can influence this relationship as they have different institutional features and income models.

We employ a difference-in-difference methodology to analyse the relationship between NIRP and bank risk-taking. The DiD methodology has become the most common method to estimate the causal relationship between outcome variables and treatment. In its simplest version, it involves two groups and two periods. The untreated group never receives the treatment, and the treated group receives treatment in the second period. A DID method examines the effect of a treatment by comparing the change in outcome from the pre-treatment to the post-treatment period for the treated group relative to the control group.

We find that banks have not increased their risk-taking across European countries since their implementation. These findings are consistent with the literature (Boungou, 2020; Bongiovanni et al., 2021). These findings suggest that negative rate policies serve the purpose they were designed for. Further, while examining the relationship between negative rates and bank risk-taking based on the type of banks, we find that commercial banks tend to take more risks, whereas savings banks exhibit more prudent behaviour. The behaviour of cooperative banks is unclear since they show the characteristics of both risk avoidance and risk-seeking. Therefore, these results are subject to business models and the ownership structure of banks.

1.3 Thesis Layout

The thesis is structured into five main chapters. This first chapter introduces the contexts around the research area, research objectives and main contributions of the research. The introduction chapter also provides a brief overview of empirical findings, data, and methodology used in the research. The next chapter, chapter 2, evaluates the relationship between different measures of banking regulations and bank risk-taking measures. The following chapter, Chapter 3, examines the impact of different aspects of the institutional environment on risk-taking in banks. We use the same sample as Chapter 2, but we use two methodologies in this chapter. We employ fixed effects and two-step System GMM methodologies to empirically evaluate the relationship between a country's institutional setting and banks' risk-taking. Chapter 4 provides an empirical analysis of the impact of negative interest rates on bank risk-taking. Central banks set negative policy rates in response to economic downturns. Therefore, we are evaluating how it affects the risk-taking behaviour of banks. Finally, Chapter 5, the Conclusion Chapter, provides the overall summary of our empirical findings, the contribution of the research and some policy implications of the findings. The chapter also discusses the strength and limitations of our research and suggestions for future research.

Chapter 2 Creditor Rights, Bank Regulations and Bank Risk-taking

2.1 Introduction

In this chapter, we examine the impact of creditor rights and bank regulations on risk-taking. Creditor rights measure the degree to which the rights of creditors are protected when their debtors become bankrupt (World Bank, 2019) and bank regulations are the activity restrictions, recommendations and requirements that banks need to adhere to, in order to generate and maintain market transparency between themselves and their customers (Barth et al., 2004).

Regulations are essential in the banking sector. Banks have the tendency to take on maximum risk to achieve higher returns and compete in the market (Beltratti and Stulz, 2012). There is a fundamental need for specific regulatory policies to minimise bank risk as they play a crucial role in the well-being of an economy. Therefore, central banks worldwide established the Basel Committee on Banking Supervision (BCBS) in Basel, Switzerland, in 1988. They published the round of deliberations known as Basel I in the same year but enforced it in 1992 in G-10 countries. Around 100 other countries implemented the regulations with minor customisations. Basel I was mainly about the minimum capital requirements of banks. Basel II was later developed and replaced Basel I in 2004 following significant losses in international capital markets. It was extended to minimum capital requirements, supervisory mechanisms, transparency, and market discipline. The banking system is expected to face the stringency of capital requirements, empowered supervisory agencies, activity restrictions, enhanced transparency and regulations that facilitate private monitoring. Basel II was expected to provide substantial benefits in helping supervisors and banks manage risks (Demirguc-Kunt and Detragiache, 2011), but the global financial crisis disclosed many weaknesses of the Basel II that triggered the need for a revised regulatory framework (Laeven and Levine, 2009). As a result, the new proposed framework, Basel III, was introduced in 2010. Basel III further strengthens the regulatory pillars of Basel II. Basel III focuses on the same but more strict guidelines as Basel II.

These regulatory reforms have had a significant impact on the risk-taking behaviour of banks (Ashraf, 2017). In this context, the existing literature has explored the effect of several specific regulatory procedures, such as private monitoring[1], capital stringency and activity restrictions on banks' risk-taking. The picture that emerges from the literature is that bank regulations lead to mixed responses in terms of risk-taking from banks. For example, while Ashraf (2017), Beltratti and Stulz (2012) support an inverse relation between capital stringency and risk-taking, Blum (1999) detects a positive relation between capital stringency and bank risk. Like bank regulations, creditor rights have displayed a positive and negative relationship with risk-taking (Hoque et al., 2012). While Houston et al. (2010) find that stronger creditor rights increase bank instability, Acharya et al. (2011) show that creditor rights decrease corporate risk-taking. Despite the growing literature, the debate on the relationship of bank regulations and creditor rights with risk-taking still needs to be settled. Therefore, we want to contribute to this debate by examining a global sample of commercial banks.

We contribute to literature in two ways. First, there is a gap in the literature on how creditor rights and bank regulations shaped the risk-taking behaviour of banks after the global financial crisis. Bank regulations have been tightened after the financial crisis. Thus, there is a need to assess whether the tighter regulations are more purposeful than they were before the global financial crisis. Therefore, in this chapter, we fill this gap by examining the impact of bank regulations and creditor rights on the risk-taking behaviour in banks after the crisis period. We perform this by interacting the year dummy from 2009 to 2014 with bank regulations and creditor rights. These interaction terms are important as they will disclose whether regulatory variables have increased or decreased bank risk post-crisis. Previous studies have not examined these variables' post-crisis effect, especially for this period and using the interaction terms.

[1] Private monitoring is referred to as the regulations that empower, facilitate, and encourage the private sector to monitor banks (Barth et al., 2004).

Another contribution we make to the empirical literature is based on data samples and methodology. Very few studies have evaluated the impact of creditor rights and bank regulations on bank risk-taking globally (Houston et al., 2010; Ashraf et al., 2020; Hoque et al., 2015; Laeven and Levine, 2009). Agoraki et al. (2011) examined the banks from 13 Central and Eastern European countries. Other studies analysed only developing economies (Bemrpei et al., 2018; Klomp and De Haan, 2014). By considering a global sample, this is a therefore a more comprehensive study on the topic.

The only study available regarding creditor rights is Houston et al. (2010). Our study differs from Houston et al. (2010) in the following ways. First, our period is from 2004 to 2014, while Houston et al. (2010) used the sample from 2000 to 2007. The consideration of the global crisis and longer period might help in producing more informative results. The advantage of using long periods is that they effectively determine the impact of explanatory variables on dependent variables. A longer period can focus on more than one business cycle or credit boom period. For example, the period from 2004 to 2014 has a boom and bust of credit across the world. Further, we use a fixed effects methodology, which is better than the Ordinary Least Squares (OLS) technique used by Houston et al. (2010). Compared to OLS, the fixed effects technique effectively controls variables that are constant over time but vary over cross-sectional units.

Regarding bank regulations, Laeven and Levine (2009) employed the top 10 largest publicly traded banks in 48 countries in 2001. However, our sample includes all publicly traded banks across 69 countries. Their sample period is 1996-2001. Therefore, we have the advantage of using a larger sample over a more extended period. Ashraf et al. (2020) used a larger sample similar to ours, but our study is different in terms of period and regulatory variables. While they have evaluated only capital regulations, we are examining two additional measures of bank regulations (activity restrictions and official supervision). This can help understand how different aspects of regulations determine risk-taking in banks.

Regarding the sample period, Ashraf et al. (2020) compare the bank risk before and during the crisis, but our sample period also includes the post-crisis period. Examining the post-crisis period can reveal if banks could manage risk better after learning the lessons from the detrimental effects of higher risk-taking during the crisis. Hoque et al. (2015) have used a global sample while evaluating the impact of capital stringency, activity restrictions and official supervision, but the study has employed only two different year periods (one is the global crisis period, 2007-08, and the other is Eurozone crisis period, 2010-11). Therefore, we have the advantage of using a longer period over their study.

Following Beltratti and Stulz (2010), Hoque et al. (2015) and Laeven and Levine (2009), we are using the three most commonly used bank regulatory measures: activity restrictions, capital stringency and official supervisory powers. They are all forms of bank regulations but measure different aspects of banks. While activity restrictions measure restrictions put on bank activities, such as investing in insurance activities, capital stringency measures the capital requirements, such as verifying capital's source and risk elements (Barth et al., 2004). Official supervisory powers measure the rights given to bank supervisors, such as obtaining information from banks (Barth et al., 2004). Further details on these measures are provided in section 2.3.3.2.

The results show that there is a positive relationship between creditor rights and the risk-taking behaviour of banks from 2004 to 2014; however, this impact weakened after the global financial crisis, consistent with Houston et al. (2010). This change suggests a potential shift in bank behaviour or in the effectiveness of creditor rights in a post-crisis environment. Similar to creditor rights, bank regulatory variables also have a positive effect on bank risk. These findings suggest that both the legal environment (creditor rights) and bank regulations are insufficient to manage bank risk over the long run. However, bank regulations are found to minimize bank risk after the crisis. These results highlight that either banks became more risk averse after the crisis or they started following the regulatory measures sincerely that helped to minimize bank risk. These results remain constant with additional robustness tests such as alternative risk measures.

Therefore, by working with (i) a more comprehensive dataset and (ii) more advanced econometric techniques than were previously considered, this analysis sheds light on a literature which generally has presented very mixed results. The analysis also presents results for the post-crisis period on which here is limited or non-existent findings. Generally, it seems that creditors rights and banking regulations tend to be increase bank risk-taking. The financial crisis appear to have made banks pay closer attention to banking regulations and act more prudently. However, somewhat surprisingly the behaviour of banks with respect to creditors rights do not seem to have been affected by the financial crisis. These findings offer valuable insights for banks, policymakers and researchers. They suggest that banks, over the long-run, cannot solely rely on regulators or policies to save themselves under evolving economic scenarios. Banks should follow internal high standard risk management policies to combat adverse situations like the global crisis. For policymakers, they highlight the need for considering alternative or new approaches to balance bank risk-taking behaviour, especially under transforming economic environment.

The rest of the chapter is structured in the following way. The following section discusses the theoretical and empirical literature on the influence of creditor rights and bank regulations on risk-taking in banks. Section 2.3 describes the data, variables, empirical model, and methodology used for the research, whilst section 2.4 presents and discusses the empirical results. Finally, the conclusion is presented in the last section.

2.2 Theoretical framework and hypotheses development

2.2.1 Banking regulations

Bank regulations are a set of rules and procedures that require compliance for the smooth running of the financial system. Bank stability is essential for sustainable economic growth and financial stability as it facilitates the efficient allocation of resources in the economy (Levine, 1998). A banking regulatory system serves various essential functions. Firstly, banks deal with asymmetric information issues (Mishkin, 1996). They smooth the flow of funds between surplus and deficit units and the transformation of funds in the financial system. Further, financial institutions are associated with externality issues (Wagner, 2010). Financial players and financial markets are closely interrelated, and the failure of banks can shake the entire economy. Therefore, regulatory standards and compliance by banks and financial intermediaries are crucial for a sound financial system.

The regulatory framework is required to mitigate the underlying principle-agent problem between depositors and financial intermediaries (Alexander, 2006). There could, therefore, be a conflict of interest depending on how banks manage the funds from depositors and the way they make them available to lenders. Similar to lenders, depositors have information asymmetry issues as they usually do not have information about the riskiness of bank lending (Barth et al., 2004). The information asymmetries may cause moral hazard problems as banks may make decisions that are not in the best interests of depositors and lenders, particularly if depositors are not inclined to encourage banks to reduce risk-taking levels because they are protected by government guarantees or deposit insurance (Gropp and Vesala, 2004). If depositors' concerns are not addressed, they can lose confidence in the banking system (Alexander, 2006). Therefore, regulatory measures are required to prevent moral hazard problems and for banks to function effectively.

The overall objective of the regulatory regime of the Basel Accord (BIS, 2022) is to create a safe and sound banking system. The various external regulatory instruments through which banks execute the regulatory requirements are entry, activity, and affiliation restrictions; capital stringency requirements; power of supervisory agencies; private monitoring; foreign entry and ownership restrictions; and deposit insurance. The employment of one instrument may influence the application of another instrument, which can change the overall impact of the regulatory regime on the banking sector. Despite following all these international regulatory standards, banks failed miserably during the crisis (Belratti and Stulz, 2012). The poor performance of financial institutions can be cited as a failure of Basel II norms (Minton et al., 2010; Srivastav and Hagendorff, 2016). Also, the effect of bank regulations on banks may vary from country to country due to different institutional settings and the fact that the Basel requirements are not legally binding (Barth et al., 2004). Therefore, evaluating governance practices set by the Basel Committee on Banking Supervision (BCBS) is required.

Various independent measures of banking regulations regulate different aspects (Barth et al., 2004). We aim to examine the three most commonly used measures of bank regulations: activity restrictions, capital stringency and official supervisory powers. These regulatory reforms may have had a significant impact on the risk-taking behaviour of banks. The relevant theoretical and empirical literature on these measures is presented below:

2.2.1.1 Restrictions on bank activities

Activity restrictions refer to the restrictions on banks to participate in non-traditional bank activities such as securities market, insurance and real estate activities and owning and controlling non-financial firms. Theoretical arguments support both the risk-inducing and risk-decreasing effects of banking regulations. Diverse activities may raise conflicts of interest between different stakeholders of banks (Saunders, 1985), and more activities enable banks to participate in risky projects (Boyd et al., 1998); therefore, activity restrictions are expected to mitigate agency conflicts and risky behaviour. Beck (2008) discusses that activity restrictions were imposed after the financial crisis 1930 to control competition and promote stability. In addition, banks are already complex organizations, and restrictions on bank activities can mitigate further complexity of banks and assist in better monitoring. Supporting this theory, Ashraf (2017) and Hoque et al. (2015) find that stricter restrictions reduce bank risk-taking. Agoraki et al. (2011) find that stricter restrictions reduce banks' credit risk and overall solvency risk by using a sample from transition countries.

The alternative theory argues that bank risks can be managed efficiently through diverse activities on products and services, suggesting that activity restrictions increase bank risk (Saunders and Walter, 1994). Claessens and Klingebiel (2001) put forward that restrictions on bank activities limit the bank's opportunities to diversify their portfolios' risk, increasing their financial fragility. Some empirical studies support this theory on the risk-inducing effect of activity restrictions (Barth et al., 2001, 2004; Laeven and Levine, 2009). Barth et al. (2001) find that restrictions on bank activities are associated with a higher probability of suffering a major banking crisis and low banking sector efficiency. Laeven and Levine (2009) also find that activity restrictions are related to a significant increase in bank risk. Moreover, Lepetit et al. (2008) document that more restrictions affect the market competition and behaviour of banks in other market segments. They find that investing in non-interest income projects decreases the insolvency risk of banks. Lepetit et al. (2008) also suggest that greater dependence on fee-based activities of banks is connected to low lending rates and under-priced borrower default risk.

To put it briefly, the views on the effects of activity restrictions are not conclusive, and therefore, we will examine its effect on bank risk-taking empirically. We set the following hypothesis to test based of the mixed theories:

H2a. Greater restrictions on bank activities decrease bank risk-taking.

H2b. Greater restrictions on bank activities increase bank risk-taking.

2.2.1.2 Capital Stringency

Stringent capital regulations include minimum capital requirements and tightness of regulations on the nature and source of capital. It is considered a primary supervisory instrument for bank stability and risk management. The core idea behind capital requirements is that adequate capital can protect depositors and mitigate the bank's risk of failure, as adequate capital ensures that assets will not have to be sold during insolvency (Allen et al., 2011; Holmstrom and Tirole, 1997). Stringent capital requirements can minimise bank risk as they enable the fast recovery of banks from crises or financial losses (Mehran and Thakor, 2011; Thakor, 2014). Adequate capital incentivises managers and owners of firms to take fewer risks when they have higher amounts of capital at risk (Gale, 2010). Therefore, the theory assumes that the greater the capital level is, the less the chances of liquidity constraints and, hence, less bank risk-taking.

The empirical literature however presents mixed findings. Berger and Bouwman (2013) point out that higher capital acts as a cushion against bank failure and increases their capability to survive at all times. Repullo (2004) highlights that a percentage increase in bank capital enhances banks' risk-bearing and risk-absorbing capacities. Hoque et al. (2015) find that greater capital leads to lower bank risks during the global and European Sovereign crises. The least capitalised banks did not survive the crisis and slowed their lending activities during the global financial crisis (Cooke and Koch, 2014). Laeven and Levine (2009) support the risk-reducing impact of capital stringency.

However, other studies show a positive relationship between capital requirements and risk-taking (Caprio et al., 2014; Koehn and Santomero, 1980). Caprio et al. (2014) show that countries with higher capital deposit ratios had a greater probability of financial crisis. Herring (2010) asserts that adequate capital standards could be a more successful regulatory tool. Stringent capital rules can also increase bank risk by reducing market discipline (Ashraf et al., 2020). It can bring down market discipline (monitoring by bank depositors and debtholders) by requiring banks to maintain less debt and high capital and giving debtholders more confidence that supervisors are monitoring banks. Further, a few studies document that strict capital regulations increase a bank's overall assets portfolio risk (Kim and Santomero, 1988; Koehn and Santomero, 1980). They argue that capital standards do so by restricting efficient asset investment limits and altering bank asset risk and value calculations.

Due to mixed evidence on the effects of capital stringency on bank risk, we assess the relationship between capital stringency and risk-taking with the following hypothesis:

H3a. Higher capital stringency requirements decrease bank risk-taking.

H3b. Higher capital stringency requirements increase bank risk-taking.

2.2.1.3 Official Supervisory Power

Official supervisory power refers to regulations that define the supervisor's rights, such as demanding information from auditors and asking banks to change their organisational structure. Banks are difficult and costly to monitor. If the supervisory authorities of the financial system have strong powers, they may be able to prevent and rectify problems in the financial sector (Barth et al., 2004). Strong supervision can prevent contagious banking sector failure by controlling information asymmetries (Fernandez and Gonzalez, 2005). Additionally, government guarantees, and deposit insurance encourage bank risk-taking by reducing incentives for depositors to monitor banks, and powerful supervisors can avert this excessive risk-taking behaviour of banks. Mohsni and Otchere (2018), in their comparative study of Canada and the US, find that strong supervisory power created a more conservative environment that restricted excessive risk-taking by Canadian banks before the global financial crisis. In their study on transition countries, Agoraki et al. (2011) find that higher supervisory power assists bank stability by lowering moral hazard and improving loan quality. Bouvatier et al. (2014) confirm that income smoothing through loan loss provisions is less pronounced in countries with robust official supervision.

In contrast, the rent-seeking theory states that powerful officials can exploit their powers and increase bank risk (Shleifer and Vishny, 1998). They can attract corruption, such as bribes and favoured constituents, especially in countries with weak legal enforcement (Shleifer and Vishny, 1998). Powerful supervision increases banks' risk activities by impairing bank lending's integrity (Beck et al., 2006). The risk-inducing effect of powerful supervisors can be more pronounced in transition economies as politicians can manipulate supervisors and control their powers to extract private benefits from banks (Stigler, 1971). Levine (2003) argues that powerful supervisors can promote competition in the financial market, and enhanced competition may increase additional risks for banks. The empirical findings of Hoque et al. (2015) support that powerful supervision leads to greater risk-taking in banks during both the global and sovereign debt crises. However, banks with strong external supervision in the presence of private monitoring performed better (Hoque et al., 2015).

Based on two alternative theories, we set our hypothesis on official supervisory power as follows:

H4a. Greater supervisory power decreases bank risk-taking.

H4a. Greater supervisory power increases bank risk-taking.

2.2.2 Creditor rights

There are two opposing theories on the impact of creditor rights on risk-taking behaviour by banks. On the one side, we might expect a risk-reducing effect of credit rights on corporate risk-taking for a given set of borrowers. Lenders can seize collateral, force payment, or get control of the borrower if creditor rights are strong. Additionally, in an environment of strong creditor rights, firm managers will face negative consequences if the firm declares financial distress, such as restrictions on reorganisation and change in management during the reorganisation. As a result, borrowers are less likely to default. Also, lenders have high recovery rates in cases of default, which minimises the overall risk of creditors. These imply that banks are subject to less risk. A few studies support this theory. Acharya et al. (2011) document that, in countries with high creditor rights, firms who borrow from banks minimise their bankruptcy by diversifying acquisitions, increasing their lines of business and implementing low cash flow risk policies. These actions imply that stronger creditor rights reduce the default risk of a bank's loan portfolio.

The alternative theory suggests that creditor rights can promote risk-taking as strengthened creditor rights nurture the confidence of banks to give loans to a broader but risky set of borrowers. Consistent with this theory, Djankov et al. (2007) find that strengthened creditor rights are associated with increased lending. Creditors may lend to high-risk borrowers with poor credit ratings when they have better rights in the event of default. This practice will escalate banks' default rates and increase banks' overall risk. The empirical findings of Houston et al. (2010) and Teixeira et al. (2020) suggest that better creditor rights offer more confidence for banks to grant loans for risky projects. Also, Adler (1991) proposes that when firms are close to default, strengthened creditor rights encourage managers to increase firm risk, but their aim is to minimise overall risk to prevent insolvency. For example, a firm may forgo valuable debt in its corporate structure or surrender a risky but potentially profitable investment opportunity. In this way, managers tend to delay default and waste assets in the process. Nonetheless, there is an argument that stronger creditor rights reduce bank risk by strengthening their position as a lender. Due to inconclusive literature, this becomes an empirical question. Therefore, we set the following hypothesis to examine this relationship:

H1a. Stronger creditor rights decrease bank risk-taking.

H1b. Stronger creditor rights increase bank risk-taking.

2.2.3 Creditor rights and bank regulations after the global financial crisis period

Bank regulations are put in place to minimize bank risk-taking. However, banks were found to be taking much risk during the crisis period despite these measures already being in place (Beltratti and Stulz, 2012; Hoque, 2013). After the crisis, bank regulations were tightened to encourage banks to take less risk with higher capital requirements introduced (Elliot et al., 2012; Economics, 2013). Banks were expected to comply with existing regulatory measures more strictly before the crisis; thus, we expect that regulatory measures will minimize bank risk after the crisis period. Stricter supervision was introduced (Fratzscher et al., 2016), leading to more prudent lending standards, and banks may naturally have chosen to abide by existing rules after witnessing the negative consequences of risky behaviour during the crisis. Therefore, we expect a risk-decreasing effect of regulatory measures on banks' risk-taking behaviour after the global financial crisis years. We test the following hypothesis:

H5a. Strict bank regulations decreased bank risk-taking after the global financial crisis.

Similarly, we would expect that creditor rights minimize bank risk as banks are expected to improve their lending practices after the crisis. Better lending practices include better screening of loan applicants and not lending to risky borrowers. Therefore, we set the following hypothesis to test the effect of creditor rights after the crisis:

H5b. Strong creditor rights decreased bank risk-taking after the global financial crisis.

2.3 Data and Methodology

2.3.1 The Sample

Following Hoque et al. (2015), we looked for the top 1500 active banks in Bankscope by total assets at the end of 2004. We include only commercial banks with deposit-taking and loan-making activities in our sample[2]. We exclude banks that are not publicly traded, foreign banks and subsidiaries of foreign banks and those who contained data for less than three years. The final sample includes 696 banks from 66 countries, as shown in Appendix 1. The dataset spans from 2004 to 2014 because the measurement of our key variable, the creditor rights index, was altered from 2015 onwards. The accounting-based data is winsorised at 1% and 99% levels to ensure that outliers do not drive the results. Our panel data is unbalanced as some banks have missing values during this period, and the sample consists of around 7000 observations.

Our data sources include Bankscope and the World Bank Database. First, we use Bankscope to download bank-level data. Numerous studies in banking literature have used the Bankscope database (Laeven and Levine, 2009; Houston et al., 2010; Shehzad and De Haan, 2013). All variables are downloaded in US dollars. The creditor rights data is collected from the 2015 World Bank's Doing Business dataset available in the World Bank database. It comprises data from 2004 to 2014. Similar to Hoque (2013), we employ the bank regulation and ownership data from the 2008 World Bank survey to analyse the relationship between bank regulation and bank risk. The country-level and governance data are from the World Bank Global Financial Development (2017) database.

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[2] We keep all commercial and publicly traded banks irrespective of the size as large banks are usually safe and results can be biased. The sample including both medium and large size banks can disclose the actual effect of regulatory variables on bank risk.

Regarding the post-crisis period, there is an ongoing debate on the length of the global financial crisis. Some authors refer start of 2009 as end of the crisis by pointing at the positive changes in the US GDP (Aloui et al., 2011; Dungey et al., 2015). However, other studies extend the crisis end date to early 2010 citing the improvements in the financial markets and rise in loan rates (Nieh et al., 2012). Following Atahau and Cronje (2020), Pati (2017) and Shah et al. (2017), we have employed 2009 as a starting point for the post crisis period. As our sample period ends in 2014, we have the post-crisis period from 2009 to 2014. To confirm our main results, we have also performed empirical analysis by using post-crisis period from 2010-2014 as a robustness check.

2.3.2 Model Specification

Bank risk-taking is a function of several bank-level, country-governance, and other macroeconomic factors (Hoque, 2013; Laeven and Levine, 2009), which we include in our modelling. The specification is as follows:

$Risk_{i,j,t} = \beta_0 + \beta_1(\text{Bank regulation})_{,j,t} + \beta_2(\text{Creditor rights})_{,j,t} + \beta_3(\text{Year\_dum}) + \beta_4(\text{Bank-regulation}^{X}\text{Year\_dum})_{,j,t} + \beta_5(\text{Credior-rights}^{X}\text{Year\_dum})_{,j,t} + \beta_6(\text{Country-level governance})_{,j,t} + \beta_7(\text{Bank-level controls})_{i,j,t} + \beta_8(\text{Macroeconomic controls})_{,j,t} + \varepsilon_{i,j,t}$

Risk is a measure of bank risk of bank i in country j at time t, β_0 is constant, and ε is the error term. While creditor rights are an index for creditor rights at the country level, bank regulation indicates various regulatory measures such as activity restrictions, capital stringency and official supervisory power. Bank regulatory variables are country-level indices. Year_dum is a dummy variable for years after the global financial crisis (from 2009 to 2014). Bank regulation^{X}Year_dum and Creditor rights^{X}Year_dum present interaction terms of bank regulatory measures and creditor rights, respectively. Government quality is used as a control for country-level governance. Bank-level controls are several accounting variables at the bank level as discussed in the upcoming section. The macroeconomic controls used are GDP per capita and current account. Bank concentration (C3 ratio) is used to control for market competition. The equation is estimated using fixed effects estimation, as discussed in the later section. The detailed definitions of all variables are shown in Appendix 2. All of these variables are discussed in detail in the following section.

2.3.3 Key Variables:

2.3.3.1 Measuring bank risk

Following Gropp and Heider (2005) and Huang et al. (2018), our primary measure of risk-taking is price volatility, which is measured as an average of the annual price deviation (high and low) of stock from its average price for each year. A higher value implies a higher bank risk. There are alternative bank risk-taking measures such as the Z-score (Houston et al., 2010; Laeven and Levine, 2009), idiosyncratic volatility (Beltratti and Stulz, 2012; Hoque, 2015), the ratio of non-performing loans to gross loans (Agoraki et al., 2011) and the stock beta (Hoque et al., 2013). The advantage of using price volatility is that it is a market-based measure instead of an accounting-based measure. It eliminates any kind of biases that could arise from accounting-level variables as they are free of bank-level reporting. Nevertheless, we use the z-score and non-performing loans and re-run our estimations as a robustness check to our results. The definitions for these variables are provided in Appendix 2.

2.3.3.2 Measuring creditor rights and bank regulation

Creditor rights: This is measured using an index based on Caprio et al. (2007), measuring the degree to which collateral and bankruptcy laws protect lenders' rights. It ranges from 1 to 10, with higher values indicating greater creditor rights. The data is available from the Doing Business project of the World Bank, widely used by scholars (Teixeira et al., 2020; Kalyvas and Mamatzakis, 2017; Safavian and Sharma, 2007).

As discussed earlier, we use three measures of bank regulation – activity restrictions, capital stringency and official supervisory power. These are available from surveys conducted by the World Bank.:

Activity restrictions: It measures whether there are limitations in the ability of banks to engage in securities market activities, insurance activities, real estate activities, and to own nonfinancial firms. The index is a sum of four different indices, and therefore, the overall index value ranges from 4 to 16. A higher value indicates more restrictions on bank activities.

Capital stringency: This is an index of regulatory oversight of bank capital, including indicators for whether the sources of funds that count as regulatory capital can include assets other than cash and government securities and whether authorities verify the source of capital. It also measures capital stringency, whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital adequacy is determined. The index value ranges from 2 to 10; a higher value means greater capital stringency.

Official supervisory power: The index measures the power of the banking sector's supervisory agency. This includes whether the supervisor may meet and demand information from auditors, whether it can force a bank to change its internal organizational structure, supersede shareholders' rights and intervene in a bank. The index value ranges from 5 to 14, and a higher value indicates a greater supervisory power.

2.3.3.3 Control variables

There is considerable evidence that bank-specific characteristics are important determinants of bank risk-taking (Ashraf, 2017; Beltratti and Stulz, 2012; Hoque, 2013). Following the literature, the bank-level controls we use in our model include the volume of deposits, loans, liquid assets, bank size and non-interest income. To shed light on the impact of bank liabilities, we use deposits as the ratio of total deposits to total assets (Anginer et al., 2014). As debated in Gorton (2010), deposit financing is not subject to runs in the presence of deposit insurance, and therefore, banks with more deposits can take more risk. However, a high deposit base can make banks less risky as they can generate high returns with available deposit funds (Demirguc-Kunt and Huizinga, 2010). Second, to capture the asset side of the balance sheet, we use the loans-to-assets ratio following Laeven and Levine (2009). Loans include mortgage loans, consumer or retail loans, commercial loans, and other loans minus losses on impaired and non-performing loans. Loans can minimize bank risk; as Beltratti and Stulz (2012) discussed, banks with more loans probably have lower exposure to off-balance sheet securities such as derivatives and, therefore, have fewer credit-risky securities. However, loans can also have a risk-inducing impact. Banks with higher loans may have attracted customers who have not been given loans by other banks because either they asked for low-interest rates or provided insufficient collateral relative to their credit quality (Foos et al., 2010). Therefore, we would expect either a positive or negative relationship between loans and bank risk.

Further, liquid assets are the ratio of liquid assets to total assets. Banks with more liquid assets can be less risky as they can cope well with any financing difficulties (Altunbas et al., 2012; Beltratti and Stulz, 2012). High liquidity can also encourage banks to perform risky lending activities (Dinger and Kaat, 2020). As a result, the impact of liquid assets on bank risk can be positive or negative. We control bank size using the natural log of banks' total assets. Large banks may take on more risk because of moral hazard issues caused by government guarantees based on the principle of "too big to fail" (Laeven and Levine, 2009). Also, larger banks have greater risk as they are more exposed to events that can adversely affect the market. However, at the same time, implicit government guarantees can make big banks less risky as their financial shocks are usually absorbed by governments (Beltratti and Stulz, 2012). Therefore, we can expect either a positive or negative relationship between bank size and risk.

Lastly, we applied non-interest income as an income diversity indicator (Laeven and Levine, 2009). Non-interest income is measured as the ratio of non-interest income to the total income of a bank. Non-interest income activities are assumed to be uncorrelated or imperfectly correlated with interest income activities (Chiorazzo et al., 2008). As a result, multiple income sources reduce bank risk by diversifying benefits and stabilizing operating income (Lee et al., 2014). Alternatively, diversification achieved through non-interest income activities can increase bank risk in two ways (De Young and Roland, 2001). First, income from lending is more likely to be stable over non-interest income as high information and switching costs prevent customers from terminating their loans. In contrast, switching banks in non-interest activities is more accessible than lending activities. Second, there are no or few capital requirements on non-interest income activities. Earnings volatility may increase because of a high degree of financial leverage. Therefore, we would expect either a positive or a negative relation between non-interest income and bank risk.

A number of country-level governance variables may play an essential role in directing banks' risk-taking behaviour (John et al., 2008; La Porta et al., 1998). To control for governance, we take the arithmetic average of six World Governance Indicators (WGIs) measuring voice and accountability, political stability, regulatory quality, rule of law, government effectiveness and control of corruption following Kaufmann et al. (2009). Higher values of the index indicate better institutional quality of a country, ranging from -2.5 to 2.5. Government quality can influence bank risk-taking in both ways. Banks are more likely to make decisions to maximize shareholder wealth in countries with better supervisory institutions, which means investing in risky projects (Beltratti and Stulz, 2012). On the contrary, better government quality can be a source of low bank risk as it improves transparency and bank governance (Fang et al., 2014). Also, diversification opportunities for banks are more prevalent under a high-quality government as it discourages the diversion of funds by influential stakeholders such as political forces (Ashraf et al., 2017; Bui, 2018). Consequently, we can expect either a positive or negative relationship between government quality and bank risk.

We control for banking concentration by taking the ratio of the assets of the three largest banks to the total assets of the whole banking industry. The impact of bank concentration on risk is mixed. Increased bank concentration can decrease competition and increase profitability, leading to a rise in the bank's franchise value (Barth et al., 2004). Greater franchise values minimize the risk-taking incentives of banks. On the other hand, low bank concentration can increase market competition, encouraging banks to take on higher risk on both the asset and liability sides of their balance sheets (Marcus, 1984). For instance, banks might lend to risky borrowers (poor credit rating) or compete on prices by charging low interest rates on loans to increase their market share (Chen, 2007). Therefore, we can expect either a positive or negative relationship between bank concentration and risk.

We also use two macroeconomic controls. First, the natural logarithm of GDP per capita is applied to control for economic development (Anginer et al., 2013). Countries with low GDP per capita indicate unstable economic environments (Wu et al., 2020). One theoretical view state that banks may follow a "wait and see" strategy as they face the problems of irreversible investment (lending) under uncertain economic conditions (McDonald and Siegal, 1986). As a result, banks may make well-informed decisions that decrease their risk when economic conditions are not stable (Brunnermeier and Sanikov, 2014). On the other side, unstable economic conditions can increase bank risk in two ways. First, the probability of default borrowers increases due to the recessionary effect of poor economic growth (Baum and Wan, 2010). This translates into the collapse of the risk profile of banks. Second, low economic growth is likely to hamper the information asymmetry faced by banks, which can lead to poor lending practices (Calmes and Theoret, 2014). Bank managers may follow herding behaviour, which means they do what others are doing instead of collecting information on their own (Banerjee, 1992). The lending activities based on herding behaviour may increase bank risk if they turn away from the bank's fundamentals. Therefore, we can anticipate the effect of GDP per capita on bank risk in either way.

Second, we control the financial position of a country by using the current account balance divided by GDP, as in Klomp and De Hann (2012). It broadly indicates the cross-border capital flows. It includes the liquidity flowing into the banking sector and capital markets (Samarina and Bezemer, 2016). An enormous inflow of international funds may increase banking risk by increasing the supply of loanable funds, minimizing domestic interest rates and provoking agency issues (Keeton, 1999; Martinez-Miera and Repullo, 2017). Therefore, we can expect a risk-inducing impact of the current account.

2.3.3.4 Summary statistics and correlations

The summary statistics are presented in Table 2.1, which shows the number of observations, mean, standard deviation, and minimum and maximum values for all the sample variables over the years 2004 to 2014. The bank-level variables have a number of observations ranging from 5390 (for price volatility) to 6619 (for bank size). For the dependent variable, price volatility has a mean value of 25.693. Since price volatility reflects the price movement over the year, the higher the volatility, the higher the bank risk and the lower the bank stability. The mean of the log Z-score is 2.715, and the standard deviation is 0.985. These values suggest that there is significant cross-sectional variation in the level of bank risk. A high value of log Z-score indicates less bank risk and high bank stability.

Regarding our main independent variables, the minimum and maximum values of the Creditor right index are 1.8 and 10, with a standard deviation of 2.249. These values indicate that the sample has a wide variety of countries with weak and strong creditor rights. The index values of bank regulatory variables also demonstrate great cross-country diversity. For example, the activity restriction index has countries with low values from 3 to 7 (UK, Spain, Netherlands, Mexico, Hongkong, Ireland, Philippines, Germany, Nigeria, and Belgium) and countries with high values from 13 to 16 (China, Colombia, Indonesia, Thailand, Chile, Taiwan, Pakistan, Ecuador Kenya, Bangladesh, and Venezuela). Similarly, capital stringency and official supervisory power show a wide variety across countries worldwide. The index values of regulatory variables were mostly the same from 2004 to 2008 and have changed a little from 2009 and mainly remained the same from 2009 to 2014. While activity restrictions and official supervisory power indices have improved or dropped globally, the capital stringency index has only improved or remained the same for sample countries.

Further, regarding other accounting-based variables, our statistics are similar to Beltratti and Stulz (2012). The range of deposits is broad, as the lowest value is 17.595%, and the highest value is 93.799%. The range of loans and liquid assets is quite similar to that of deposits. The range of non-interest income is extremely wide as the minimum and maximum values range from 2.081% to 73.695%, respectively.

Also, non-interest income has a mean of 23.455 with a standard deviation of 13.069, which indicates that commercial banks had higher variation in diversification of their source of income. The bank size has a mean value of 16.570, ranging from 11.639 to 22.869. These statistics show that the dataset consists of medium and large banks. Regarding macroeconomic variables, the log of GDP per capita has a mean of 4.146 with a standard deviation of 0.617. While current account ranges from -26.120% to 22.933%, bank concentration has 24.584% and 100% as the lowest and highest values, respectively.

Table 2-1 Descriptive statistics of variables used in the empirical model.

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
Risk-taking variables					
Price volatility	5,390	25.69	8.99	1.37	70.50
Log Z-score	5,681	2.72	0.99	-6.35	5.37
Non-performing loans	5,678	3.90	6.89	0.00	181.76
Main explanatory variables					
Creditor rights	7,656	6.55	2.25	1.80	10.00
Restrict	7,638	10.89	2.42	3.00	16.00
Capital	7,553	6.65	1.80	2.00	10.00
Official	7,638	11.66	2.20	5.00	16.00
Bank-level control variables					
Deposits	6,557	70.29	16.93	17.60	93.80
Loans	6,577	61.73	14.00	13.34	85.86
Liquid assets	5,992	31.59	14.10	7.12	91.43
Non-interest income	6,402	23.46	13.07	2.08	73.70
Bank size	6,619	16.57	1.79	11.64	22.87
Country-level control variables					
Government quality	7,574	0.51	0.74	-1.29	1.63
Log GDP-capita	7,301	4.15	0.62	2.70	5.01
Bank concentration	7,450	49.39	18.12	24.58	100.00
Current account	7,289	-0.58	5.00	-26.12	22.93

We also test for the issue of multicollinearity before we perform data analysis. Table 2.2 presents a correlation analysis between our sample's dependent and independent variables. The highest correlation coefficient is 0.827, which is between loans and liquid assets and between government quality and the log of GDP per capita. These values are within acceptable levels because all correlation coefficients are lower than 0.85.

Table 2-2 Spearman correlation coefficient matrix for dependent and independent variables

Variables	Log Z-score	Price volatility	Creditor rights	Restrict	Capital	Official	Deposits	Loans	Liquid assets	Non-interest income	Bank size	Government quality	Log GDP-capita	Bank concentration	Current account
Log Z-score	1.00														
Price volatility	0.12	1.00													
Creditor rights	0.12	-0.12	1.00												
Restrict	-0.06	0.02	0.04	1.00											
Capital	0.15	0.22	0.08	0.26	1.00										
Official	-0.15	-0.15	0.25	0.22	0.13	1.00									
Deposits	-0.31	-0.18	0.02	0.30	-0.08	0.07	1.00								
Loans	-0.05	-0.12	0.08	0.11	-0.02	0.04	0.12	1.00							
Liquid assets	0.02	0.11	-0.13	-0.10	0.00	-0.11	-0.01	-0.83	1.00						
Non-interest income	0.02	-0.09	-0.04	-0.25	-0.20	-0.08	-0.25	-0.18	0.12	1.00					
Bank size	0.01	0.08	-0.12	-0.24	-0.13	-0.34	-0.32	-0.12	0.14	0.30	1.00				
Government quality	-0.20	-0.44	0.52	-0.22	-0.20	0.10	-0.03	0.10	-0.15	0.09	0.11	1.00			
Log GDP-capita	-0.21	-0.40	0.52	-0.06	-0.06	0.21	-0.02	0.12	-0.19	0.02	-0.01	0.83	1.00		
Bank concentration	0.14	0.06	-0.35	-0.36	-0.24	-0.32	-0.30	-0.01	0.01	0.18	0.33	0.01	-0.17	1.00	
Current account	-0.07	0.04	-0.13	-0.13	-0.38	-0.23	0.20	-0.08	0.12	0.08	0.23	0.02	-0.06	0.36	1.00

2.3.4 Methodology: Fixed Effects

There are two estimation approaches to examining a panel dataset: the fixed and random effects models. The fixed effect approach is used when we want to control for omitted variables that vary between subjects but do not change across time (Baltagi and Baltagi, 2008). However, if the researcher believes there are no omitted variables or the omitted variables are uncorrelated with the independent variables of the model, a random effects approach is suitable. Random effects can produce unbiased results in this scenario. Given that some variables have limited within variation, a random effect may be preferred to a fixed effects estimator. However, if the independent variables and the country-specific effect from the error (μ) are correlated, this will make the random effects estimates inconsistent. Thus, leading to the correct model being fixed effects.

The Hausman test is also usually used to choose between fixed and random effects methods. The Hausman test also detects endogenous variables in a regression model. The test's null hypothesis is that the preferred model is random effects, and therefore, the alternative hypothesis is that fixed effects are the best model. If the Hausman test does not reject the null, then the random effects coefficients are consistent. It tests whether the unique errors are correlated with the explanatory variables. We have performed the Hausman test, and the results are shown in Appendix 3. The p-value is 0, which is less than 0.05 (significant). It means that we reject the null hypothesis that random effect is a preferred model and accept the alternative hypothesis. Therefore, we employ fixed effects over random effects models.

2.4 Empirical results and discussion

Table 2.3 presents the fixed effect estimation results of price volatility against all independent variables in their respective estimation columns. We have performed separate estimations for individual bank regulatory variables: regression 1 for activity restrictions, regression 2 for capital stringency and regression 3 for official supervisory powers. Robust standard errors are used for inference to control for heteroskedasticity and serial correlation. In sensitivity analysis, we clustered the standard errors at the country level, at a higher level of aggregation, but the results did not change (Appendix 4).

2.4.1 Creditor rights

Table 2.3 shows the results of creditor rights against the risk-taking measure of banks. The creditor rights index is estimated in all regressions and presented in estimation numbers 1, 2 and 3. The positive sign of coefficients indicates that stronger creditor rights encourage the risk-taking behaviour of banks. These results are significant at a 1% level through all estimations. The findings are consistent with the findings of Houston et al. (2010) and suggest that stronger creditor rights give lenders the confidence to lend to risky borrowers, as in the case of default, banks will have the power to recuperate their investments through grabbing collaterals. A unit increase in the creditor rights index increases price volatility by a 1 to 1.5-unit increase. The interaction terms of creditor rights with the dummy that captures the financial crisis from 2008 onwards also show a positive impact of creditor rights on risk-taking but significant only with estimation 3. This finding suggests that even after the financial crisis, the banks have not changed their behaviour with respect to creditor rights. They are still taking risks after the crisis with the confidence that if something goes wrong, they will be able to recuperate their investments through, for example, grabbing collateral.

While the literature review discussed studies that showed both the risk-inducing and risk-reducing effects of creditor rights, our results support creditor rights' risk-enhancing effects. Our analysis, which is based on a more extensive dataset and over a longer period, confirms the findings of Houston et al. (2010). Moreover, we also show by interreacting the creditor rights variable with a dummy variable representing the post-crisis period that creditor's rights continued to have a risk-inducing effect even after the crisis. The results support the view of moral hazard issues associated with stronger creditor rights that we have discussed in section 2.2.1. Stronger creditor rights are correlated with increased lending (Djankov et al., 2007). In other words, financial institutions may be willing to lend to a large number of borrowers that also include borrowers with poor credit ratings when they have strong rights to recover. This strategy can escalate the overall default rate in the bank's portfolio.

Table 2-3 Fixed effect regression estimates for banking regulatory measures against price volatility (risk-taking)

The table shows fixed effect regression using panel dataset across 66 countries over the period 2004-2014. Price volatility is the dependent variable which is measured as a stock's average annual price (high and low) from its average price for each year. The main explanatory variables are creditor rights, Activity Restrictions (Restrict), Capital Stringency (Capital) and Official Supervisory Power (Official). Regression 1, 2 and 3 represents estimations for restrict, capital and official respectively. Quality of Government is used to control for the legal environment (Kaufman et al., 2008). Bank level controls used are Deposits, Loans, Liquid Assets, Non-interest Income and bank size. Whereas Log GDP-capita, bank concertation and current account are macro-economic controls. Year_dum is a dummy variable for years 2009 to 2014. CR*Year_dum is interaction between creditor rights and Year_dum whereas BR*Year_dum is interaction between each of the regulatory measure and Year_dum. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

Variables	Price Volatility	Price Volatility	Price Volatility
	(1)	(2)	(3)
Creditor rights (CR)	1.540[a]	1.191[a]	1.313[a]
	(0.263)	(0.261)	(0.252)
CR*Year_dum	0.114	0.229[c]	0.255[c]
	(0.152)	(0.145)	(0.143)
Restrict	0.494[a]		0.243[c]
	(0.146)		(0.130)
Restrict*Crisis_Year_dum	-0.592[a]		
	(0.134)		
Capital		0.998[a]	
		(0.257)	
Capital*Crisis_Year_dum		-0.853[a]	
		(0.207)	
Official			0.243[c]
			(0.130)
Official*Crisis_Year_dum			-0.373[a]
			(0.137)
Government quality	-1.475	-3.521[c]	-1.490
	(1.838)	(1.926)	(1.956)
Deposits	-0.016	0.001	-0.010
	(0.023)	(0.023)	(0.024)
Loans	-0.181[a]	-0.167[a]	-0.161[a]
	(0.045)	(0.048)	(0.047)
Liquid assets	-0.129[a]	-0.110[b]	-0.110[b]
	(0.046)	(0.050)	(0.049)
Non-interest income	-0.017	-0.021	-0.019
	(0.021)	(0.021)	(0.021)
Bank size	-3.376[a]	-3.169[a]	-3.288[a]
	(0.774)	(0.765)	(0.808)
Log GDP-capita	-7.573[a]	-8.525[a]	-8.890[a]
	(2.788)	(2.850)	(2.826)
Bank concentration	0.101[a]	0.089[a]	0.101[a]
	(0.015)	(0.016)	(0.016)
Current account	0.216[a]	0.272[a]	0.195[a]
	(0.053)	(0.062)	(0.056)
Year_dum	10.426[a]	8.382[a]	7.759[a]
	(2.087)	(1.608)	(2.046)

Constant	108.672[a]	110.079[a]	114.306[a]
	(10.236)	(11.172)	(12.012)
Observations	3,909	3,902	3,909
R-squared	0.321	0.327	0.308

2.4.2 Bank regulations

2.4.2.1 Activity restrictions

We now focus on the impact of the three different measures of bank regulation on bank risk-taking. The estimation results for restriction on bank activities, capital stringency and supervisory powers of authorities are given in Columns 1, 2 and 3, respectively of Table 2.3. In Column 1, activity restrictions share a positive relationship with bank risk-taking. One unit increase in activity restrictions leads to an approximately 0.5 unit increase in price volatility of banks. We reject the hypothesis that greater restrictions on bank activities reduce risk-taking in banks. If banks are given liberty (low restrictions), they may participate in high-risk projects due to moral hazard issues (Boyd et al., 1998). However, our results, consistent with the empirical evidence of Laeven and Levine (2009) and Ashraf et al. (2020), indicate that restrictions imposed on bank activities do not necessarily minimise bank risk. One reason is that restrictions on bank activities do not allow banks to diversify their portfolios into securities, insurance, and real estate. Financial institutions might end up having risky investments due to limitations in diversifying their income, which increases banks' overall risk.

2.4.2.2 Capital Stringency Requirements.

The results suggest that capital stringency induces risk-taking in banks. It can be seen in estimation 2 of Table 2.3 that the coefficient of capital stringency is positive and significant. A unit increase in capital stringency increases the price volatility by almost one unit (0.998). We reject our hypotheses that capital stringency minimises bank risk-taking. The magnitude of the capital stringency index is somewhat higher as compared to activity restrictions and official supervisory power indices. Our results are in line with the theoretical view that stringent capital requirements weaken the market discipline, which in turn reduces the quality of the bank's portfolio and, hence, increases bank risk (Boot and Greenbaum, 1993). Additionally, higher capital requirements can minimise bank profits. If bank profits are lower, banks will have a smaller incentive to avoid default (Blum, 1999). Stringent capital requirements can push banks toward regulatory arbitrage, increasing overall risk (Koehn and Santomero, 1980). Lundtofte and Nielsen (2019) document that regulatory costs associated with strict capital requirements increase the asset's portfolio risk of banks by altering the value calculations of bank assets. However, our findings contradict the empirical literature (Ashraf et al., 2020). This difference could be due to the variation in our data periods. While they have employed data from 1998 to 2009, we have used the period 2004-2014.

2.4.2.3 Official supervisory powers

Higher supervisory power is also found to increase bank risk-taking. As shown in estimation 3 of Table 2.3, a one-unit change in the power of supervisors causes almost 0.24 change in price volatility. The magnitudes are lower than the effects of activity restrictions and capital stringency indices on bank risk. We reject the hypothesis that official supervisory powers help in reducing bank risk. The results support the rent-seeking view on supervisory powers, which states that powerful supervisors may force banks to allocate credit to their favourite parties to generate private and political benefits. Given that our data sample includes many banks from less developing and less developed countries, where corruption tends to be more prevalent, our results are probably being influenced by the banks in those countries. Powerful supervisors impair the integrity of bank lending activities. These results also support the agency issues highlighted by Boot and Thakor (1993) and Kane (1990) between taxpayers and bank supervisors, as discussed in section 2.2.1.

Table 2.3 also presents the results of interaction terms. We interacted bank regulatory variables with a year dummy (from 2009 to 2014) to examine the impact of bank regulations in the years after the crisis. According to the preceding discussions, bank regulations have not helped minimise bank risk-taking over the long run (2004-2014). However, the results of interaction terms contrast the earlier findings. We find that activity restrictions, capital stringency and official supervisory power have helped in reducing risk during the 2009 to 2014 period. As shown in estimations 1 to 3, these variables have significant and negative coefficients, which shows that price volatility drops as the strength of regulatory variables increases. Therefore, we cannot reject the hypothesis that bank regulations decrease bank risk after the crisis. There could be two possibilities for the change in bank regulations' impact before and after the crisis. One is that strengthening regulatory measures after the crisis may have encouraged banks to improve their lending standards. Another possibility is that banks may voluntarily become risk-averse after witnessing the adverse effects of high-risk activities during the crisis. It is also possible that regulators, just like risk agencies, were taking it easy and not wholly enforcing the regulations. Then the crisis hit, and suddenly, they started enforcing the regulations seriously.

To summarise, bank regulations are in place to deter banks from taking a lot of risk. The financial crisis of 2008 exemplified the damage bank risk-taking can do to the financial sector and the real economy. It seems, however, that over our entire sample, banking regulations have not served this purpose. What is even more shocking is that they have intensified the risk-taking among banks. These results are consistent with findings in Laeven and Levine (2009) and Ashraf et al. (2020). However, we also extend our work by interacting the banking regulations with the dummy variable for the financial crisis and onward years to show that after the onset of the financial crisis, banking regulations started having more of a desired effect. More specifically, after the onset of the financial crisis, all three banking regulation measures led to a drop in risk-taking by banks. This may be due to the fact that banks become more aware of the dangers of engaging in risky activities. We know some banks become more careful with lending, for example, in the aftermath of the crisis. This more careful approach is also characterised on the global dataset. Such a result has rarely been portrayed in the literature.

2.4.2.4 Control variables:

Table 2.3 also presents the results of control variables. The negative coefficients of government quality (significant only in estimation 2) show that a stronger legal environment promotes less risk-taking in banks. The findings support the view that banks are less likely to accept high and unjustified risk in countries with better government quality (Barth et al., 2009; Voghouei et al., 2011). Regarding bank-level controls, while deposits and non-interest income variables are not significant throughout, loans, liquid assets and bank size variables show risk-reducing impact. The results of loans, liquid assets and bank size are consistent with the existing literature (Beltratti and Stulz, 2012; Saunders et al., 1990).

As for macroeconomic factors, GDP per capita has a negative effect on bank risk-taking. The results imply that banks are less susceptible to risk in countries with higher GDP. Higher coefficient values support the view that a stable economic environment is vital for bank stability. Further, bank concentration and current account variables tend to promote risk-taking behaviour in banks. The results of bank concentration are consistent with Boyd and De Nicolo's (2005) model that less competition attracts moral hazard problems. However, bank concentration does not capture the competition faced by banks from financial institutions outside the banking industry. The current account results align with the fact that the inflow of funds in an economy can cause agency issues.

2.5 Robustness checks:

2.5.1. Robustness test: alternative risk-taking measure (Z-score)

In this section, we perform the robustness analysis of results reported in the previous section. We use alternative measures of bank risk to check the robustness of the results. We employ the natural logarithm of the z-score following Laeven and Levine (2009). A higher log-z (Z-score) means less bank risk, which is the inverse of the bank's insolvency probability (Roy, 1952). Z-score is the distance to default and is measured as the capital asset ratio plus the return on assets (ROA) divided by the standard deviation of asset returns (σROA). The results for the z score are presented in Table 2.4. Regarding our key variables of interest, starting with banking regulations, our results are generally consistent with the estimations presented earlier. That is, stronger banking regulations lead to higher risk-taking. This is particularly visible with the estimations in column 3. When we interact the banking regulations variable with the crisis dummy, once again, we find that bank regulations have led to risk-taking generally after the financial crisis. These effects are evident in columns 1 and 2. With regards to creditor rights, they increased risk over the entire sample, similar to our findings with price volatility. Interestingly, however, when we interact creditor rights with the crisis dummy, the results suggest that stronger creditor rights led to more banking stability after the crisis. This is in contradiction to the findings regarding price volatility. Stronger creditor rights make banks more stable as banks can recuperate any loan defaults through collaterals, and it may be that banks became more cautious after the crisis. Therefore, they were providing loans only to businesses with high-value collateral, which can easily compensate for losses. The differences in results between the Z-score and the price volatility can also be due to the slight difference in the sample size of the Z-score and price volatility and the difference in the specific information each of the variables is capturing.

2.5.2. Robustness test: instrument variable analysis

Our study, similar to many other works in empirical finance, suffers from endogeneity issues, which here arises mainly from potential reverse causality (Barth et al., 2013; Houston et al., 2010). In this case, there is a concern that the relationship between bank risk-taking and banking regulatory measures is likely to be affected by a two-way casual effect. For example, the level of risk-taking by banks might influence the regulations on capital stringency and restrictions on bank activities. Low risk-taking could motivate regulatory agencies to adopt relaxed standards towards their specific circumstances. We have applied instrumental variables approach to deal with this potential endogeneity problem. Following literature, we use legal origin as an instrument variable (Beck 2003; Houston et al., 2010; La Porta et al., 1999). Legal origin is less likely to impact risk-taking of banks directly. Alternatively, it is more likely to influence risk-taking via influencing bank regulations of different institutions.

We test for the validity of instruments by testing the under identification, weak identification and over identification of instrument variable. P-values for under and weak identification tests were below 0.1 which the null hypothesis of under and weak identification. The p-value for over-identification is above 0.1 which accepts the null hypothesis that the instrument variable is exogenous. We also check for endogeneity by performing Durbin and Wu-Hausman tests. The p-values are less than 0.1 which indicates that our instrument variable is valid. The results are presented in Appendix 4a. In all the estimations, our main results are robust.

2.5.3. Other robustness tests

We perform another set of robustness checks by removing the dominant country from the sample. As the US banks dominate our sample, they may be driving our results. When omitting US banks from the sample, the results remain unchanged and are presented in Appendix 4. As a further robustness test, in Appendix 4, we cluster the standard errors at the country level, and once more, the results remain unchanged.

Further robustness checks involve running separate regressions for the creditor rights and banking regulations. The results are reported in Appendices 5 and 6 and suggest that that our results remain qualitatively unchanged.

The final robustness check involves considering the post-crisis period to start in 2010 instead of 2009. The results are presented in Appendix 7. Once again, the results remain qualitatively the same.

Table 2-4 Robustness tests: Fixed effect regression estimates for banking regulatory measures against log Z-score (risk-taking measures)

The table shows fixed effect regression using panel dataset across 66 countries over the period 2004-2014. Z-score is distance to default which is measured as (ROA+CAR)/σ(ROA. The main explanatory variables are creditor rights, Activity Restrictions (Restrict), Capital Stringency (Capital) and Official Supervisory Power (Official). Regression 1, 2 and 3 represents estimations for restrict, capital and official respectively. Quality of Government is used to control for the legal environment (Kaufman et al., 2008). Bank level controls used are Deposits, Loans, Liquid Assets, Non-interest Income and bank size. Whereas Log GDP-capita, bank concertation and current account are macro-economic controls. Year_dum is a dummy variable for years 2009 to 2014. CR*Year_dum is interaction between creditor rights and Year_dum whereas BR*Year_dum is interaction between each of the regulatory measure and Year_dum. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

Variables	Log Z-score	Log Z-score	Log Z-score
	(1)	(2)	(3)
Creditor rights (CR)	-0.022[b]	-0.014[c]	-0.010
	(0.010)	(0.010)	(0.010)
CR*Year_dum	0.020[a]	0.019[a]	0.020[a]
	(0.007)	(0.006)	(0.006)
Restrict	-0.001		
	(0.006)		
Restrict*Crisis_Year_dum	0.008[c]		
	(0.005)		
Capital		0.001	
		(0.009)	
Capital*Crisis_Year_dum		0.014[c]	
		(0.008)	
Official			-0.009[c]
			(0.006)
Official*Crisis_Year_dum			-0.005
			(0.006)
Government quality	0.074	0.099	0.067
	(0.096)	(0.099)	(0.095)
Deposits	-0.006[a]	-0.006[a]	-0.006[a]
	(0.002)	(0.002)	(0.002)
Loans	-0.000	-0.001	-0.001
	(0.002)	(0.003)	(0.002)
Liquid assets	-0.003	-0.003	-0.003

	(0.002)	(0.002)	(0.002)
Non-interest income	-0.000	0.000	-0.000
	(0.001)	(0.001)	(0.001)
Bank size	-0.110[a]	-0.109[a]	-0.118[a]
	(0.034)	(0.034)	(0.034)
Log GDP-capita	0.582[a]	0.551[a]	0.562[a]
	(0.130)	(0.132)	(0.131)
Bank concentration	-0.002[b]	-0.002[a]	-0.001[b]
	(0.001)	(0.001)	(0.001)
Current account	0.001	0.002	0.002
	(0.003)	(0.003)	(0.003)
Year_dum	-0.191[a]	-0.190[a]	-0.042
	(0.074)	(0.071)	(0.089)
Constant	2.822[a]	2.937[a]	3.087[a]
	(0.453)	(0.461)	(0.441)
Observations	4,400	4,378	4,400
R-squared	0.047	0.049	0.048

2.6 Conclusion and recommendations

This chapter examines the impact of creditor rights and bank regulation on bank risk-taking. We empirically test the relationship between these variables and bank risk by using a sample of 696 commercial banks worldwide from 2004 to 2014. We also examine if the effect of creditor rights and bank regulation on bank risk is any different after the global crisis period, as banks across the world faced severe crises during the global financial crisis. The after-crisis effect is determined using the interaction terms between regulatory variables and dummy variables of years from 2009 to 2014. This is our main contribution, as we are not aware of any studies that have considered post-crisis effects of regulatory variables and creditor rights on bank risk-taking.

Theoretically, there are contrasting views on the impact of creditor rights and bank regulation on the risk-taking behaviour of banks (Acharya et al., 2011; Barth et al., 2004, 2013), which existing studies have confirmed empirically (Agoraki et al., 2011; Houston et al., 2010; Laeven and Levine, 2009). When using a fixed effects estimator, we find that both creditor rights and bank regulatory variables such as activity restrictions, capital stringency and official supervisory powers induce risk-taking in banks. These findings are consistent with the existing literature (Beck et al., 2006; Caprio et al., 2014; Houston et al., 2010). However, after interacting our variables with the crisis dummy, it would appear that banking regulations helped in reducing bank risk after the global financial crisis. This result indicates that strict regulations after the crisis might have encouraged banks to become more stringent in terms of lending (Aiyar et al., 2015). Similarly, based on the findings from the Z score, it would seem that stronger creditor rights led to banks becoming more prudent after the crisis.

In terms of broad implications, these findings raise concern over the effectiveness of bank regulations as bank reform policies encourage excessive reliance on countries following these regulations. Instead, we do not find any support that creditor rights and bank regulations help in minimizing the bank risk-taking activities over the 2004 to 2010 period. However, our results show that banking regulations appear to have disciplined the risk-taking behaviour of banks after the financial crisis. We do not suggest that bank regulations are unnecessary, but these are also insufficient to manage bank risk. However, tightening regulatory variables has helped reduce risk after the crisis.

Chapter 3 Institutional environment and bank risk-taking

3.1 Introduction

The global financial crisis (GFC) impacted the financial system globally, but the magnitude of the negative consequences of the crisis was different for different countries. This highlights the cross-country variation in the risk-taking practices of banking institutions. Academics and lawmakers suggest that variation in the legal and institutional environment is the principal cause of this cross-country risk-taking behaviour by banking institutions (Houston et al., 2010).

Extensive research has been performed to analyse the impact of institutional quality on economic growth and financial development (Henisz, 2000; Heckelman and Powell, 2010; La Porta et al., 1997, 1998; Roe and Siegel, 2011). They establish that a stable institutional environment promotes higher economic growth and is an important determinant of the financial development of a country. Some research has also been conducted on the impact of the institutional environment on bank activities, such as banking performance and capital ratios (Alraheb et al., 2019). The quality of the institutional environment of the banking sector has also been found to be an important determinant of bank risk-taking (Chen et al., 2015; Godlewski, 2006; Uddin et al., 2020; Fang et al., 2014; Toader et al., 2018). The existing studies, however, primarily focus on emerging nations and generally provide mixed findings about the impact of institutional quality on bank risk-taking.

In the previous chapter, which focused on the impact of creditor rights and banking regulation on bank risk-taking, we also used the institutional environment, measured by the World Governance Indicator (WGI), as one of the control variables. Our results showed that they share a negative relationship with risk-taking. In other words, good institutional quality helps in minimising risk-taking in banks. The variable institutional environment employed in most studies is an aggregate of various components of institutional features – a practice that we also followed in the previous chapter. However, the institutional environment variable contains different components, which are: (i) Voice and Accountability (V&A), (ii) Political Stability (PS), (iii) Regulatory Quality (RQ), (iv) Government Effectiveness (GE), (v) Rule of Law (RL) and (vi) Control of Corruption (CC). Although these different measures all relate to the institutional context of a country, they measure different things as suggested by their names[3]. It is conceivable that a country is politically stable, but the level of corruption may be extremely high. In such a context, the aggregate measure of the institutional environment may hide the effects of the less dominant component. It then becomes crucial that the individual effects of each component of the institutional environment are studied in depth so that we understand how they individually can influence banks' risk-taking behaviour. This is essentially where the main contribution of this chapter lies.

A handful of studies have investigated the impact of the individual components of the institutional environment variable on risk-taking. Most of them have been conducted for specific regions or countries; for example, Boudriga et al. (2010) for MENA regions, Uddin et al. 2020 for emerging economies, Barbu and Boitan (2020) for EU countries and Zhou (2018) for China. Only Houston et al. 2010 and Bui and Bui (2019) conducted their studies using a global sample. What is clear from all these studies is that not all individual institutional components affect bank risk-taking in the same manner. Moreover, the effect of a particular component of the institutional environment is not the same across all regions or countries. For example, while Boudriga et al. (2010) find that Control of Corruption reduces risk-taking by banks in the MENA region, Toader et al. (2018) find that Control of Corruption increases the risk-taking behaviour of commercial banks in Central and Eastern Europe. The differences in the findings between the studies can be explained by three main factors: (i) sample of countries, (ii) time period employed and (iii) econometric

[3] The detailed descriptions of the six components are provided in section 2.3.

methodology. We intend to contribute to the discussions in the literature by taking these factors into account. In particular,

(i) We intend to conduct our estimation on a global sample as opposed to most studies in the literature, which have been conducted for specific regions or economies. The rationale is that banks were adversely affected during the financial crisis across the globe. Therefore, it is essential to understand the risk factors as well as the role of institutions on a global scale. As mentioned earlier, there are only two such studies: a) Houston et al. 2010 conducted their study based on data from 69 countries, and b) Bui and Bui (2019) conducted their study based on 58 countries, both of which found very contrasting results. Therefore, because of the scant literature, we intend to contribute to this debate by employing a dataset that covers 66 countries. This selection is due to the availability of the data on Bankscope[4].

(ii) The time period could potentially explain some of the differences between Houston et al. (2010) and Bui and Bui (2019). Houston et al. (2010) conducted their study from 2000 to 2007, while Bui and Bui (2019) conducted their study from 2000 to 2014. The sample in Bui and Bui (2019) is longer, encompassing the 2007/8 financial crisis episode. Thus, the longer sample and the financial crisis may have had an impact on their results. We contribute to this discussion by employing data from 2004 to 2014. Once again, this selection is due to data availability on Bankscope.

Therefore, given the discussion in (i) and (ii), the countries in our sample are almost similar to Houston et al. (2010), but it is over a longer period. Bui and Bui (2019) have a slightly longer period than ours, but ours contains more countries than their group of countries. These countries are Slovakia, Sri Lanka, Taiwan, Togo, Tunisia, Turkey, Vietnam, and Zimbabwe. Many of these countries are significant for a global sample while studying bank risk-taking behaviour.

[4] We use the sample of commercial banks across 66 countries. See section 3 for more details about the sample.

For example, over the last two decades, Vietnam has become one of Asia's fastest-growing economies, with an average GDP growth of 7.2% (The World Bank, 2022). Bank assets have grown from 15.14% in 1992 to 50% in 2004 and 115% in 2014 (The Global Economy, 2023) and acted as a great source of economic capital. The banking industry has developed robustly and played an essential part in connecting savings, production, and consumption. The scrutiny of bank risk-taking behaviour becomes more crucial when the banking system develops rapidly. Similarly, Turkey is one of the wealthiest and largest economies in Asia. Turkey has witnessed high growth rates from 2002 to 2017 (The World Bank, 2022). Since banks in Turkey offered attractive investment opportunities for investors with equity returns of more than 15-20% in 2003-2006, Turkey's loans to GDP ratio increased from 15% to almost 30%. Turkish banks, from 2006 onwards, have also seen a constant increase in the size of their assets (Partovi and Matousek, 2019). Turkey forms an important part of our global sample because of the strong economy and growth in the banking sector. Further to these two countries, Taiwan may have performed poorly over the last two decades, but it is an integral part of the world's economy. It is the 16th largest importer and exporter of merchandise in 2021 (WTO, 2021) and the top player in the world's technology industry. Slovakia became part of the European Union and NATO in 2004 and the Eurozone in 2009, which makes it an important part of the global sample to study bank risk-taking. Because of the presence of these significant and additional countries, our sample would potentially yield more informative findings relating to bank risk-taking in comparison to the sample of Bui and Bui (2019).

(iii) In terms of econometric methodology, Houston et al. (2010) use the Ordinary Least Square (OLS) method in the estimations, while Bui and Bui (2019) used a Generalized Least Square (GLS) method. The different methodologies may also have impacted the results. We intend to contribute to the literature by employing more advanced and better econometric techniques that have been employed in these studies. In particular, in contrast to OLS and Feasible Generalised

Least Squares (FGLS), we intend to use fixed effects models and the two-step system Generalised Methods of Moments (GMM). Fixed effects models are a more advanced version of OLS models as they allow for differences due to the effects of time and individual countries (Wooldridge, 2002, 2010). At the same time, OLS does not distinguish between different periods and cross-sections in a panel model (Baltagi and Baltagi, 2008). OLS can only be employed when we have different samples for every year or time unit (Semykina and Woolridge, 2010). Therefore, OLS is not a suitable model to analyse our panel dataset. Also, the fixed effect model controls for unobserved heterogeneity (any unobserved factors that can affect bank risk-taking), which OLS cannot. Therefore, our fixed effect model significantly improved over the OLS model used by Houston et al. (2010).

Compared to OLS, FGLS is better at tackling the issues of heteroskedasticity cross-sectional and serial correlation issues in a panel model (Davidson and MacKinnon, 1993). However, it is generally challenging to depict statistical inferences from estimations of the FGLS model for the following reasons (Amemiya, 1985). First, the GLS estimator is usually unavailable. When it is available, it is available at the expense of more conditions. FGLS perform very badly if these conditions are not correctly imposed. Therefore, it is difficult to find whether or not the FGLS estimator is biased.

We finally use the GMM model, which is better than all OLS, FGLS and fixed effects models. First, the GMM model helps with controlling for the potential persistence of bank risk by using the lag of the dependent variable. The persistence of bank risk is well documented in the literature (Delis and Kouretas, 2011). Second, system GMM helps tackle the potential endogeneity of bank risk-taking with bank-specific factors, banking industry factors and bank regulations. It allows using some of the explanatory variables as endogenous variables and some as instrument variables (Roodman, 2006). In other words, it not only uses the listed instrument variables but also attaches the lag of endogenous explanatory variables. As a result, endogenous variables become predetermined and will be uncorrelated with the error term. Also, the GMM model controls for any unobserved heterogeneity that exists between banks. This unobserved effect is difficult to measure correctly. GMM model produces a system of two equations (two-step system); one is an original equation, and the second one is the transformed equation. Therefore, more instruments are generated, improving the model's efficiency. The results from fixed effects and GMM models are compared in section 5.2.1.

In summary, therefore, our third contribution to the literature is by using two methodologies (fixed effects and GMM), which are better than the methodologies used by Houston et al. (2010) and Bui and Bui (2019).

(iv) We also contribute by analysing further why the six components of the institutional environment variable (WGI) have shown varying impacts of bank risk-taking. In line with existing literature, we find the risk-inducing effect of PS (Ashraf, 2017; Bui and Bui, 2019) and the risk-reducing impact of other components of the WGIs. However, the existing studies have yet to explore the reason behind the contrary effect of PS on bank risk-taking. Based on major economic events that happened during our sample period, such as the global financial crisis and its connection with the US, we employed various subsamples of countries and different periods as a means to get further insights into the relationship between components of WGI and bank risk-taking.

As a preview of our results, using the two methodologies, FE and two-step system GMM, we find that V&A, GE, RQ, RL and CC help mitigate banks' risk-taking behaviour. However, regarding PS, higher political stability induces risk-taking in banks. Our findings are in line with the results of Ashraf (2017) and Bui and Bui (2019). We also dig into which factors are driving the risk-inducing impact of PS, and we find that the US banks during the global financial crisis period and European banks during the 2009-2014 period are driving the risk-inducing impact of PS.

This work contributes to the literature by (i) looking at the individual components of the WGIs, (ii) using a richer dataset and more advanced econometric techniques. These results generally show the risk-mitigating effect of individual WGIs and highlight the need to look at the individual components of the WGIs on which there is very minimal work in the literature. The dynamic relationship between bank risk-taking the components of the WGIs has also been largely ignored in the literature. The work here highlights that policies could potentially be wrongly devised if the dynamic nature is not taken into account. The work here also suggests that the relationship between WGIs and bank risk taking can vary significantly from country to country and therefore it is imperative every country investigates their individual bank risk-taking and WGIs relationship before designing policies.

The remainder of the chapter is organised in the following way. The upcoming section presents the literature review and hypothesis development. The following two sections discuss data, variables, empirical model, and methodology in detail. Section 5 presents and discusses the empirical findings. Robustness checks and the conclusion section at the end follow it.

3.2 Literature review and hypothesis development

The Law and finance literature has established that legal rules such as investor protection, creditor rights and the quality of their enforcement significantly influence the financial development of a country (La Porta et al., 1997, 1998). They clearly show that countries with weaker rights and poor quality of law enforcement have smaller and narrower capital markets. Despite the primary focus of the literature on the significance of the legal environment, the institutional environment is equally important for the performance of the financial market. The institutional environment is composed of customs, regulations, and accepted norms widespread in societies, organizations and countries and shape organizational behaviour and practices (Swaminathan and Wade, 2016). In other words, the institutional environment presents the customs, traditions and institutions that determine how a country's power and authority are exercised (Kaufmann et al., 2000). This consists of:

a) how governments are elected, monitored, and replaced.

b) the extent to which governments can manage their resources effectively formulate, enforce, and monitor sound policies.

c) the respect of citizens and institutions that control social and economic interactions.

Generally, studies on institutional environment use the Worldwide Governance Indicators (WGIs) provided by the World Bank, which also makes the six components of the WGI available. As noted earlier, these are Voice and Accountability (V&A), Political Stability (PS), Government Effectiveness (GE), Regulatory Quality (RQ), Rule of Law (RL), and Control of Corruption (CC). We will employ these measures in this current study.

The literature suggests that a stable political system (Bordo and Rousseau, 2006; Voghouei et al., 2011), the existence of corruption (Aidt, 2009) and the rule of law (Boudriga et al., 2010) determine the degree of financial development of a country. Subsequently, institutional quality also matters for the banking stability of a nation. Some literature has considered how bank risk-taking, and performance are determined by the quality of country-level governance (Beltratti and Stulz, 2012; Fang et al., 2014). The literature on the institutional environment and banking sector, in general, is briefly discussed below, followed by a more in-depth discussion on the institutional environment and bank risk-taking.

3.2.1 Institutional factors and banking activities

The institutional environment is vital in determining the cross-country differences in bank activities such as bank capital, bank deposit, and bank performance (Beltratti and Stulz, 2012). Qian et al. (2018) investigated the impact of the institutional environment on bank loans in 25 developing countries. They employ investor protection, law enforcement, trust, and religion as representatives of the institutional environment. They find that the institutional environment significantly impacts bank loans. Alraheb et al. (2019) studied the relationship between institutional environment and bank capital ratios using a sample of 160 banks in the MENA countries. They find that banks hold higher risk-weighted regulatory capital ratios in countries with higher political stability and appear to be safer than banks in countries with poor political stability. Nguyen (2022) explored the relationship between institutional quality and bank deposit ratios in European countries. The study found that institutional quality, especially the rule of law, strengthens bank deposit growth.

3.2.2 Institutional environment and bank risk-taking

However, our primary focus in this chapter is on the effects of the institutional environment on banking stability/ bank risk-taking. In this regard, there is reasonably comprehensive literature. Fang et al. (2014) studied the impact of institutional quality reforms on bank stability in transition economies. They find that banks tend to have reduced non-performing loans and lower return on asset (ROA) volatility when institutional quality is improved. Klomp and De Haan (2012) examine banks from 21 OECD countries and find that better institutional quality helps minimise banks' capital-assets risk and liquidity-market risk. Further, the literature suggests that countries where institutions support efficient supervision and information availability absorb financial shocks better and encourage banking stability (Anginer and Demirguc-Kunt, 2014; Barlevy and Veronesi, 2003).

3.2.3 Individual components of institutional environment and bank risk-taking

As mentioned in the introduction, the institutional environment, measured by the WGI, consists of 6 components. In the first instance, we will describe those components and discuss how each of these factors can be expected to influence bank risk-taking and subsequently build our hypotheses.

3.2.3.1 Voice and Accountability

Voice and Accountability (V&A) is an index that measures the extent to which a country's citizens can participate in selecting their government, as well as freedom of expression, freedom of association, and free media. Theoretically, a free press can lower information asymmetry issues in a country (Brunetti and Weder, 2003). A higher level of information accessibility can impact bank risk-taking in two alternative ways. On the one side, an increased flow of information can reduce the cost of credit for banks, such as an adverse selection, reducing the risk to the overall banking industry (Delis et al., 2020). On the other hand, greater transparency regarding financial imbalances and accompanying risks can influence the associated stakeholders, such as bank depositors. It can discourage them from trusting the banking sector and, hence, increases banks' overall risk by increasing the likelihood of withdrawing bank deposits (Goldstein, 2022).

The empirical evidence regarding the impact of V&A on bank risk-taking is mixed. Using the global sample, Bui and Bui (2019) find the risk-reducing effect of V&A. Similarly, Boudriga et al. (2010) find that V&A reduces non-performing loans for the MENA region, while Uddin et al. (2020) find that V&A

encourages bank risk in their study on emerging countries. Houston et al. (2010), using a global sample, however, do not find any significant impact of V&A on bank risk-taking. Therefore, based on these arguments, we set the following hypotheses:

H1a. Greater voice and accountability can decrease bank risk.

H1b. Greater voice and accountability can increase bank risk.

3.2.3.2 Political stability

Political stability (PS) is the perception of the likelihood that the government will be destabilized or overthrown by unconstitutional or violent means, including political violence and terrorism. In theory, political stability can influence bank risk in two opposing ways. It can increase bank risk in two ways. First, governments of stable political economies ensure financial stability using various tools such as deposit insurance. Banks are likely to take more risk when they are aware that their risks will get transferred to governments and taxpayers due to moral hazard issues (Demirgüc-Kunt and Detragiache, 2002). Second, higher political stability can increase bank risk by promoting competition in the credit market. A stable political system attracts a higher level of investment, and hence, the availability of cheap financing options increases the competition in the credit market (Boubakri et al., 2014). Increased competition would induce banks to charge lower interest rates for loans and decrease their market share. As a result, banks extend loans to risky borrowers to increase their market share and compensate for reduced interest margins. This, in turn, increases the overall risk of banks. Ashraf (2017), in their study on an international sample of banks, finds that sound political institutions encourage bank risk-taking. Zhou (2018) also finds that political stability increases risk-weighted assets in commercial banks in China. Bui and Bui (2019) also find the risk-inducing impact of political stability in their global sample.

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However, political stability can decrease bank risk by preventing government expropriation. Government expropriation in banks can occur in various ways (Brown and Dinc, 2005). For instance, powerful politicians may grant licenses to their favoured parties, force banks to sanction loans to parties of their interests, seek bribes to approve financial contracts, and many more. The expropriation risk and its negative consequences on banks is expected to be lower in politically stable countries. This would help in minimizing the default loans and financial inefficiencies of banks. Due to moral hazard, Cheng et al. (2018) find that banks with political connections are more likely to take additional risks in weak political economies. In their study on MENA countries, Ghenimi et al. (2017) find that political instability contributes to bank instability. Barbu and Boitan (2020) find that political stability reduces bank risk in EU countries. The studies of Houston et al. (2010) (international sample) and Uddin et al. (2020) (emerging countries sample), however, do not find any significant impact of political stability on bank risk-taking.

Therefore, we set the following hypothesis:

H2a. Greater political stability can decrease bank risk.

H2b. Greater political stability can increase bank risk.

3.2.3.3 Government Effectiveness

Government Effectiveness (GE) is an index that measures the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies. Government effectiveness is crucial as inefficient governments can take advantage of their leading role in various phases of risk governance such as decision-making, setting legislation and implementing policies (Zuo et al., 2017). Countries can effectively respond to risks and take action if their governments formulate sound policies and implement them efficiently. Panayides et al. (2015) state that governments embrace proactive and effective managerial behaviours and practices to induce better performance in different industries under strong government effectiveness. However, the empirical results are mixed. Houston et al. (2010) find an insignificant impact of GE on bank risk-taking, but Bui and Bui (2019) see the risk-reducing impact. Both studies mentioned above used a global sample. Regarding emerging countries, Uddin et al. (2020) find that government effectiveness combats excessive risk-taking in banks. Chen (2009) (in African countries) also reveals that countries with efficient governments have more efficient banking industries. In contrast, Zhou (2018) finds that an increase in government effectiveness increases the default risk of banks in China. They argue that improvement in government service may promote competition in banks, and as a result, increased competition fluctuates the rate of return on banks' assets. On the basis of these arguments, we set the following hypothesis:

H3a. Greater government effectiveness can decrease bank risk.

H3b. Greater government effectiveness can increase bank risk.

3.2.3.4 Regulatory Quality

Regulatory Quality (RQ) is an index that measures the ability of the government to formulate and implement sound policies and regulations that permit and promote market competition and private-sector development. Theoretically, regulatory quality should minimize the bank risk as an increase in supervision quality allows governments to regulate the market better and implement policies that can combat the hazardous investment of banks. Supporting the theory, Kim et al. (2014) put forward that higher regulatory quality curbs the risk-taking effect of deposit insurance by reducing moral hazard. The study is based on 10 ASEAN member countries and Korea. Houston et al. (2010) also find the risk-reducing impact of RQ by using the global sample. Barbu and Boitan (2020) find the risk-reducing effects of RQ in their study of banks in the EU. Boudriga et al. (2010) find that RQ reduces risk-taking by banks in the MENA region. Zhou (2018) finds RQ reduces the holdings of risk-weighted assets by Chinese commercial banks. Bui and Bui (2019) and

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Uddin et al. 2020, however, do not find any significant impact of RQ on bank risk-taking. Therefore, we set the following hypothesis:

H4a. Greater regulatory quality can decrease bank risk.

3.2.3.5 Rule of Law

Rule of Law is an index that measures the extent to which agents have confidence in and abide by the rules of society, particularly the quality of contract enforcement, the police, and the courts, as well as the likelihood of crime and violence. A better rule of law can promote accountability in a bank's behaviour since it prevents the escaping banks from the consequences of unwise decisions. Such impact encourages banks to do responsible lending and, hence, combat the excessive risk-taking by banks. Additionally, improving the quality of contract enforcement, police, court, and property rights promotes bank stability by attracting investors' funds (Bui and Bui, 2019). Using the international sample, Houston et al. (2010) and Bui and Bui (2019) do not find any relationship between rule of law and bank risk-taking. Zhou (2018) also does not find any significant impact of RL on the risk-taking behaviour of Chinese commercial banks. Godlewski (2006) investigated the role of the rule of law in determining the credit risk-taking of banks in emerging countries. The study concludes that the rule of law may help reduce banks' risk-taking incentives. Uddin et al. (2020) find that RL reduces bank risk-taking in emerging economies. Similarly, Boudriga et al. (2010) find the risk-reducing impact of RL on banks in MENA regions. Therefore, we set the following hypothesis:

H5a. Greater rule of law can decrease bank risk.

3.2.3.6 Control of Corruption (CC)

The indicator Control of Corruption measures the extent to which the policies are applied to control corruption in a country. Corruption is defined as the extent to which public power is exercised for private gain, including petty and grand forms of corruption and ‘‘capture’’ of the state by elites and private interests. Higher values of Control of Corruption indicate better control over corruption. In theory, corruption can impact bank risk-taking in different ways. On the one hand, corruption elevates the cost of lending, which can result in a decrease in lending and an increase in the likelihood of borrower defaults. Corruption can lead to misallocation of resources from genuine projects to poor ones. As a result, it can increase bank risk. Supporting this theory, Khwaja and Mian (2005) document that corporations with political connections acquire a large number of bank loans but result in higher defaults. Other cross-country studies find that countries with severe corruption have higher non-performing loans (Park, 2012) and suffer from a drop in the growth of lending by banks (Detragiache et al., 2008). Laeven and Valencia (2013) find that banking crises are more prevalent in countries with severe levels of corruption. This finding proposes that control of corruption may reduce bank fragility and prevent turmoil in the banking sector. Houston et al. (2010) and Bui and Bui (2019) find the risk-reducing impact of CC. Barbu and Boitan (2020) find that CC reduces risk-taking by banks in the European Union. Boudriga et al. (2010) find risk-reducing effects on banks in the MENA region. Goel and Hasan (2011) associate greater corruption with more bad loans by using the international sample of commercial banks. Uddin et al. (2020) find that CC reduces bank risk-taking in emerging economies. Chen et al. (2015) examines the relationship between corruption and bank risk-taking in emerging countries and find that higher levels of corruption induce risk-taking behaviour in banks.

However, corruption can also decrease bank risk. A few empirical studies support that the presence of corruption promotes resource allocation efficiency (Leff, 1964; Acemoglu and Verdier, 2000). For example, bribers can save time costs by moving ahead of slow-serving public service (Lui, 1996) or giving contracts to the highest bidder in return for bribes by executives when only a big party can offer the enormous bribe (Beck and Maher, 1986). Highly efficient and productive firms can offer higher bribes and receive more bank loans. This way, large or politically connected banks can decrease their risk. Zhou (2018), in his study based on Chinese commercial banks, finds that corruption control promotes the holdings of risk-weighted assets. Toader et al. (2018) find that corruption helps mitigate the risk-taking behaviour of commercial banks in Central and Eastern Europe.

Based on arguments mentioned above, we set the following hypothesis:

H6a. Greater control of corruption can decrease bank risk.

H6b. Greater control of corruption can increase bank risk.

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3.3 Data and Variables

3.3.1 Data

We are evaluating the relationship between the institutional environment and bank risk-taking by employing a bank sample across the globe from BankScope (Houston et al., 2010; Laeven and Levine, 2009). We limited our selection to commercial and publicly traded banks due to their significance to economies. Our period is from 2004 to 2014. BankScope provides access to all consolidated, unconsolidated data of banks, but we restricted only to banks with unconsolidated statements to eliminate any duplicates in the sample. We also exclude any subsidiaries from our sample. Our final sample consists of 696 deposit-taking and loan-making across 66 countries from across the globe. The list of countries is shown in Table 3.1. Our panel dataset is unbalanced in nature. To avoid bias of results by outliers, we have winsorised the bank-level variables at 1% and 99%. Regarding data sources, we retrieve our bank-level data from Bankscope (Houston et al., 2010; Laeven and Levine, 2009). Other country-level variables, such as macroeconomic and banking regulation data, are employed from the World Bank Database[5]. Finally, World Governance Indicators (WGI) data are used from the World WGI database[6].

[5] The regulation and macroeconomic data is accessed from https://datacatalog.worldbank.org/search/dataset/0038632/Bank-Regulation-and-Supervision-Survey and https://databank.worldbank.org/source/worldwide-governance-indicators.

[6] The data on WGIs is accessed from https://datacatalog.worldbank.org/search/dataset/0038026/Worldwide-Governance-Indicators.

Table 3-1 List of Countries with number of banks used in the sample.

S no.	Country	Number of banks	S no.	Country	Number of banks
1	Argentina	5	34	Morocco	5
2	Australia	12	35	Namibia	2
3	Bangladesh	16	36	Netherlands	4
4	Belgium	3	37	Nigeria	10
5	Botswana	3	38	North Macedonia	1
6	Brazil	13	39	Norway	2
7	Canada	13	40	Pakistan	12
8	Chile	7	41	Panama	1
9	China	27	42	Peru	5
10	Columbia	7	43	Philippines	10
11	Costa Rica	1	44	Poland	9
12	Croatia	1	45	Portugal	1
13	Czech Republic	1	46	Romania	2
14	Denmark	9	47	Russia	10
15	Ecuador	3	48	Singapore	4
16	Egypt	6	49	Slovakia	3
17	Finland	3	50	South Africa	5
18	France	4	51	South Korea	5
19	Germany	3	52	Spain	6
20	Greece	5	53	Sri Lanka	4
21	Hongkong	6	54	Sweden	3
22	India	33	55	Switzerland	6
23	Indonesia	19	56	Taiwan	25
24	Ireland	3	57	Thailand	10
25	Israel	7	58	Togo	1
26	Italy	15	59	Tunisia	8
27	Japan	73	60	Turkey	12
28	Jordan	9	61	Ukraine	3
29	Kazakhstan	5	62	United Kingdom	7
30	Kenya	1	63	United States	176
31	Lebanon	5	64	Venezuela	4
32	Malaysia	10	65	Vietnam	7
33	Mexico	4	66	Zimbabwe	1

3.3.2 Measuring bank risk-taking

Risk-taking can be measured in different ways. For example, the Log of Z-score is used by Beltratti and Stulz (2010), Laeven and Levine (2009), and Barth et al. (2004). Fernández and Gonzalez (2005) employed non-performing loans to gross loans. Mohsni and Otchere (2018) use ROA volatility and Return on Equity (ROE) volatility. Following Gropp and Heider (2005) and Huang et al. (2018), price volatility is our primary risk-taking measure. It is measured as the deviation in the annual share price of banks from the average price for each year. Volatility here is referred to as how quickly the prices of stock move. High volatility in stock prices implies potential losses and increased risk. Therefore, a high price volatility value indicates a bank's high risk-taking and vice-versa. The main advantage of using price volatility over other risk-taking measures is it removes any potential manipulation that may arise by reporting false accounting figures by banks. Finally, we employ frequently used risk-taking measures in literature (Laeven and Levine, 2009; Baselga-Pascual et al., 2015), log Z-score as an alternative measure in the robustness section. Z-score measures the bank's probability of insolvency (Roy, 1952). It is calculated as follows:

$$Z - score = \frac{Return\ on\ assets\ (ROA) + Equity\ to\ total\ assets\ ratio}{standard\ deviation\ of\ ROA}$$

Therefore, a higher value of Z-score presents that a bank is farther from insolvency or default and, thus, represents more stability. As Z-Score is highly skewed, the natural log form of Z-score is used.

3.3.3 Measuring banking industry controls

In addition to using components of WGIs (institutional environment measure), several explanatory variables relating to (i) banking industry control, (ii) bank-specific control, and (iii) macroeconomic controls will be employed. We now discuss the specific variables in each category, starting with banking industry controls.

We control for banking regulation by using the capital stringency index. In the previous chapter, we investigated the impact of three regulatory measures - activity restriction, capital stringency and official supervisory powers – on bank risk-taking and found a similar effect. Therefore, here, we are using capital stringency to represent banking regulations. Capital stringency requirements can mitigate bank risk as they can act as a cushion against financial losses (Mehran and Thakor, 2011). At the same time, strict capital requirements increase the portfolio risk of banks by limiting their investment opportunities. They impair the bank's lending capacity. Therefore, the capital stringency index can potentially increase as well as decrease bank risk-taking.

We control the banking industry competition by using bank concentration. It is the ratio of the total assets of the three largest industry banks to the total assets of the entire banking industry in a country. A higher value of bank concentration indicates a less competitive market. The impact of competition on bank risk can also be positive or negative. On one side, increased competition can increase bank risk on banks' liability and asset side. In competitive markets, banks usually charge low interest rates on loans because of the high supply of loans and to compete on prices (Chen, 2007). Banks are more likely to provide loans to borrowers with poor credit ratings in the presence of low-interest rates. On the other hand, uncompetitive markets are more prone to promote risky lending (Beck, 2008). In concentrated banking systems, big banks are more subject to the "too big to fail" policy of regulators and, hence, are involved in irresponsible lending practices (Schaeck et al., 2009). In brief, we can expect either risk-inducing or risk-reducing impact of bank concentration.

3.3.4 Measuring bank-specific controls

We follow the literature in including some commonly used bank-specific controls in our model. We will now discuss these variables in more detail.

First, we use the ratio of deposits to total assets. As per agency theory, managers of high-deposit banks are more likely to invest in risky projects to increase shareholder wealth or serve their private interests (Hoque, 2013). On the other side, high deposit ratios can strengthen banks financially and help generate higher returns, making them less risky (Demirguc-Kunt et al., 2010). Therefore, we can expect deposits' positive or negative impact on risk-taking.

Second, we use bank size as a natural log of total assets. Large banks can be riskier as they are primarily associated with major market events than small banks. Also, governments are most likely to protect major banks of their economies in the event of defaults or shocks (Laeven and Levine, 2009). Because of this moral hazard issue, large banks tend to take more risk. On the other hand, large banks have better capital and government guarantees to absorb the shocks of financial crises in the country (Beltratti and Stulz, 2012). They are also able to generate higher returns due to large capital. Therefore, bank size can also help in minimizing the bank risk. Overall, we can expect the effect of bank size on bank risk on either side.

Further, we control for income diversity by using a non-interest income ratio. On one side, income diversity can decrease bank risk by diversifying banks' overall portfolio risk and helping improve income (Lee et al., 2014). On the other side, high non-interest income activities can be risky for banks as income from these sources is not stable and increases the financial leverage of banks (De Young and Roland, 2001). Hence, we expect a positive or negative relationship between non-interest income and bank risk.

Finally, we control the asset side of banks by using the ratio of loans to total assets. High loans may indicate the adoption of poor lending standards by managers to get more incentives as fees from higher profitability (Dell'Ariccia and Marquez, 2006). This practice presents the association of increased risk with a large amount of loans. However, banks with high amounts of loans may be least associated with off-balance-sheet items, which reduces their credit-risky securities (Beltratti and Stulz, 2012). Consequently, we expect the effect of loans on risk-taking to be positive or negative.

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3.3.5 Measuring macroeconomic controls

We allow for two measures of macroeconomic conditions in our models, a practice common in the literature. First, we use GDP growth in the form of a percentage of the gross domestic product of a country. Low GDP growth can make it difficult for banks to examine the riskiness of the borrowers and project income from their future investment projects (Wu et al., 2022). Uncertain economic conditions can encourage banks to make bad and risk-taking decisions. However, low GDP growth can decrease bank risk as banks are more likely to adopt a "wait and see" approach and become more cautious while making credit and investment decisions under uncertain economic conditions (Aastveit et al., 2017; Bernanke, 1983). Therefore, GDP growth can positively or negatively impact bank risk-taking. Second, we use the current account as a macroeconomic control. A high current account balance indicates a stronger position in a country as the inflow of funds is greater. When a country's position is strong, banks can take more risks as they can overestimate the returns on future projects (Keeton, 1999). At the same time, a high current account can decrease bank risk. The market conditions and trust of investors are stronger under the solid financial position of the country. As a result, banks have more investment funds and deposit funds, and banks are more likely to have less risk and better returns through these funds. Therefore, we can expect the relationship between current account and bank risk on both sides.

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3.3.6 Summary statistics

Table 3-2 Summary statistics of variables used in the empirical model.

Variables	Observations	Mean	Standard deviation	Minimum	Maximum
Risk-taking measures					
Price volatility (%)	5,390	25.694	8.992	1.370	70.500
Log Z-Score	5,681	2.720	0.990	-6.350	5.370
Bank-level controls					
Deposits ratio (%)	6,557	70.292	16.934	17.595	93.800
Loans ratio (%)	6,577	61.726	14.005	13.341	85.863
Non-interest income (%)	6,402	23.456	13.070	2.081	73.695
Bank size (Log)	6,619	16.571	1.791	11.640	22.869
World Governance Indicators					
Voice and accountability index	726	0.504	0.875	-1.750	1.800
Political stability index	726	0.031	0.926	-2.810	1.620
Government effectiveness index	726	0.819	0.894	-1.550	2.440
Regulatory quality index	726	0.716	0.859	-2.240	2.230
Rule of law index	726	0.702	0.974	-1.920	2.100
Control of corruption index	726	0.618	1.023	-1.500	2.470
Banking industry controls					
Capital Stringency index	726	6.649	1.796	2.000	10.000
Bank concentration (%)	726	49.219	18.020	25.720	100.000
Macroeconomic controls					
Current account (%)	726	-0.226	5.554	-26.121	27.143
GDP growth (%)	726	3.407	3.386	-17.669	19.675

Table 3.2 presents the summary statistics of all the variables used in the model. Our primary dependent variable, price volatility, ranges from 1.370 to 70.50. Regarding our main independent variables, V&A values range from -1.750 to 1.800 with a standard deviation 0.875. PS has minimum and maximum values of -2.810 and 1.620, respectively, with a mean value of 0.031. GE has values from -1.550 to 2.440 with standard deviation and mean of 0.894 and 0.819, respectively. The minimum and maximum of RQ are -

2.240 and 2.230. The RL has a mean of 0.702 and a standard deviation of 0.974. CC has a maximum standard deviation of 1.023 among all WGIs. The range of deposits and loans is quite similar for bank-level variables, from 13.341 to 93.800. These ranges indicate that our dataset has a wide range of deposit-taking and loan-making commercial banks. Bank size is a natural log form of total assets ranging from 11.640 to 22.869. Capital stringency has a mean and standard deviation of 6.649 and 1.796, respectively. Our dataset has highly concentrated to less concentrated markets with values ranging from 25.720 to 100 per cent. The range of current account and GDP growth also indicates the presence of countries with diverse economic conditions.

Table 3.3 shows the correlation matrix between all variables. The coefficient values indicate the extent of collinearity between these variables. The correlation matrix has a minimum value of -0.54 between V&A and GDP growth and a maximum value of 0.97 between RL and CC. All WGIs are highly correlated, with coefficients ranging from 0.66 to 0.97. Because of this high correlation, we have analysed them separately as six different regression models

Table 3-3 Correlation matrix

Variables	Price volatility	Voice and accountability	Political stability	Government effectiveness	Regulatory quality	Rule of law	Control of corruption	Deposits	Loans	Non-interest income	Bank size	Capital	Bank concentration	Current account	GDP growth
Price volatility	1.00														
Voice and accountability	-0.31	1.00													
Political stability	-0.38	0.66	1.00												
Government effectiveness	-0.44	0.79	0.81	1.00											
Regulatory quality	-0.44	0.82	0.79	0.96	1.00										
Rule of law	-0.42	0.84	0.81	0.97	0.96	1.00									
Control of corruption	-0.45	0.83	0.81	0.97	0.95	0.97	1.00								
Deposits	-0.17	-0.08	-0.06	-0.01	-0.09	-0.02	-0.04	1.00							
Loans	-0.14	0.07	0.10	0.12	0.12	0.11	0.09	0.29	1.00						
Non-interest income	-0.02	0.18	0.16	0.15	0.18	0.13	0.17	-0.29	-0.19	1.00					
Bank size	0.08	0.10	0.20	0.17	0.16	0.14	0.17	-0.35	-0.15	0.28	1.00				
Capital stringency	0.18	0.00	-0.24	-0.07	-0.07	-0.03	-0.09	0.01	-0.01	-0.11	-0.12	1.00			
Bank concentration	0.04	-0.15	0.05	-0.05	-0.03	-0.08	0.01	-0.30	-0.06	0.11	0.22	-0.24	1.00		
Current account	0.06	-0.15	0.14	0.05	-0.04	-0.05	0.01	0.03	-0.03	0.08	0.18	-0.27	0.25	1.00	
GDP growth	0.17	-0.54	-0.44	-0.47	-0.49	-0.51	-0.48	0.06	-0.06	-0.15	-0.04	-0.01	0.08	0.14	1.00

3.4 Empirical model and methodology:

3.4.1 Model specification

We have discussed that bank risk-taking is a function of various bank-level, country-level, and industry-level variables. Therefore, we set the following empirical model to test our hypothesis on the relationship between institutional environment and bank risk-taking:

$Risk_{i,j,t}$ = β_0 + β_1(individual institutional environment indicators)$_{,j,t}$ + β_2(Banking-industry controls) $_{,j,t}$ + β_3(Macroeconomic controls) + $_{,j,t}$ β_4(Bank-level controls)$_{i,j,t}$ + β_5(Year)$_t$ + $\varepsilon_{i,j,t}$

$Risk_{i,j,t}$ presents the risk-taking variable of bank i in county j over time t. Price volatility is our primary risk-taking measure. The Z score will also be used as a measure of risk-taking to establish the robustness of the findings. The institutional environment indicates the six WGIs used for country j at time t: voice and accountability, political stability, government effectiveness, regulatory quality, rule of law and control of corruption. Capital stringency and bank concentration are banking industry controls used in the model. GDP growth and current account are used as macroeconomic controls for the respective countries. Bank-level controls consist of deposits, loans, non-interest income and bank size for bank i in country j at time t. $Year_t$ presents controlling for year fixed effects to absorb any time-varying breakdowns that can influence risk-taking in banks. $\varepsilon_{i,j,t}$ is the error term of the model.

3.4.2 Methodology

3.4.2.1 Fixed effects

Random and fixed effects are the most commonly used techniques to analyse the panel model (Cantu et al., 2022; Dinger and te Kaat, 2020; Saghi-Zedek and Tarazi, 2015). The main challenge in a panel dataset is the issue of omitted variables (Wooldridge, 2002). Random and fixed effect models are well-equipped to tackle this unobserved heterogeneity issue. Under the random effects model, there are either no omitted variables or if omitted variables exist, they are not correlated with the independent variables used in the model. Also, the model must follow strict exogeneity. This implies that bank risk-taking is not correlated to independent variables at any given point. Whereas when omitted variables are correlated with the explanatory variables in the model, this bias generated by omitted variables can be controlled by using the fixed effects approach. This is one reason why we use fixed effects over random effects to investigate our empirical model. The effect of any unobserved factors goes away over time under the fixed effects model

(Wooldridge, 2015). Also, we perform the Hausman test to choose the preferred model from fixed and random effects. The results in Appendix 3 show that all six models' p-values in the Hausman test are 0. These results indicate that we can reject the hypothesis that the random effects technique is a preferred model, and therefore, we choose fixed effects over random effects to analyse our model.

3.4.2.2 System GMM

We also use a two-step system GMM to analyse the panel dataset. There are two main advantages of using system GMM estimation for this chapter. As mentioned earlier, it helps control for the potential persistence of bank risk by using the lag of the dependent variable. The persistence of bank risk is well documented in the literature (Delis and Kouretas, 2011). Second, system GMM helps tackle the potential endogeneity of bank risk-taking with bank-specific factors, banking industry factors and bank regulations. It allows the use of some of the explanatory variables as endogenous and some as instrument variables.

We follow Agoraki et al. (2011) and Borio et al. (2017) to identify endogenous and predetermined variables in our GMM model. We treat bank-level variables as endogenous because banks' past and current risk-taking strategies can impact bank-level variables. For example, a bank's profitability drops when a bank has higher credit risk because of poor lending practices. The uncertainty in the banking industry may also result from economic downturns or unfavourable monetary policies, but it can always directly impact main bank characteristics (Schwert, 1989). When a bank is at higher risk, it can affect the confidence of its depositors, and as a result, the bank can lose its deposits and liquidity simultaneously (Chen et al., 2018). In addition, bank managers consider the current risk status of banks to formulate future strategic decisions (Djalilov and Piesse, 2019). Existing literature has also identified bank-level controls as endogenous (Teixeira et al., 2020; Bemrpei et al., 2018). Bank managers might have incentives to expand liquid assets if it becomes risky for them to protect themselves against premature withdrawal of funds (Kohler, 2015). Therefore, bank-specific variables can be considered endogenous based on these arguments.

We also treat bank regulatory and banking industry variables as endogenous. First, it is possible that bank risk-taking can impact the degree of regulation. The high risk of the banking industry may encourage supervisors to improve current bank regulatory practices and the quality of supervision. For example, capital requirements were increased by regulators after witnessing the risk-taking by banks during the global financial crisis. Additionally, regulators may become lax in regulating the banks if banks are doing well both economically and financially despite following prudent risk-taking practices over the long run. Therefore, following Delis et al. (2012) and Djalilov and Piesse (2019), we treat bank regulations as endogenous. Further, for bank concentration, there is a possibility that depending on the existing risk status of the bank, a weaker and troubled bank can merge with a healthy bank in the market. This merger can influence the competition status in the banking sector and, as a result, increase the market concentration. Therefore, we treat bank concentration as an endogenous variable in the GMM model.

We applied country-level governance indicators as predetermined variables, which are also called weakly exogenous. Banks are likely to modify their strategies according to the status of institutional quality every year (Delis et al., 2012). For example, banks can set their lending rates interest rates after noticing the level of institutional strength in the previous period. It infers that a change in governance quality at present can influence the bank's risk-taking in the future. We also treat macroeconomic controls as partly exogenous. Banks can adjust their risk-taking strategies by looking at the phase of the business cycle of a country. They can have relaxed strategies during the expansion phase and vice-versa. Therefore, macroeconomic indicators can be considered forward-looking. The current economic condition can influence bank-level indicators in the future.

3.5 Empirical findings and discussion

As we have discussed before, we are presenting the results by using both fixed effects and two-step system GMM methodologies. The fixed effect model is a static model and does not use the lagged values of price volatility (dependent variable). On the other hand, the GMM model extends the FE model further and controls for endogeneity by using the lagged values of dependent variables as instruments.

3.5.1 Fixed effect (FE) results

Table 3.4 presents the regression results of all explanatory variables against price volatility using the fixed effect methodology. The six columns, 1-6, show regressions of each WGI. To control for correlation and heteroskedasticity, we use robust standard errors. For sensitivity analysis, the standard errors are also clustered at the country level (results are shown in Appendix 2).

In line with previous studies, we find differing impacts of each measure of institutional quality on bank risk-taking. The coefficient of V&A is positive, but it is not statistically significant. The coefficient of PS is negative, but it is also statistically insignificant. The coefficient of GE is -2.027 and significant at 5%. One unit increase in the GE index decreases the price volatility of banks by approximately 200%. This result shows that sound policies and their effectiveness help curb banks' excessive risk-taking behaviour.

The coefficient of RQ is negative and significant at 1%. It is the largest coefficient among all WGIs, indicating that the RQ substantially impacts bank risk compared to other governance indicators. A unit increase in RQ decreases the price volatility by more than 400%. For RL, the coefficient is negative and almost significant at 10%. It helps in curbing the risk-taking behaviour of banks. CC shows an opposing impact as compared to other important institutional quality measures. The coefficient of CC is 1.594. A unit increase in the CC index increases price volatility by almost 106%.

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Table 3-4 Baseline model: Fixed effect results against price volatility.

WGI VARIABLES	(1) Price Volatility	(2) Price Volatility	(3) Price Volatility	(4) Price Volatility	(5) Price Volatility	(6) Price Volatility
Voice & Accountability	0.157					
	(1.080)					
Political stability		-0.037				
		(0.661)				
Government effectiveness			-2.027[b]			
			(0.982)			
Regulatory quality				-4.669[a]		
				(1.025)		
Rule of law					-2.401	
					(1.548)	
Control of corruption						1.594[c]
						(0.824)
Capital string. index	0.442[a]	0.443[a]	0.473[a]	0.502[a]	0.449[a]	0.442[a]
	(0.156)	(0.152)	(0.157)	(0.151)	(0.154)	(0.152)
Deposits	0.024	0.024	0.020	0.018	0.024	0.028
	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)	(0.024)
Loans	-0.088[a]	-0.088[a]	-0.086[a]	-0.084[a]	-0.089[a]	-0.087[a]
	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)	(0.018)
Non-int income	0.006	0.006	0.006	0.009	0.005	0.007
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)
Bank size	-4.891[a]	-4.891[a]	-4.923[a]	-4.618[a]	-4.993[a]	-4.853[a]
	(0.722)	(0.722)	(0.721)	(0.700)	(0.727)	(0.716)
Bank concentration	0.080[a]	0.080[a]	0.079[a]	0.062[a]	0.081[a]	0.084[a]
	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)	(0.015)
GDP growth	0.083	0.083[c]	0.091[c]	0.104[b]	0.090[c]	0.057
	(0.051)	(0.050)	(0.052)	(0.051)	(0.050)	(0.050)
Current account	0.175[a]	0.174[a]	0.166[a]	0.118[b]	0.161[a]	0.196[a]
	(0.053)	(0.060)	(0.055)	(0.056)	(0.054)	(0.056)
Constant	99.985[a]	100.088[a]	102.805[a]	100.451[a]	103.792[a]	97.556[a]
	(11.858)	(11.790)	(12.073)	(11.553)	(11.981)	(11.697)
Observations	4,555	4,555	4,555	4,555	4,555	4,555
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
R-squared	0.319	0.319	0.321	0.329	0.321	0.321

We did not find any association between deposits and non-interest income with bank risk-taking for bank-specific control variables. We find consistent evidence that loans and bank size help curb banks' risky behaviour. A percentage increase in loans decreases price volatility by approximately 9%. Therefore, results imply banks with higher loans are more likely to have less credit-risky securities (Beltratti and Stulz, 2012). Regarding bank size, a percentage increase in bank size decreases price volatility by approximately 500%. Large banks are associated with less risk-taking as they usually have large capital and government support to absorb financial losses (Beltratti and Stulz, 2012). Regarding bank industry control, we find that capital stringency promotes bank risk-taking. This supports the view that strict capital standards impair market discipline, which results in a decline in the quality of a bank's investment portfolio (Caprio et al., 2014). Also, strict capital requirements require banks to maintain certain capital, which can limit their investment opportunities. As a result, this can prevent them from diversification and increase their risk. The coefficient of bank concentration shows that more competitive markets encourage banks' risk-taking activities. One per cent change in bank concentration is increasing price volatility by approximately 8%. This aligns with the theoretical view that banks are more likely to lend to risky borrowers and at low interest rates to compete in a competitive market (Beck, 2008).

Regarding macroeconomic controls, higher GDP growth is associated with high bank risk. This is in line with the view that banks may not be as cautious of their investments during high GDP as they can be during low GDP growth (Bernanke, 1983). As a result, they might end up investing in risky investments. Higher current account balances are also favouring more bank risk. These results indicate that greater economic development attracts foreign investment to the country and increases investor confidence in the market. As a result, banks can overestimate the return on some projects and end up being high risk (Keeton, 1999).

3.5.2 Discussion of fixed effect results

As presented in Table 3.4, the coefficient signs of all WGIs have shown different signs. However, these results differ from what we should expect based on the correlation matrix. We can see in the correlation matrix, Table 3.3, that six WGIs are highly correlated, with values ranging from 0.66 to 0.97. Also, these WGIs are measuring the overall government quality of a country. Therefore, it is reasonable to expect a similar coefficient sign of six WGIs during an empirical estimation.

To find out which factors could be responsible for the varied effect of WGIs, we re-estimate each of the baseline regressions for the WGIs by individual governance indicators by adding each set of control variables (WGI, bank-level controls, banking industry controls, macroeconomic controls) sequentially. The six tables are presented in Appendices 7 to 12. We find that the coefficient signs of all WGIs are negative except for political stability. The effect remains the same when we add bank-level controls in the first step and when we apply banking-industry controls in the second step. However, V&A, PS and CC coefficient signs reverse when we add country-level variables to the model in the final step. Aside from the linkages between the WGIs, the correlation analysis presented earlier did not explicitly suggest any major autocorrelation issues. Nevertheless, the estimation results here seem to suggest that the correlation among some variables is having some influence on our model estimates. Therefore, we proceed further by dropping some of the variables from each of the macroeconomic, banking industry, and bank-level control groups. The WGIs are the focus of this study, and therefore, we will not drop any of them. From the set of macroeconomic variables, GDP growth is a very important variable that is needed to control for country characteristics that can influence bank risk-taking and will not be dropped. We will drop the current account, which one may argue can be represented by GDP. We drop one of the two banking industry controls; since banking regulations play an essential role after the financial crisis, we retain banking regulations and drop bank concentration. We drop deposits from the bank-level control group as the other variables appear more routinely in the banking stability literature. The results of this exercise are reported in Table 3.5.

Table 3-5 FE estimations by removing correlated variables (deposits, bank concentration and current account) against price volatility.

VARIABLES	(1) Price Volatility	(2) Price Volatility	(3) Price Volatility	(4) Price Volatility	(5) Price Volatility	(6) Price Volatility
Voice & Accountability	-1.104					
	(1.233)					
Political stability		0.601				
		(0.645)				
Government effectiveness			-2.643[b]			
			(1.038)			
Regulatory quality				-6.741[a]		
				(1.064)		
Rule of law					-2.877[c]	
					(1.654)	
Control of corruption						-0.019
						(0.872)
Loans	-0.089[a]	-0.091[a]	-0.087[a]	-0.082[a]	-0.090[a]	-0.089[a]
	(0.019)	(0.019)	(0.019)	(0.018)	(0.019)	(0.019)
Non-interest Income	0.013	0.016	0.014	0.017	0.013	0.014
	(0.020)	(0.020)	(0.020)	(0.020)	(0.020)	(0.021)
Bank Size	-5.847[a]	-5.849[a]	-5.859[a]	-5.114[a]	-5.960[a]	-5.873[a]
	(0.684)	(0.691)	(0.684)	(0.659)	(0.696)	(0.689)
Capital Stringency Index	0.401[a]	0.400[a]	0.433[a]	0.498[a]	0.400[a]	0.389[b]
	(0.155)	(0.150)	(0.155)	(0.147)	(0.151)	(0.151)
GDP growth	0.080	0.071	0.086	0.113[b]	0.086	0.076
	(0.053)	(0.054)	(0.054)	(0.052)	(0.052)	(0.051)
Constant	122.130[a]	121.484[a]	123.937[a]	114.336[a]	125.601[a]	121.794[a]
	(10.861)	(10.860)	(11.027)	(10.321)	(11.248)	(10.863)
Observations	4,597	4,597	4,597	4,597	4,597	4,597
R-squared	0.290	0.290	0.293	0.314	0.292	0.289
Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Number of Banks	492	492	492	492	492	492

The signs of all the coefficients of the WGIs are negative except for political stability, which is also not significant. These results are more in line with expectations based on correlation values of six WGIs. Only three out of six WGIs show a statistically significant impact on risk-taking. More specifically, GE, RQ and RL reduce volatility in share prices in a statistically significant manner. The results on GE correspond to that of Panayides et al. (2015), who suggest that governments that are proactive and encourage effective managerial behaviours and practices induce better performance in different industries. This result is also in line with Bui and Bui (2019). Interestingly, Houston et al. 2010 did not find a significant impact of GE on risk-taking, but we do. It would seem, therefore, that the longer sample period and the more sophisticated method used in this study influence the findings.

Regarding RQ, our results align with Houston et al. 2010 and are consistent with the view that better regulatory quality through improved banking supervision can reduce bank risk-taking. Interestingly, Bui and Bui (2019) do not find a significant impact of RQ on bank risk-taking. Therefore, it seems that the additional countries we employ and the improved estimation technique we use in relation to Bui and Bui (2019) influence our findings. With respect to RL, the findings are consistent with Uddin et al. 2020 and the view that an improved rule of law encourages banks to lend responsibly and, therefore, take less risk. Interestingly, neither Houston et al. 2010 nor Bui and Bui (2019) find a significant impact of the rule of law on bank risk-taking. Once again, our results imply that the data sample and estimation techniques influence the results. Intriguingly, V&A, PS and CC are not significant despite the high correlation index between the WGIs. Using PS, we push our model further to explain why some of these WGIs do not display a statistically significant linkage with bank risk-taking. In particular, we investigate whether specific countries or periods may influence the findings. Thus, we run the estimations over different periods and with different groups of countries.

The sub-samples, based on time periods, are created based on the global financial crisis (global financial crisis). The global financial crisis was the most severe crisis since the Great Depression of the 1930s. The origin of the global financial crisis is associated with the housing bubble in the US (Blundell-Wignall and Atkinson, 2009). While several significant financial institutions across the globe crumbled, numerous other financial companies only survived with the help of huge government support (Helleiner, 2011). A stable political system always uses various tools, such as deposit insurance or other state support, to ensure financial stability in a country (Ashraf, 2017). Therefore, we create (i) a pre-crisis (2004-2006), (ii) a crisis period (2007-2009) and (iii) a post-crisis period. In terms of creating samples based on countries, we create (i) a sample with just the USA, as it is by far the country with the highest number of banks (see Appendix 1). (ii) a sample without the USA to see to what extent it is influencing the findings in other countries. (iii) a sample with only European banks to get a clearer picture of regional differences. We will start by looking at results with the USA only and without the USA for different time periods in Table 3.6. Subsequently, we will look at the results for Europe and different samples in Table 3.7.

In column 1, for the sample without the USA, the effect of PS is insignificant on bank risk-taking for the entire period. However, when we look at the corresponding results for the USA only, in column 2, the results suggest that PS increases the volatility and, therefore, riskiness of banks in a statistically significant manner. In particular, one unit increase in the PS index increases price volatility by approximately 200%. We further explore the extent to which this significant relationship between PS and bank risk-taking by the USA was affected by the financial crisis. Therefore, we look at the evolution of this relationship in (i) the pre-crisis period (2004 -2006), (ii) the crisis period (2007 -2009), and (iii) post-crisis period (2010 -2014). The corresponding results are in columns 3, 4 and 5 of Table 3.6, respectively.

Table 3-6 Fixed effect analysis for political stability against price volatility by using sub-samples with and without USA.

	(1) Price volatility	(2) Price volatility	(3) Price volatility	(4) Price volatility	(5) Price volatility
	Sample without USA (2004-2014)	Sample with only USA (2004-2014)	Sample with only USA 2004-2006	Sample with only USA 2007-2009	Sample with only USA 2010-2014
Political stability	-1.184	1.957[a]	-3.029[a]	102.707[a]	-26.255[a]
	(0.885)	(0.649)	(0.204)	(5.224)	(1.554)
Constant	26.325[a]	20.741[a]	19.527[a]	-20.115[a]	37.100[a]
	(0.367)	(0.195)	(0.035)	(2.153)	(0.815)
Observations	3,801	1,589	410	425	754
R-squared	0.110	0.458	0.576	0.706	0.544
Control variables	Yes	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes	Yes
Number of Banks	418	153	139	145	153

The coefficients of PS during three different time periods are highly statistically significant at 1%. However, PS does not have the same sign across all three time periods. In the pre-crisis and post-crisis periods, PS shares a negative relationship with bank risk-taking, indicating that PS reduces risk-taking. It is interesting to note that the magnitude of this relationship increases by almost 10-fold between the pre-crisis and post-crisis periods. This is indicative of the effectiveness of the government in bringing stability to the banking sector by injecting money into the sector, as well as into other sectors through programs such as Troubled Asset Relief Programs (TARP). During the crisis period, the relationship between PS and bank risk-taking is positive and statistically significant. This suggests that during the crisis period, political stability led to high volatility in the share prices of banks. Banks were involved in risky lending practices in the US just before the crisis, which resulted in higher price volatility of banks during the crisis period. We all are aware of the house price bubble, which started around 2000, reached to its peak in early 2006 and started to decline in 2007. Mortgage contracts establish a long-term relationship between banks and customers and provide banks with a long-term income supply. In the years just before the crisis, the banks were facing huge competition pressure. The need to establish a profitable market share in the booming property market encouraged them to relax their due diligence standards (Coffee, 2009). As a result, they ended up sanctioning large amounts of mortgage loans to risky borrowers. The mortgage loan amounts were high-risk as well because they were sanctioned against a temporary house price boom. Further, the presence of deposit insurance and government support under a stable political environment in the US encouraged the moral hazard problem (Dowd, 2009). When banks were aware that the US government would bail out them in case of worst economic conditions, they did not think twice before making risky investments during the global financial crisis time. As a result, banks showed higher risk-taking behaviour under political stability.

Table 3-7 FE estimations against price volatility by using sub-samples with only European countries and different time periods.

VARIABLES	(1) Price vol	(2) Price vol	(3) Price vol	(4) Price vol
	2004-2014	2004-2006	2007-2009	2010-2014
Political stability	-5.181[b]	-2.417[b]	-0.110	2.647[c]
	(2.026)	(1.126)	(1.771)	(1.396)
Constant	28.278[a]	26.878[a]	22.674[a]	28.530[a]
	(1.255)	(0.748)	(1.329)	(1.110)
Observations	722	179	191	352
R-squared	0.382	0.312	0.708	0.061
Control variables	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Number of Banks	72	63	66	72

We now discuss the results of a similar exercise as above for European countries. The results in Table 3.7 provide some interesting insights into the relationship between PS and bank risk-taking. It is becoming clear from the analysis in Tables 3.6 and 3.7 that the effect of PS appears to be dependent on countries. While for the entire period for the USA, the relationship is positive and significant, and without the USA, it is insignificant; it is negative and statistically significant. It is, therefore, not a surprise that PS was found to be insignificant for the entire sample, as the opposing effects are probably negating each other. For the European countries and the entire period, Column 1 of Table 3.7, the negative relationship implies that political stability decreases bank risk-taking. As discussed earlier, this is likely due to stable governments promoting sound policies among banks who, in turn, can focus on providing funds for profitable projects rather than taking on undue risk by providing funds to companies with close connections to governments. Looking at how the global financial crisis impacted the relationship between PS and bank risk-taking also provides interesting results. Pre-crisis, Column 2 in Table 3.7, the relationship between PS and risk-taking is negative. The relationship is insignificant during the crisis, in Column 3 of Table 3.7. Post-crisis, in

Column 4 of Table 3.7, the relationship turns positive. While in the USA, the political stability made banks more stable after the financial crisis, in Europe, we observe the opposite. After the financial crisis, banks became more volatile in Europe. The literature suggests that, generally, this may be due to stable governments promoting more competition and, therefore, more risk-taking. However, there may be some additional reasons. Over the post-crisis period, 2010 to 2014, a number of European countries experienced the sovereign debt crisis whereby a number of governments in Europe were holding debt well above the set limit in Europe. A well-known example is Greece, whose sovereign debt reached 113% of GDP while the limit in the Eurozone is 60%. Therefore, in spite of having political stability, governments in Europe were grappling with issues such as the European sovereign debt. European banks hold a significant amount of the sovereign debt and were inevitably affected by the European debt crisis.

The analysis results in this chapter so far have provided some fascinating insights into the linkage between WGIs and bank risk-taking. Although our work is similar to Houston et al. (2010) and Bui and Bui (2019), in many cases, our results differ. Our estimations show that these can be attributed to the sample of countries and also estimation techniques. Further to these, our estimations also suggest that the relationship between WGIs and bank risk-taking could be quite dynamic; that is, it is changing over time, as illustrated by the in-depth analysis with PS. Our analysis shows that major economic events such as the financial crisis and the European sovereign debt crisis can distort the relationship between WGIs and bank risk-taking. The current literature needs to emphasise the dynamic nature of the relationship between WGIs and bank risk-taking. This study provides some early insights into this dynamic relationship. It recommends further in-depth analysis, focussed on individual countries and specific political and economic events that may influence the relationship between WGIs and bank risk-taking.

3.5.3 Two-step system GMM results

To check the robustness of our main findings from the FE model, we also use a two-step system GMM methodology. FE model results can potentially be biased because the FE model does not control for endogeneity. Endogeneity bias can produce inconsistent estimates, which gives wrong assumptions and false conclusions (Ketokivi and McIntosh, 2017). Whereas GMM deals with endogeneity issues very efficiently, as discussed in the methodology section. The lag of price volatility used in the GMM model, see Table 3.8, acts as an instrument here and controls for any potential endogeneity (such as unobserved heterogeneity, dynamic heterogeneity, and simultaneity) (Roodman, 2009). GMM model transforms the data internally by subtracting the present value of price volatility from the past value of price volatility. In this manner, the number of observations is decreased, and this whole exercise of internal data transformation improves the GMM model efficiency.

Before we look at the results, we need to ensure that the GMM model satisfies some conditions. In particular, we need to ensure that the standard covariance matrix is robust to panel-specific heteroskedasticity and autocorrelation. Indeed, the Arellano-bond (AR1), which tests the first-order autocorrelation in the first difference errors, shows that the values of AR1 are 0 and thus accept the presence of first-order serial correlation. The results indicate that the first leg of the dependent variable is exogenous. AR2, which tests for the presence of second-order serial correlation, shows that the values range from 0.113 to 0.433 and, therefore, reject the existence of second-order serial correlation.

Instruments play an important role in GMM, and we also need to test that they are valid instruments. There is a tendency in a GMM model to create a large number of instruments for every variable, time period and lag distance. We apply a collapsed instrument matrix following Roodman (2006) to avoid this proliferation of instruments. This helps in creating only one instrument for every variable, time period and lag distance. Too many instruments can weaken the validity of the Hansen test, which in turn affects the validity of instrument variables. Therefore, we restrict the number of instruments to 47 by using collapse, which is smaller than the number of banks/groups. The Sargan and Hansen tests check for the overall validity of the instruments. The insignificant p-values of both tests indicate that our instrument variables set is valid.

Table 3-8 Baseline model two step system GMM results against price volatility.

VARIABLES	(1) Price Volatility	(2) Price Volatility	(3) Price Volatility	(4) Price Volatility	(5) Price Volatility	(6) Price Volatility
Lagged Price volatility	0.986[a]	0.890[a]	0.873[a]	0.864[a]	0.894[a]	0.893[a]
	(0.026)	(0.036)	(0.026)	(0.029)	(0.026)	(0.027)
Voice & Accountability	-0.968[c]					
	(0.496)					
Political stability		1.098[a]				
		(0.317)				
Government effectiveness			-0.672[b]			
			(0.312)			
Regulatory quality				-0.690[c]		
				(0.416)		
Rule of law					-0.717[a]	
					(0.263)	
Control of corruption						-0.768[a]
						(0.252)
Deposits	-0.060[b]	-0.104[a]	-0.060[a]	-0.035	-0.034	-0.013
	(0.026)	(0.040)	(0.022)	(0.029)	(0.024)	(0.021)
Loans	0.027	-0.092[c]	0.046[c]	0.016	0.041	0.038
	(0.025)	(0.049)	(0.028)	(0.031)	(0.028)	(0.028)
Non-interest Income	-0.069[b]	-0.097[b]	-0.045	-0.044	-0.049	-0.038
	(0.033)	(0.042)	(0.034)	(0.030)	(0.031)	(0.032)
Bank Size	0.465[c]	-0.348	0.185	0.340	0.383[c]	0.565[a]
	(0.249)	(0.412)	(0.240)	(0.336)	(0.215)	(0.196)
Capital Stringency Index	-0.184[c]	0.183	-0.015	0.117	0.014	0.004
	(0.103)	(0.147)	(0.109)	(0.099)	(0.106)	(0.116)
Bank Concentration	-0.061[a]	0.042[c]	-0.044[a]	-0.025	-0.048[a]	-0.042[a]
	(0.017)	(0.022)	(0.016)	(0.017)	(0.016)	(0.015)
GDP Growth	-0.343[a]	-0.059	-0.432[a]	-0.359[a]	-0.406[a]	-0.390[a]
	(0.100)	(0.084)	(0.097)	(0.100)	(0.094)	(0.104)
Current Account	0.050	0.041	0.153[a]	0.215[a]	0.138[a]	0.153[a]
	(0.053)	(0.067)	(0.057)	(0.060)	(0.052)	(0.049)
Constant	3.652	20.365[c]	7.414	0.000	2.255	0.000
	(5.725)	(10.766)	(5.113)	(0.000)	(5.514)	(0.000)
Observations	4,100	4,100	4,100	4,100	4,100	4,100
Number of banks	485	485	485	485	485	485
Instruments	37	38	47	47	47	47
Arellano-bond: AR (1)	0.00	0.00	0.00	0.00	0.00	0.00
Arellano-bond: AR (2)	0.114	0.433	0.154	0.279	0.134	0.113
Sargan test (p-value)	0.405	0.169	0.362	0.281	0.390	0.289
Hansen test (p-value)	0.304	0.243	0.126	0.122	0.166	0.115

The results in Table 3.8 indicate that bank risk-taking is persistent. The lag of price volatility (dependent variable) measures the degree of persistence of the risk measure. As shown in columns 1 to 6, the coefficients of the lag of the dependent variable range from 0.864 to 0.986 and are significant at 1% in all estimations. These results strongly support that the previous year's risk-taking positively and significantly impacts the current year's risk-taking choices. These results denote the persistence of bank risk-taking and justify using dynamic panel model analysis in our study.

In terms of the WGIs, the results in Table 3.8 support our findings from the FE model in Table 3.5. In particular, with the fixed effects estimation, GE, RQ and RL shared a negative and statistically significant result with bank-risk taking. This is also the case here, although the magnitudes of the relationships are somewhat smaller. The results, therefore, reinforce our earlier finding with the fixed effect estimations that better GE, RQ and RL reduce volatility in bank share prices and, therefore, reduce bank-risk taking. Furthermore, the remaining three WGIs share a statistically significant relationship with bank risk-taking. V&A and CC, consistent with GE, RQ, and RL, share a negative association with bank risk-taking. In other words, improvement in V&A and CC leads to less bank-risking taking. The findings are consistent with the views that better V&A can lower information asymmetry and thus reduce the risk of adverse selection, while better CC can reduce the risk of misallocation of resources. In contrast to the other five WGIs, PS shares a statistically significant but positive relationship with bank risk-taking. This suggests that more political stability leads to more risk-taking. To some extent, this result is not surprising, given our earlier in-depth analysis with PS using the FE models. We found evidence for both positive and negative of PS with bank risk-taking, and we discussed that this relationship is quite dynamic and dependent on the countries being looked at. As an example, if we perform the test with a sample that excludes the USA, see Table 3.9, we find that the relationship between PS and risk-taking becomes insignificant, similar to what we observed in Table 3.6[7].

Regarding control variables, unlike FE model results, we do not find any conclusive results for capital stringency and loans by using the GMM model. We find that deposits and non-interest income are curbing banks' risky behaviour. These results are significant in columns 1, 2, and 3 number estimations in Table 3.8. The result of deposits supports the view that banks with large deposits are less risky because they can generate higher returns with available deposits (Demirguc-Kunt et al., 2010). The non-interest income result provides evidence that diversification achieved through different income sources minimizes banks' overall risk (Lee et al., 2014). The coefficients of deposits and non-interest income are insignificant in FE model results. The positive and significant coefficients of the current account in estimations 3 and 5 support the FE model results.

[7] Regarding subsamples of banks only from the US and banks from European countries, GMM is not producing the estimations because the subsamples with just the US and European countries are very small. GMM requires more degrees of freedom to produce some reliable results.

Table 3-9 GMM model results by using subsample of banks other than the US (rest of the countries)

	(1)
VARIABLES	Price volatility
Political stability	-0.106
	(0.378)
Constant	0.000
	(0.000)
Observations	2,798
Number of Banks	344
Instruments	34
Arellano-bond: AR (1)	0.000
Arellano-bond: AR (2)	0.387
Sargan test (p-value)	0.228
Hansen test (p-value)	0.492

3.6 Further Robustness checks

We perform further robustness checks by using an alternative measure of risk-taking. Similar to Houston et al. (2010) and Bui and Bui (2019), we use log Z-score. Contrary to price volatility, a higher log Z-score indicates less bank risk-taking. Therefore, we would expect opposite coefficient signs of explanatory variables with log Z-score compared to price volatility. We re-estimate our main models for GMM (Table 3.8) using the Z score as the dependent variable. The corresponding results are given in Table 3.10.

The value of AR1 is zero, accepting the hypothesis that first-order serial correlation is present in the model. Therefore, the lag of the log Z-score is exogenous. The AR2 values range between 0.440 and 0.621, helping to reject the presence of any second-order serial correlation in the model. The statistically insignificant values for both Hansen and Sargan tests show that our instruments are valid. The lag of the log Z-score has coefficients ranging from 0.850 to 0.953 in six estimations, and all are highly significant at 1%.

With regards to the relationship between WGIs and bank risk-taking, the results are in line with the corresponding results in Table 3.8. V&A, GE, RQ, RL and CC all share a positive relationship with the z score, thus indicating less risk-taking by banks, just as in Table 3.8. PS leads to more risk-taking by banks, which once again is similar to what we found in Table 3.8, but in this instance, the relationship is insignificant. Our in-depth analysis with PS in the earlier section explains this. In particular, we found that the relationship between PS and risk-taking is quite sensitive to the sample of countries and time periods employed.

Table 3-10 Robustness check: Baseline model GMM model estimation against Log Z-score

	(1)	(2)	(3)	(4)	(5)	(6)
	Log Z-score	Log Z-score	Log Z-score	Log Z-score	Log Z-score	Log Z-score
Lagged Log-Z-score	0.850[a]	0.953[a]	0.862[a]	0.912[a]	0.877[a]	0.870[a]
	(0.054)	(0.050)	(0.050)	(0.040)	(0.042)	(0.045)
Voice & Accountability	0.067[c]					
	(0.037)					
Political stability		-0.006				
		(0.036)				
Government effectiveness			0.052[b]			
			(0.025)			
Regulatory quality				0.095[b]		
				(0.038)		
Rule of law					0.058[b]	
					(0.024)	
Control of corruption						0.053[b]
						(0.022)
Deposits	-0.005[c]	-0.002	-0.005[b]	-0.002	-0.004[b]	-0.006[b]
	(0.003)	(0.003)	(0.002)	(0.002)	(0.002)	(0.003)
Loans	-0.004[c]	0.001	-0.003	-0.004[b]	-0.003	-0.003
	(0.002)	(0.004)	(0.003)	(0.002)	(0.002)	(0.003)
Non-interest Income	-0.002	-0.007[c]	-0.002	-0.001	-0.001	-0.003
	(0.003)	(0.004)	(0.004)	(0.002)	(0.003)	(0.004)
Bank Size	-0.038	-0.026	-0.038[b]	-0.027	-0.035[c]	-0.050[b]
	(0.024)	(0.022)	(0.018)	(0.023)	(0.020)	(0.022)
Capital Stringency Index	-0.004	0.004	-0.009	0.008	-0.006	-0.005
	(0.010)	(0.012)	(0.010)	(0.007)	(0.009)	(0.010)
Bank Concentration	0.002	-0.002	0.002	-0.002	0.002	0.003[c]
	(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.002)
GDP Growth	0.018[b]	0.006	0.016[c]	0.032[a]	0.018[b]	0.014[c]
	(0.009)	(0.009)	(0.009)	(0.008)	(0.007)	(0.009)
Current Account	-0.002	0.013	-0.002	0.005	-0.003	-0.001
	(0.005)	(0.009)	(0.005)	(0.004)	(0.005)	(0.005)
Constant	0.000	0.000	0.000	0.000	0.000	1.646[b]
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.690)
Observations	4,243	4,243	4,243	4,243	4,243	4,243
Number of Banks	538	538	538	538	538	538
Instruments	78	35	78	43	78	78
Arellano-bond: AR (1)	0.00	0.00	0.00	0.00	0.00	0.00
Arellano-bond: AR (2)	0.557	0.621	0.559	0.440	0.539	0.556
Sargan test (p-value)	0.154	0.872	0.288	0.192	0.158	0.260
Hansen test (p-value)	0.535	0.796	0.554	0.360	0.532	0.552

3.7 Conclusion and recommendations

In this empirical chapter, we investigate the effect of different institutional environment measures (WGIs) on bank risk-taking. The existing literature has paid very little attention to exploring this area. Also, the available studies have only used the aggregate of the institutional environment. Only a couple of studies, in particular, Houston et al. (2010) and Bui and Bui (2019), have explored the individual WGIs by using the global sample. Therefore, we provide further insights into the relationship between individual components of WGIs and bank-risking taking by using (i) more advanced econometric techniques that have been used before and by using an updated sample of countries and time periods. In particular, using a sample of commercial banks worldwide from 2004 to 2014, we investigate the relationship between institutional quality and bank risk-taking. We employ fixed effects and two-step system GMM methodologies, and our dependent variable is price volatility. We also use log Z-score as an alternative risk measure following Houston et al. (2010) and Bui and Bui (2019).

Our key findings are as follows. (i) Although the effect of each of the WGIs on bank risk-taking is generally in the same direction, the magnitude is not always the same. One of the WGIs, PS, even displayed an opposite sign to the others. These results show the importance of focusing on the individual components of WGIs rather than focusing on the aggregate value, which has largely been the case in the literature. (ii) Although our study is quite similar to Houston et al. 2010 and Bui and Bui (2019) in terms of data set and time period, we find some significant differences in our findings. The differences can be linked to the estimation techniques used in an updated sample of countries. (iii) Our in-depth investigation with one of the WGIs (PS) also shows that the relationship between WGIs and bank risk is quite dynamic (time-varying) and is dependent on specific countries. This aspect of the relationship has not received much attention in the literature. To the best of our knowledge, this is one of the early studies on this topic.

Overall, our findings generally suggest that improvement in the components of the institutional environment, WGIs, leads to less risk-taking. The policy implication of these general findings is that governments around the world should improve their institutional environments, which will lead to less bank risk-taking and, therefore, reduce the risks of a financial sector collapse, which, as the financial crisis of 2007/8 showed, can have a long-lasting and devasting impact on economies. Nevertheless, our investigations also suggest that we should not take the positive influence of a strong institutional environment on reducing bank risk taking for granted. Sound policies can inadvertently lead to some issues, e.g., political stability leading to more competition in the banking sector and, therefore, more risk-taking. It is imperative, therefore, that we keep a close eye on (i) the consequences of the WGIs and bank risk-taking and remedial actions if banks start taking too much risk and (ii) the dynamic nature of the institutional environment and bank risk-taking. Many factors can distort the relationship, as exemplified by our analysis of the effects of the financial crisis. The European sovereign debt crisis is another example we used in our discussions. Further research could examine the dynamic relationship between institutional environment indicators and bank risk-taking more closely by focusing on individual countries and looking at significant structural changes in the economy and how they impact the bank risk-taking and WGIs relationship.

Chapter 4 Negative Interest Rates and Bank Risk-taking

4.1 Introduction

In response to the global financial crisis (GFC), many central banks across the world adopted several monetary easing tools, such as reducing interest rates. This is performed to boost capital flow in the economy and promote economic growth. While intending to achieve these policy objectives, some countries across the globe, such as Japan, Sweden, Denmark, and many other European countries, have further lowered the policy rates below zero. According to negative interest policy rates (NIPR), the banks pay interest on deposits and reserves they keep at central banks (CB) (Haksar and Kopp, 2020). In this chapter, we evaluate the impact of negative interest rates on bank risk-taking behaviour.

Negative interest rates used to be rare events in the past, but recently, the Euro area implemented negative interest rates in the years 2014 to 2019. Japan still has this policy, which started in 2016. Given the rarity of this policy, especially in recent times, academic work on this policy is minimal. Low or negative interest rates are usually implemented to rejuvenate depressed economies (Bongiovanni et al., 2021). There is an ongoing debate on whether negative interest rates are able to perform the desired functions, such as strengthening economic development by facilitating lending. Some studies put forward that low-interest rate policies have helped in achieving the desired purpose of central banks (Draghi, 2016), but others argue that low-interest rates pose a financial stability risk to financial and banking sectors as they are lending more risky loans (Carney, 2016). Research on the impact of negative interest rates and bank risk-taking, the focus of this chapter, is also scant. Only a handful of papers, such as Florian (2018), Bongiovanni et al. (2021) and Bubeck et al. (2020), have explored the relationship between negative interest rates and bank risk. In addition to this, the empirical evidence is also mixed. While a few papers (Florian, 2018; Boungou,

2020) find that negative policy rates help in minimising bank risk, Bubeck et al. (2020) find that negative rates encourage risk-taking behaviour in banks in search of yield. Therefore, we want to provide further insights into this topic, which is of great interest to policymakers but where research is minimal, and the available evidence is somewhat contradictory.

This chapter is in the spirit of Boungou (2020), Bongiovanni et al. (2021) and Carbo-Valverde et al. (2021) in terms of the type of data and methodology employed. Boungou (2020) employs a global dataset comprising 59 countries; Bongiovanni et al. (2021) use data from OECD countries, and Carbo-Valverde et al. (2021) use data from European countries. We also employ European data like Carbo-Valverde et al. (2021). However, our study distinguishes itself from Carbo-Valverde et al. (2021) in some important ways: First, we only consider countries that adopted negative interest rates in the same year, which in our case is 2014. Allowing countries with differing dates for the adoption of negative interest rates in the sample not only presents econometric challenges but also makes it hard to identify which adoption dates are impacting the banks' behaviour more significantly. Having a homogeneous adoption date was also a reason to choose the European sample, as most countries in our sample are part of the common currency area, and therefore, their monetary policies are governed by the European Central Bank (ECB). The ECB introduced the negative interest rate policy for its member countries in June 2014. Second, we consider some alternative measures of banking stability to Carbo-Valverde et al. (2021). The main variable of interest in Carbo-Valverde et al. (2021) is the net interest margin. Although net interest margin has been employed regularly as a measure of banking stability, we believe that, given the circumstances, it may not be the most appropriate measure. In particular, in a negative interest rate environment, the net interest margin is likely to shrink or even be negative. The two main components of the net interest margin are the interest income and interest expenses. Net interest margin is essentially the difference between interest income and interest expenses. Both components will likely fall in a low or negative interest rate environment. The interest income is likely to fall more in a negative interest rate environment. One of the reasons can be that in a negative interest rate environment, banks incur a negative interest rate on their central bank reserves, but they normally do not charge retail customers a negative interest rate on their deposits for fear of losing them. These arguments, therefore, suggest that the net interest margin can fall in a negative interest rate environment and is not necessarily a sign of instability of banks. Our main measure of bank stability is the Z score, which has been employed in several studies (e.g., Bongou, 2020; Bongiovanni et al., 2021) and is less susceptible to the issues faced by the net interest margin in a negative interest rate environment. Third, we also investigate whether the different types of banks – commercial, cooperative and savings - display any difference in their behaviour towards risk in a negative interest rate environment. This is the first study to make such an investigation. Commercial, cooperative and savings banks differ in their institutional features and business models. These banks' main features and differences are provided in Table 4.1 below. For example, compared to cooperative and savings banks, commercial banks are mainly profit-generating organisations and are owned by shareholders. They are more likely to take aggressive actions to avoid excess costs generated by negative deposit rates (under NIPR) and turn towards risky investments in search of yield. Because of these different features, we can expect different responses from commercial, cooperative and savings banks towards NIPR (Goddard et al., 2004; Paroush and Schreiber, 2019).

Table 4-1 Table showing the main features of commercial, cooperative and savings banks.

Features	Commercial Banks	Cooperative Banks	Savings Banks
Ownership form	They operate in the local communities. Most commercial banks are privately-owned.	They are owned by the members. Members act as both owners and customers of banks.	They are community focused financial institutions. They are developed with the purpose of encouraging savings among the poor people. They are owned by depositors (members).
Business model	They provide traditional retail banking services to the local communities. They take deposits and make loans to households and businesses within the same community.	They operate in areas of their members. They do retail deposit-taking and the provision of credit to households and local businesses.	They provide savings services, some consumer loans, and loans to local businesses.
Profit orientation	They are profit making organizations.	They do not seek to maximize profits; however successful cooperatives are profitable enterprises.	They also do not seek profits however successful savings banks generate surplus profits which is used to generate reserves.
Source: Chapter 11, Community Banking Institutions, The Oxford Handbook of Banking.			

Using our main dependent variable, Z-Score, we find that negative rates help minimise bank risk. Our results are consistent with Boungou's (2020) and Bongionvanni et al. (2021) findings. Various robustness checks also confirm these results. Finally, the results on different type of banks reveal that the relationship between NIPR and bank risk also depends on the nature of the banks. We find that commercial banks are riskier than other type of banks. Commercial banks may have been involved in risky projects to recover costs incurred by negative rates as they are mainly profit-oriented organisations. Savings banks are found to be safest in the presence of negative rates. These results make sense for savings banks as most of the savings' banks are owned by the public, and they act as non-profit organisations. Therefore, they were less likely to be involved in riskier activities to generate profits. Cooperative banks were found to take risks a few years after the implementation of NIPR. As cooperative banks have to distribute the surplus to their members, they might have adopted risky strategies to generate some income after NIPR.

The contributions of this study can therefore be summarised as follows: (i) We provide evidence on a literature that has provided mixed findings. One of the novelties in this regard is to consider a homogenous treatment date for the adoption of the negative interest rate policy. Using heterogenous treatment dates as in some studies poses econometric challenges which can lead to questionable findings. (ii) This is the first study to compare the risk-taking behaviour of commercial, savings and co-operative banks in a negative interest rate environment. The main findings are that the negative interest rate policy leads to less risk-taking and that commercial banks appear to take more risk in comparison to Co-operative and savings banks. These findings highlight the importance of considering type of banks when formulating negative interest rate policies. Not one policy can be suitable for banks with different complexities.

The rest of the chapter is as follows. The following section discusses the theoretical arguments, related literature, and hypotheses on low or negative interest rates and bank risk-taking. Section 4.3 describes the data, methodology and key variables used in the analysis. It is followed by a discussion of empirical findings and robustness checks. Finally, we conclude the chapter and suggest some policy recommendations based on empirical findings.

4.2 Literature review and hypothesis setting

4.2.1 Low or negative interest rates and bank risk-taking

Many central banks adopted low-interest-rate policies in the years following 2000 and post-the-crisis after witnessing the consequences of the global financial crisis. The interest rates were lowered to close to zero. In recent years, many central banks in developed countries have even adopted negative interest rates. Table 4.2 below displays countries that have adopted negative interest rates along with their corresponding adoption dates. Low-interest rates are generally perceived positively by consumers and businesses as they, for example, lower their borrowing costs. Negative interest rates are also generally perceived positively, as banks do not generally pass on negative interest rates to retail customers. Consumers, therefore, enjoy the benefits of low-interest rates without incurring the cost of negative interest rates. The impact of negative interest rates on the behaviour, in particular, on their risk-taking behaviour, is not so clear cut. For one, the literature on negative interest rates is quite sparse as this is not a strategy that central banks use quite often. Additionally, the behaviour of banks towards risk appears to be determined by their intrinsic features. e.g., business model, size and capitalisation. Thus, faced with negative interest rates, some banks become more risk-seeking while some become more risk-averse.

Low or negative interest rates can increase bank risk through two channels. One is through the "search for yield" (Rajan, 2006). The primary avenue for a bank's revenue is traditional loans, but they become less profitable in the presence of low-interest rates. Banks tend to avoid negative deposit rates for their customers in fear of deposit withdrawals (Arteta et al., 2016). As a result, their net interest margin (the difference between deposit rate and lending rate) declines when banks pay on the reserves they have with CB. In other words, their profitability is likely to reduce, and therefore, banks tend to find alternative ways to generate profits. Negative interest rates may encourage bank managers to invest in projects with higher returns, but those projects are risky.

Table 4-2 List of countries presented with their date of adoption of negative interest rates.

S No.	Country	Adoption of negative interest rates
1	Austria	June-2014
2	Belgium	June-2014
3	Bulgaria	January-2016
4	Cyprus	June-2014
5	Denmark	July-2012
6	Estonia	June-2014
7	Finland	June-2014
8	France	June-2014
9	Germany	June-2014
10	Greece	June-2014
11	Hungary	March-2014
12	Ireland	June-2014
13	Italy	June-2014
14	Japan	February-2016
15	Latvia	June-2014
16	Lithuania	June-2014
17	Luxembourg	June-2014
18	Netherlands	June-2014
19	Norway	September-2015
20	Portugal	June-2014
21	Slovakia	June-2014
22	Slovenia	June-2014
23	Spain	June-2014
24	Sweden	February-2015
25	Switzerland	January-2015

The second channel through which low-interest rates can increase bank risk is its effect on cash flows and valuations. The book value of banks' profits is increased through increased valuation gains of collaterals and increased asset prices due to negative interest rates (Borio and Gambacorta, 2017). Banks' balance sheets become stronger, and this could change the banks' perception and appetite towards risk. As a result, banks tend to find ways to utilize this surplus credit they hold through valuation increases. To employ surplus credit, banks search for potential borrowers. This can lead to aggressive lending practices, which minimizes the risk premium from lending, and hence, yield spread is compromised (Adrian and Shin, 2010). Banks end up employing loose lending standards, which increase banks' overall risk.

Most empirical literature supports the risk-inducing view of low interest rates (Bubeck et al., 2020). Ioannidou et al. (2009) find that banks increase their risky lending practices and charge lower rates to risky borrowers in the presence of low-interest rates. Altunbas et al. (2010) also found an association between low-interest rates over a longer period and increased risk-taking by banks in their sample of European and the US listed banks. Angeloni et al. (2015) assert that a bank's risk increases, especially on the funding side, when central banks decrease policy rates. They find that bank's liabilities become more expensive when interest rates are higher, and as a result, banks are encouraged to deleverage and minimize the holdings of risky assets. Delis and Kouretas (2011) find strong evidence for the Euro area banks in support that low-interest rates shift the composition of bank portfolios towards a riskier position. They also find that this impact is less for banks with high levels of capitalization and stronger for banks engaged in non-traditional banking activities. Therefore, they suggest that effective regulation of these bank characteristics and loose monetary policy are also essential for prudent bank behaviour.

Altunbas et al. (2009), in their sample of listed banks in the European Union and the USA, find that a decrease in short-term interest rates decreases bank risk over a shorter period but increases it over the long run. They interpret that a bank's lending behaviour changes while issuing new loans when a low-interest rate persists for longer. This change in behaviour could be the result of the bank's struggle with net interest margins over the long run. Jimenez et al. (2010) also support that banks loosen their lending policies when they sanction new loans with low short-term interest rates and lend to borrowers with poor credit histories.

Regarding negative interest rates, Bubeck et al. (2020) find that they encourage risk-shifting behaviour in banks by leading them to reach for yield. Arteta et al. (2016) also find that low-interest rates decrease financial stability, especially when rates drop below zero and if they are employed for a prolonged period.

Heider et al. (2019) find that the increase in the riskiness of syndicate loans between 2013 and 2015 in Europe is associated with the adoption of negative interest rates by the ECB. Basten and Mariathasan (2018) studied a sample of Swiss retail banks to check their reaction to negative rates by SNB. They reveal that banks transferred their liquid assets away from the central bank to the interbank market and more riskier asset classes, such as uncollateralized loans and mortgages. Their results also imply that the cost of loans was transferred to bank customers in response to negative rates. Swiss banks that were more influenced by negative policy rates increased their income by increasing the fee and loan-related income as compared to banks that were less affected.

Negative interest rates can also lead to more prudent behaviour by banks. Nucera et al. (2017) state that negative interest rates may lead to less non-performing loans. Bongiovanni et al. (2021) also discuss the "deleverage" hypothesis, which also supports less risk-taking following negative interest rates. In response to the global financial crisis and the Eurozone crisis, central banks adopted quantitative easing to improve macroeconomic conditions and bank balance sheets. Quantitative easing provided banks with excess liquidity, which enabled banks to de-lever their post-crisis balance sheets. They used the additional funds to buy safe liquid assets such as government bonds with zero risk weighting to increase risk-adjusted capital. In this way, they rebalanced their risky balance sheet items instead of using additional funds to extend further loans. Molyneux et al. (2019) also find that the number of loans is greatly reduced in banks with countries that adopted negative rates as compared to banks in other countries. In support of this view, Bongiovanni et al. (2021) find that banks in countries with negative interest rates reduce holding of risky assets by 10 per cent compared to banks in countries that have not adopted negative interest rate policy. They do so by investing in safer liquid assets such as sovereign bonds.

Some other empirical studies also find that negative interest rates do not increase bank risk (Boungou, 2020; Florian, 2018). In his study on German banks, Florian (2018) does not find any support that banks have lowered their lending standards in response to low-interest rates to generate profits. He has instead found that banks benefit through the shrinkage of loan loss provisions due to negative interest rates. Luchetta (2007) reports that low interest rates facilitate low bank risk, and high-interest rates may increase bank risk-taking. Boungou (2020) also supports through their international dataset that bank risk-taking is lower in countries with negative interest rates. Bongiovanni et al. (2021) find that banks adopt safer and liquid assets to strengthen their capital instead of increasing risk in search of yield position when negative rates are adopted. Overall, very few studies have explored this area, and the empirical evidence present is inconclusive. Therefore, we fill this literature gap by conducting this research.

Based on the above theoretical arguments and empirical findings, we set the following hypothesis:

H1a: Negative interest rates decrease bank risk-taking.

H1b: Negative interest rates increase bank risk-taking.

The literature also shows that bank characteristics are important in determining the relationship between negative rates and bank risk (Bongiovanni et al., 2021; Nucera et al., 2017). Nucera et al. (2017) show that the riskiness of banks due to negative rates is higher for smaller banks, whereas the risk of larger banks declines. Unlike small banks, which rely more on traditional banking, larger banks have diversified sources of income, which may make them less affected by compromised profit margins due to NIPR as compared to small banks. Heider et al. (2019) state that banking institutions with higher deposits are unable to transfer negative policy rates to their customers. Their result indicates that high-deposit banks lend less to risky borrowers. These results show that high-deposit banks do not want to lose their deposits and prefer to keep their position safer. Eggerston et al. (2017) also support the association of poor lending growth with negative rates in high-deposit banks. These results indicate additional risk-taking by banks (because of a smaller number of loans), which would encourage the moral hazard problem of managing loans and eventually lead to financial instability. Bongiovanni et al. (2021) find that negative rates are more risk-inducing for banks with stronger capital ratios and banks in less competitive markets. The high market power of banks in less competitive markets could enable them to increase costs on loans to increase profits, which increases bank's ability to make riskier loans. The findings of Boungou (2020) also support that the risk-taking impact of negative rates depends on bank characteristics, such as bank size and the level of capitalization. Studies such as De Nicolo et al. (2010) also highlight the role of banking regulations in influencing the effect of interest rates on bank risk. They observe that when interest rates fall, banks with higher capital ratios increase leverage and reduce the monitoring of credit risk. Agur and Demertzis (2012) find that regulations such as capital requirements do not counter balance the risk-inducing channel of interest rates.

4.2.2 Commercial banks, cooperative banks, savings banks, and risk-taking behaviour

In theory, commercial banks have more willingness to take risks over cooperative and savings banks. Commercial banks are more profit oriented as their shareholders and institutional investors monopolise wealth maximisation. This can contribute to excessive risk-taking by commercial banks. On the other hand, cooperative banks do not aim to maximise profits. They look to maximising their member customers' surplus instead of profits and the well-being of their stakeholders, such as members and employees (Hesse and Cihak, 2007). Savings banks are similar to cooperative banks, but they are not owned by members. Savings banks are either state-owned or non-profit foundations that offer banking services. They have social purpose along with financial goals, which can make them less willing to take risks (Ayadi et al., 2009). In addition to this, since cooperative and savings banks have long-term fiduciary relationships with their members and consumers, they have fewer information asymmetry issues than commercial banks and can monitor their borrowers in a better way (Coccorese and Ferri, 2020). As a result, they can be less risky than commercial banks.

There are some additional reasons why the risk-taking behaviour of these three types of banks might differ. First, the business model of different bank types is different. Both cooperative and savings banks are mainly involved in lending activities, whereas commercial banks focus on lending and non-lending activities. These non-lending activities constitute non-interest income activities. Although involvement in different activities can diversify the income and make commercial banks less risky, there are also stances where they can end up in high-risk activities in the search for yield. Second, they follow different funding structures. While cooperative and savings banks predominantly have only customer deposits to finance their loans, commercial banks primarily employ wholesale funds to fund their loans. Commercial banks can hold a large part of these funds as a buffer against financial or liquidity shocks, which can make them less risky as compared to cooperative and savings banks. Also, commercial banks are usually larger than cooperative and savings banks (Barra and Ruggiero, 2021). Larger size can help commercial banks to absorb financial shocks efficiently, which can make them less risky.

The empirical literature on the risk-taking behaviour of different types of banks is scant. Chaddad and Cook (2004) and Hansmann (2000) suggest that cooperative banks have fewer incentives to take risks. They find in their study on the US banks that these institutions follow low-risk strategies than commercial banks. Garcia-Marco and Robles-Fernandez (2008), in their study on Spanish financial intermediaries, find that commercial banks are more risk-inclined than savings banks. Ianotta et al. (2007), by using a sample of banks across 15 European countries, found that savings and cooperative banks efficiently managed their loan portfolios and owned less risky assets than commercial banks. There is no study that has addressed the risk-taking approach of different types of banks in response to NIPR. Therefore, we will test the hypotheses H1a and H1b based on different types of banks.

4.3 Data and Methodology:

4.3.1 Data

We are evaluating the impact of negative interest rates on risk-taking in banks by using a sample of banks across 36 European countries. The sample consists of commercial banks, savings banks, and cooperative banks. We use unconsolidated data for all these banks from Bankscope from 2009 to 2020. The accounting data in BankScope is not sufficiently available before 2012, and like other sectors, the onset of the covid phase in 2020 had major turbulence in the financial sector. Therefore, due to data limitations and to remove any bias because of the COVID crisis, we have restricted our final sample from 2012 to 2019.

Further, we restricted our sample to banks for which the data was available from 2012 to 2019 to keep our panel data balanced in nature. Also, our data sample only consists of active banks present in 2012, and we exclude any bank entrants after 2012. Finally, we remove any countries that adopted NIPR before and after 2014. This list includes Bulgaria (adopted in January 2016), Denmark (adopted in July 2012), Norway (adopted in September 2015) and Sweden (adopted in February 2015). As a result of all these filtered activities, we have a final sample of 761 banks across 27 European countries. Our sample has countries that adopted NIPR in 2014 only. Table 4.2 shows the list of countries used in the sample with the date of adoption. This allows us to have information two years before the adoption of negative interest rates and five years after the adoption, making a decent sample to analyse the impact of NIPR. In addition to Bankscope, we employ the World Bank Database to download macroeconomic variables and other banking industry controls such as creditor rights and credit information index.

4.3.2 Methodology and Empirical model

Following the empirical literature such as Berger and Roman (2015), Carbo-Valverde et al. (2021), Fang et al. (2014), and Molyneux et al. (2019), we apply the difference-in-difference (DiD) approach to examine the negative rate policy impact on bank risk-taking behaviour. The DiD methodology has become the most common method to estimate the causal relationship between outcome variables and treatment. The treatment refers to a specific event, and in our study, the treatment refers to the date negative interest rates were adopted. In its simplest version, the DiD approach involves two groups and two periods. The untreated group, also referred to as the control group, does not receive the treatment; that is, they do not adopt negative interest rates. The treated group receives treatment in the second period; that is, the countries in that group adopt negative interest rates in the second period. Our treated group consist of banks in 18 countries that received treatment in the year 2014. A DiD method examines the effect of a treatment by comparing the change in outcome from pre-treatment to post-treatment period for the treated group relative to the control group. Our pre-treatment period is 2012 and 2013, and the post-treatment period consists of 2014 and onwards. Table 4.2 presents the list of countries with the year of adoption and the number of observations from each country. There are some European countries that implemented NIPR in different years—for example, Denmark in 2012, Sweden, Switzerland, Norway in 2015 and Bulgaria in 2016. We do not include these countries in our sample to remove any possible bias caused by heterogeneous treatment groups. As we can see in Table 4.2, the majority of countries take on the negative rates from 2014; therefore, we only choose the year 2014 as the year of treatment intervention. We employ the following empirical model:

$$\begin{aligned} Risk - taking_{ijt} &= \alpha + \beta_1 Treated_{ij} + \beta_2 Post_{jt} + \beta_3 (Treated_{ij} * Post_{jt}) + \beta_4 Bank \\ &- level\ controls_{ij} + \beta_5 Banking\ industry\ controls_{jt} \\ &+ \beta_6 Macroeconomic\ controls_{jt} + \beta_7 Year_t + \beta_8 Bank_i \\ &+ \varepsilon_{ijt} \qquad (1) \end{aligned}$$

As discussed in the Introduction, our primary risk-taking measure is the Z-score, as it is widely employed in the banking stability literature. We also discussed that measures such as net interest margin, which are often used as a measure of banking stability, may not be an appropriate measure in this context. More specifically, in a negative interest rate environment, a decrease in net interest margin is not necessarily a sign that banks are taking on more risk but rather an inevitable outcome of the negative interest rate policy. Similar arguments can be made about a number of variables that are often used in the banking literature, whereby an adverse impact on those variables is not necessarily a sign of banking instability but rather an outcome of the monetary policy or a sign of what's happening in the economy. We have already discussed why the net interest rate margin may not be an appropriate measure of risk in this context. We will also use the variable non-performing loans to further illustrate this argument. Non-performing loans are a measure often associated with banking instability. In the context of negative interest rates, non-performing loans are expected to decrease as loan repayments become cheaper. However, this effect may not be instantaneous as most loans tend to be taken on a fixed rate, and therefore, the benefit of low or negative interest rates may not be obtained until the fixed term expires. Another reason the non-performing loans may not decrease is because of the state of the economy. Negative interest rates are implemented because the economies of many countries are suffering, which results in higher unemployment. As a consequence, non-performing loans are likely to increase. In other words, negative interest rates do not necessarily encourage lending more to risky customers, which results in increased non-performing loans, but rather, non-performing loans may be a result of increased job losses in a poorly performing economy. Given these arguments, it then becomes imperative to carefully choose a measure that will reflect the risk-taking attitude of banks and have no other effects. This by no means is an easy task. As stated earlier, our main variable of interest will be the Z-score, as it is widely used in the banking literature and appears to be less susceptible to the issues encountered by net interest margin and non-performing loans. As a robustness check, we will employ the following two variables: (i) risk-weighted assets and (ii) central bank (CB)reserves. We employ risk-weighted assets as banks will either increase their holdings of risky assets in search of higher yields or deleverage (hold less risky) and substitute them with safer assets. Central bank reserves are a variable that is likely to suffer from similar issues to that of net interest margin and non-performing loans as negative interest rates will lead to banks incurring a penalty on their central bank reserves and, as such, are likely to substitute away their excess central bank reserves into other forms of investment that are less taxing. In this context, a reduction in central bank reserves will not necessarily be a sign of distress but rather a sign that banks are trying to maximise the returns on their financial assets. We, therefore, primarily use the central bank reserves to decipher the actions of banks with the caveat that it is not necessarily an optimal measure of risk-taking.

In Equation (1), Risk-taking$_{ijt}$ presents risk-taking of bank *i in* country *j* at year *t.* Treated group is a dummy variable equal to 1 if bank *i* is affected by negative interest rates in country *j*, and it is 0 otherwise. Post is a dummy variable for years following the introduction of NIPR. In the literature on bank risk-taking, the main determinants employed tend to be bank level variables, banking industry control variables and macroeconomic variables (see for example, Boungou 2020, Bongiovanni et al. 2021 and Carbo-Valverde et al. 2021). The commonly used bank-level variables are return on assets (ROA), loans growth, cost-income, non-interest income, equity-assets, customer deposits to assets, liquidity, non-performing loans (NPLs) and bank size. The commonly used banking industry controls are legal rights index and credit information index. They control for country's standards on credit market. Macroeconomic controls are GDP growth, inflation, and domestic credit to GDP ratio. They control for country-level variation that can influence our results. $Year_t$ are year fixed effects that control for time varying shocks that can influence bank risk-taking and ε_{ijt} is error term of the equation. The discussion on the choice of all these control variables and their detailed definitions are provided in the upcoming section.

When evaluating the impact of negative rates on bank risk using DiD methodology, the DiD model should satisfy a few assumptions. The parallel trend assumption is the most crucial assumption to ensure the validity of a DiD model. This assumption requires that the relative variation between the trends of the treated and control groups is constant over time in the absence of treatment. It is difficult to perform a formal test on the data for this assumption, but the best available way is to plot the trends between the two groups graphically. We present three graphs for Z-Score, risk-weighted assets, and CB reserves to total assets, respectively. Figure 1 shows the movement of Z-Score for both treatment and control groups from 2012 to 2019. Both groups followed almost similar trends from 2012-2014 until 2014 when some countries started adopting negative interest rates. The Z-Score of adopter countries shows some upward trend compared to the control group, which shows some downward trend from 2014 to some years after the implementation of NIPR.

Further, Figure 2 shows the trend of risk-weighted assets (RWAs) for adopter (treatment group) and non-adopter (control group) countries from year 2012 to 2019. The RWAs of both groups followed a similar downward trend only from 2013 to 2014. The control group shows an upward trend from 2014, but then it follows the upward trend from 2015 onwards. However, the treatment group followed a continuous downward trend from 2014 to 2019. These trends show that banks of adopter countries show less risk-taking behaviour as compared to non-adopter countries. Figure 3 presents the parallel trend graph of CB reserves to total assets for both treatment and control groups from year 2012 to 2019. Both groups show a normal trend till 2014, but the trend varies after the implementation of treatment. While the trend line of the control group shows fluctuation throughout all years after 2014, the CB reserves of the treatment group show an upward trend from 2014 onwards. The graph shows that NIPR has impacted both groups separately. All these patterns of Figure 4.1, Figure 4.2 and Figure 4.3 indicate that the parallel trend assumption holds true for our dataset.

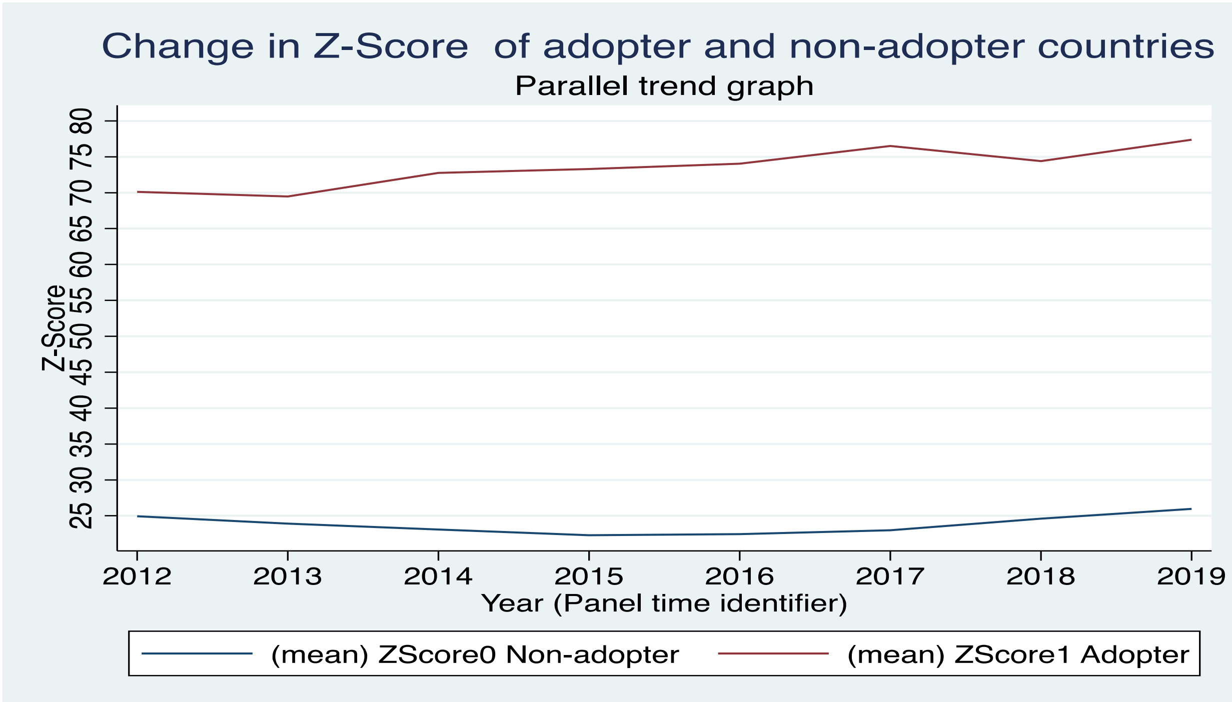

Figure 1 Graphical representation of trend of Z-Score for treated group (orange line/adopter countries) and control group (blue line/non-adopter countries) from 2012 to 2019.

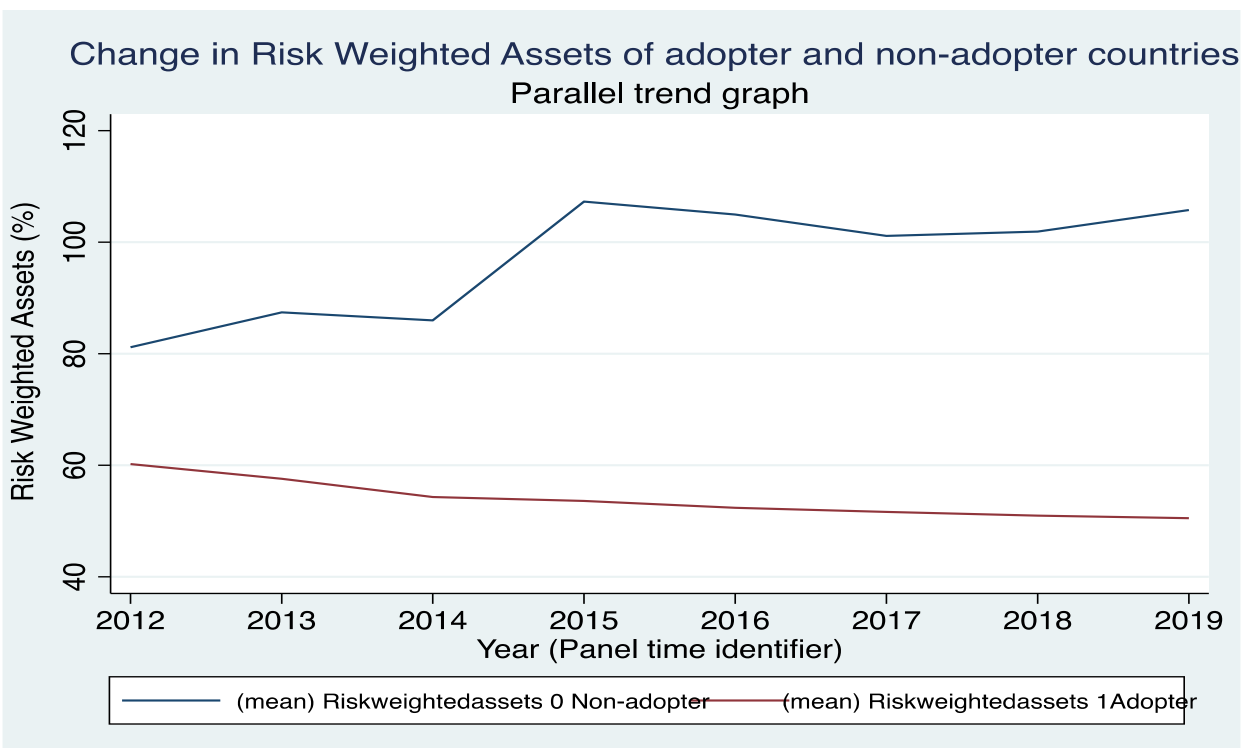

Figure 2 Graphical representation of trend of Risk Weighted Assets for treated group (orange line/adopter countries) and control group (blue line/non-adopter countries) from 2012 to 2019.

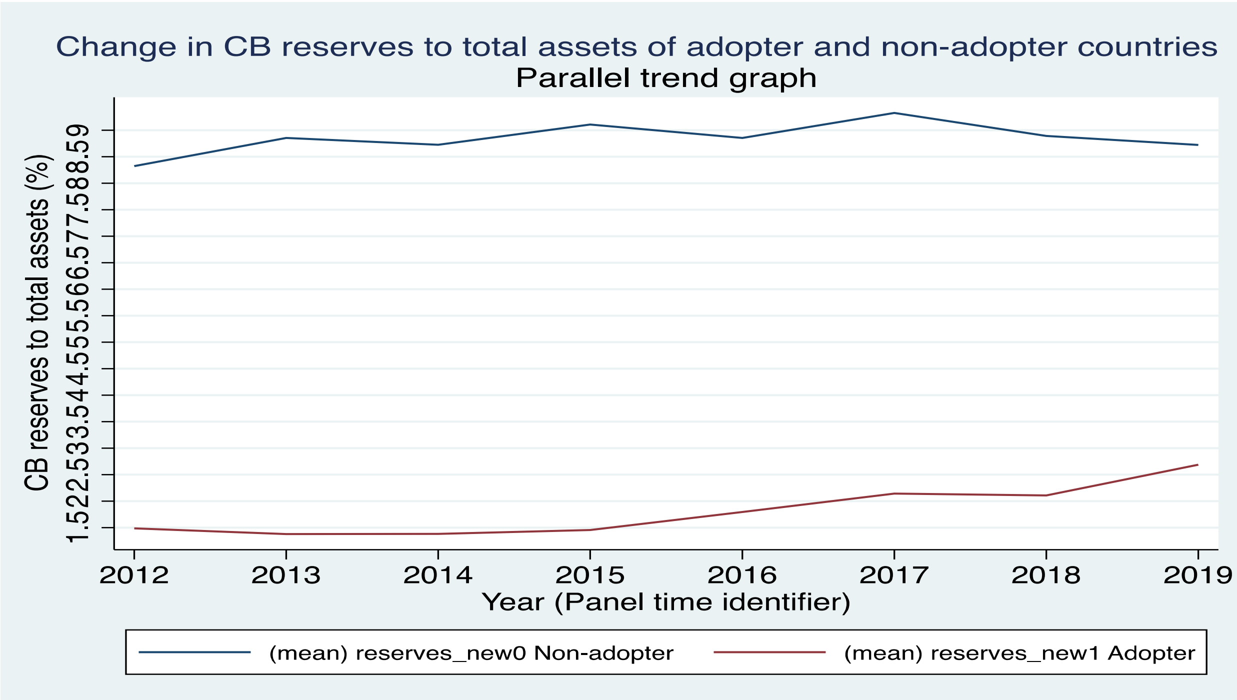

Figure 3 Graphical representation of trend of CB reserves to total assets for treated group (orange line/adopter countries) and control group (blue line/non-adopter countries) from 2012 to 2019.

4.3.3 Key Variables

4.3.3.1 Dependent variables

As discussed in the earlier section, we employ three different measures for the dependent variable. First, following Laeven and Levine (2009) and Houston et al. (2010), we are using Z-Score. Z-Score measures the distance from insolvency (Roy, 1952). Insolvency is a state where bank losses get more than the equity (equity is less than profits). It is measured as return on assets (ROA) plus capital to assets ratio divided by the standard deviation of return on assets (σROA). Following Houston et al. (2010), we calculate the standard deviation of ROA over the 8-year period (2012-2019) for each bank. Higher σROA will translate into higher bank fragility. Therefore, as per the calculation, Z-Score is the inverse of the probability of insolvency. A higher value of Z-Score indicates that the bank is more stable and less close to insolvency (a higher Z-Score means the bank takes less risk). As per the theoretical views discussed in the hypothesis development section, NIPR can impact Z-Score in either way.

The second measure is the risk-weighted assets following Boungou (2020). It is also represented as RWAs. It is calculated as the ratio of average risk-weighted assets to total assets. It is presented in percentages. A higher value of RWAs would indicate an increase in bank risk-taking. According to the arguments presented in the previous section, we would expect that NIPR can influence RWAs in either way. Third, we use the ratio of central bank reserves to total assets to evaluate the impact of NIPR on bank risk-taking. However, as we discussed earlier, central bank reserves may not be an appropriate measure of banking stability. This is because NIPR intends to promote the credit supply in the economy by charging interest on the bank's excess reserves instead of paying the interest. Simultaneously, if these reserves are retained as retail deposits, they are costly to maintain from a regulatory or operational perspective (banks may have to pay deposit rates to their depositors). The higher the reserves in this situation, the higher the negative impact on the bank's profits. One way to reverse this negative impact on bank profits is to increase lending by providing low-interest rates, and this negative interest rate is likely to negatively impact bank reserves at central banks. In this case, the drop in central bank reserves is not necessarily a sign of distress by banks, and the negative interest rate is designed to do. Nevertheless, we use central bank reserves as one of the dependent variables in order to observe how it is impacted by the negative interest rates. This will also give us an idea as to whether or not banks are actually lending more, as the policy was designed to do.

4.3.3.2 Control variables

4.3.3.2.1 Bank-specific controls

Bank characteristics are important determinants of bank risk. Following the literature, for example (Ashraf, 2017; Hoque, 2013), we employ several bank-level controls. We control for the size of the bank by using the natural log of total assets[8]. There are mixed theories on the risk impact of bank size. On one side, large bank are more likely to adopt risky strategies due to moral hazard issues caused by government guarantees based on the "too big to fail" principle (Laeven and Levine, 2009). On the other hand, large banks may be less exposed to risk as they are protected by implicit government guarantees that absorb their financial losses (Beltratti and Stulz, 2012). Also, larger banks can have more flexibility to effectively manage uncertain liquidity issues because they have better access to capital markets (Konishi and Yasuda, 2004). The empirical findings are also mixed (Mercieca et al., 2007; Baselga-Pascual et al., 2015). Therefore, we can expect the effect of size on bank risk in either way.

We control for the liquidity risk of banks, and it is measured as the ratio of liquid assets to total assets. It is normalized by converting to natural log form[9]. Banks with more liquid assets can be less risky as they can be more efficient in coping with financial uncertainties and liquidity shortfalls (Altunbas et al., 2009). On the contrary, high liquidity can cause agency issues and encourage managers to invest in risky projects (Dinger and Kaat, 2020). Bank manager's compensation is partly based on the amount of loans, and more liquidity may encourage managers to lower the lending standards so that they can increase their compensation (Acharya and Naqvi, 2012). The empirical literature also provides mixed evidence (Hong et al., 2014; Hoque, 2013). As a result, we would expect either a positive or a negative relationship between liquidity and bank risk-taking.

We use the ratio of total customer deposits to total assets to proxy for bank liabilities (Anginer et al., 2014). Deposit financing is not subject to runs in the presence of deposit insurance, and therefore, banks with more deposits can take more risk (Gorton, 2010). Also, as per the agency theory, managers and shareholders are

[8] Following Carbo-Valverde et al. (2021) and Beltratti and Stulz (2012), we use the natural log of total assets. Total asset is a widely distributed variable with large values, and by using natural log, the distribution is likely to behave as normal distribution which helps in better regression analysis.
[9] The ratio of liquid assets to total assets in the sample was highly skewed which could impact the regression analysis. Therefore, we transformed this ratio to natural log for to make distribution behave like normal distribution.

more likely to direct funds to high-risk investments when banks have high deposit ratios. However, high customer deposits can make a bank's position less risky as they have more funds to diversify their income and to cope well under difficult financial conditions (Demirguc-Kunt et al., 2010). Therefore, we can expect the effect of the ratio of customer deposits to total assets on bank risk, either positive or negative. Further, we use equity to assets ratio to capture the capital side of banks following Carbo-Valverde et al. (2021). On one side, a high equity-asset ratio presents a stronger position for a bank and suggests that the bank can have more flexibility to combat a financial downturn. The bank is also more likely to face less trouble from the debt overhang issue (Myers, 1977). However, at the same time, banks with higher equity to assets highlight agency issues and therefore, shareholders can influence managers to take on high-return but risky investments as they have high stakes on board (Beltratti and Stulz, 2012). Therefore, equity to assets can have either a positive or negative relationship with bank risk.

We also use non-interest income as an explanatory variable. It is measured as the ratio of non-interest income to the operating revenue of a bank. Income from sources other than interest income activities can make the investment portfolio of banks less risky and help in producing a good amount of income over a period (Lee et al., 2014). At the same time, more income from non-interest income activities can encourage managers to generate more income, and as a result, they can invest in risky projects (De Young and Roland, 2001). The empirical evidence is also not conclusive (Chen et al., 2017; Williams, 2016). Therefore, we would expect either a positive or a negative relation between non-interest income and bank risk.

We also capture the effect of management efficiency on bank risk raking. This is measured through the cost-to-income ratio (Valverde and Fernandez, 2007). A high cost-income ratio indicates poor senior management practices, which may result in poor strategies, such as difficulty in monitoring borrowers to ensure good lending standards (Berger and De Young, 1997). Therefore, it can be related to high risk. Some empirical studies also suggest the risk-inducing impact of a high cost-income ratio (Altunbas et al., 2007; Hou et al., 2014). Therefore, we can expect a risk-inducing impact of cost to income.

Loan growth is used to control the effect of lending policies on bank risk-taking. Loan growth is measured as annual growth in gross customer loans and advances. On one side, loan growth can increase bank risk by creating asset price bubbles and lending to risky borrowers (Bhowmik and Sarker, 2021; Borio and Lowe, 2002). For example, excessive credit growth is considered a prime indicator of the global financial crisis (Borio, 2010). Loan growth strategies may be beneficial in the short term but have long-term hidden risks such as high default rates (Keeton, 1999). On the other side, credit growth may not necessarily mean inviting more risk for banks. For example, banks may diversify the risk of their loan portfolios by expanding geographically and exploring new profitable lending opportunities (Amador et al., 2013). Also, Kohler (2012) argues that if the loan growth of a bank is accompanied by growth in the whole credit market/their competitors, then it is not necessarily high risk-taking. They put forward that if banks exhibit abnormal loan growth than their competitors, then only this indicates that banks have lowered their lending standards and have attracted risky borrowers. The empirical evidence is also mixed (Foos et al., 2010; Laeven and Majnoni, 2003). Therefore, we can expect either side effect of loan growth.

We control for bank performance by using return on assets (ROA). Rajan (2006) suggests that banks with more profits are less motivated to search for yield, and therefore, they reduce the risk level of their investment portfolio. Also, high-performing banks are better at coping with financial and liquidity shortfall shocks, which can make them less risky. However, high-performing banks are usually associated with high-risk projects, which can make their position risky (Dell'Ariccia and Marquez, 2006). Therefore, ROA can either increase or decrease bank risk. We also employ NPLs as an explanatory variable in cases where NPLs are not the dependent variable. Berger and Udell (2004) find that banks are more likely to tighten their lending standards after facing a certain level of impaired loans in their accounts. This action can either decrease bank risk by lowering the volume of bad loans in the future or increase bank risk by limiting the bank's loan portfolio and hampering the main source of interest income. Therefore, we can expect the risk impact of NPLs to be on either side.

4.3.3.2.2 Banking industry controls

We control for industry features that may affect bank risk-taking. First, we use creditor rights, which measure the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders, thus facilitating lending. The index has a range from 0 (weak rights) to 10 (strong rights) in 2012 and 0 (weak rights) to 12 (strong rights) from 2013 to 2021. The index values are converted to percentages to make them equivalent. Creditor rights can either decrease bank risk by minimizing the default rates (Fang et al., 2014) or increase bank risk by boosting the bank's confidence to give loans to a wider but risky set of borrowers in the presence of strong recovery rights (Houston et al., 2010). Second, we use the credit information index, which measures rules affecting the scope, accessibility, and quality of credit information available through public or private credit registries. The index has a range of 0 (availability of less credit information) to 6 (availability of more credit information) in 2012 and 0 (availability of less credit information) to 8 (availability of more credit information) from 2013 to 2021. The index values are converted to percentages to make them equivalent. Information sharing can decrease bank risk by reducing information asymmetries and enhancing transparency (Houston et al., 2010). Alternatively, credit information sharing may provide greater access to credit to riskier borrowers, and as a result, the risk of the bank's portfolio increases (Guerineau and Leon, 2019). Based on contradictory theories, we can expect that both creditor rights and the credit information index can increase or decrease bank risk-taking.

4.3.3.2.3 Macroeconomic controls

We employ three macroeconomic variables to control the country's economic conditions. First, we use GDP growth; a lower growth rate indicates tougher economic conditions. Theoretical views are mixed. Poor economic growth can increase bank risk by increasing the default risk of borrowers (Wu et al., 2020). The recessionary effect of poor GDP growth can impact the income of general households and corporate profitability, which further reduces their interest or loan-paying capacity. Also, under these scenarios, they are less likely to borrow, which further deteriorates the bank's risk profile. Further, poor economic growth leads to economic uncertainty, which can make it difficult for banks to forecast the return on projects accurately (Calmes and Theoret, 2014). This can lead to managerial herding behaviour in lending, which means managers may look at the previous decision-makers instead of collecting their own information while making credit-making decisions. The herding behaviour is more likely to result in risky decisions. On the other hand, these uncertain economic conditions can promote a "wait and see" approach among bank managers while making decisions (McDonald and Siegal, 1986). Since the borrower's paying capacity is reduced under poor economic growth, the bank's investments (lending) get locked in these periods. As a result, banks must follow the option of waiting, and banks can make safer investment decisions when their assets are locked under poor economic conditions. Empirical findings are also mixed (Aastveit et al., 2017; Wu et al., 2020).

Second, we use inflation, and it can also impact bank risk in either way. High inflation, on one side, can negatively impact the income of existing borrowers. As a result, it can increase the default and credit risk of banks. The empirical findings of Baselga-Pascual et al. (2015) support this view. At the same time, high inflation reduces the real rates of return on bank loans, which may encourage banks to reduce their lending activity (Boyd et al., 2001). The credit risk also reduces with a decrease in the quantity of bank assets (lending activities) due to high inflation. Some empirical studies support the risk-reducing impact of inflation (Ashraf et al., 2017; Klomp and Haan, 2014).

Finally, we use the ratio of domestic credit to GDP. On one side, a high supply of domestic credit to the private sector may indicate poor lending standards by the banking sector, which can increase the credit risk of banks. On the other side, it can strengthen the asset side of banks and increase the interest income. This can help in minimizing the bank risk. Overall, based on these arguments, we can expect a risk-reducing or risk-inducing impact on GDP growth, inflation, and the domestic credit-GDP ratio.

4.3.4 Summary statistics and correlations

Table 4.4 presents summary statistics of all variables used in regression analysis. All accounting ratios, macroeconomic variables and credit indices are presented in percentages to keep uniformity in the data except for Z-Score, bank size and liquidity. The summary statistics table shows the number of observations, mean, standard deviation, minimum and maximum of all variables of the sample over the period from 2012 to 2019. The total number of observations is 5217.

The accounting variables are winsorised at different levels. First, Z-Score is winsorised at the 90th percentile from the top end only. The sample had some banks with extremely high Z-scores. We winsorised the Z-Score from the top end to remove any result bias because of extremely healthy banks. ROA and equity- to total assets are winsorised at three standard deviations outside the mean. This is again performed to ensure that the sample does not have extremely healthy and defaulting banks, which can influence the main results. Similar to Z-Score, the ratio of CB reserves to total assets is also winsorised at the top 90%. Further, liquidity ratio and bank size are employed in the natural log form. The values of these variables were highly skewed. They are transformed into natural log form so that the distribution behaves like a normal distribution. NPLs are winsorised only at the top end at 99%. Banks with high levels of bad loans have less capacity to lend further loans. Our sample had extremely high NPL values. These extreme values can impact our main results. Therefore, we winsorised it at the top level to remove possible bias. Finally, risk-weighted assets, loan growth, non-interest income, cost to income and customer deposits to assets are winsorised at 1% and 99%. The distribution of these variables had extremely small and large values, which could create bias in our main analysis. For example, cost to income had some negative values, which indicate negative income and some high-income banks. These negative values and high cost-income ratio present extremely fragile and high-income banks, respectively. The presence of these banks could produce bias in the results; therefore, we winsorised them at both the top 99% and bottom 1%.

As shown in Table 4.4, our dependent variable, Z-Score, ranges from -37.59 to 486.93, with a mean of 65.69 and a standard deviation of 89.25. This mean and standard deviation suggests that there is significant cross-sectional variation in the level of bank risk. The minimum and maximum values of Z-Score show large variations in bank stability across banks and countries. Bank-specific control variables such as ROA, loan growth, cost to income, equity to assets and non-interest income have a wide range of minimum and maximum values. Regarding our main independent variable, the negative interest rate is a dummy variable that presents the treatment status. This variable has value 1 for all banks that are affected by the adoption of negative or low-interest rates in a country and is called the treated group. This variable takes 0 otherwise and is considered a control group. Creditor rights and credit information index are used as institutional controls and are normalised by converting them into percentage forms. Both variable percentages range from 0 to 100. Regarding macroeconomic controls, GDP growth, inflation and private credit to GDP are also presented in percentages. The descriptive of macroeconomic indicators indicates diversity in the economic growth of countries over the years. For example, the GDP growth range from -9.77 to 25.16.

Table 4-3 summary statistics of variables used in the DiD regression.

Variable	**Observations**	**Mean**	**Std. Dev.**	**Min**	**Max**
Z-Score	5,217	67.06	90.84	-37.60	486.93
Risk Weighted Assets	4,265	59.32	30.17	17.15	322.15
Reserves	5,217	2.63	3.78	0.00	12.97
ROA	5,217	0.25	1.12	-8.70	9.30
Loan growth	5,217	7.32	19.19	-38.17	108.77
Cost-income	5,217	67.10	19.27	24.86	159.31
Non-interest income	5,217	38.24	15.85	-2.54	91.82
Equity-assets	5,217	10.20	5.35	-5.39	41.00
Customer deposits	5,217	58.80	18.43	3.61	97.64
Liquidity	5,217	2.47	0.87	-2.55	4.58
NPLs	5,217	10.99	10.20	0.00	93.49
Bank size	5,217	14.41	2.00	9.11	21.20
GDP growth	5,217	0.61	1.96	-9.77	25.16
Inflation	5,217	1.62	3.08	-2.10	59.22
Private credit	5,217	85.78	20.70	21.78	255.31
Creditor info index	5,217	85.46	11.65	0.00	100.00
Legal rights index	5,217	30.10	17.43	8.33	100.00

Table 4.5 presents correlation matrix which is performed to check for collinearity issues present among variables before the data analysis. The correlation values range from -0.43 to 0.44. The highest correlation is 0.44 which exists between legal rights and CB reserves to total assets ratio. These correlation values indicate that no serious correlation issues exist between variables used in the regression analysis.

Table 4-4 Correlation matrix of variables used in the DiD regression.

	Z-Score	Risk Weighted Assets	CB reserves to total assets	ROA	loan growth	cost to income	Non-interest income	Equity to assets	customer deposits to assets	liquidity	NPLs	bank size	GDP growth	inflation	private credit to GDP	credit
Z-Score	1.00															
Risk Weighted Assets	-0.11	1.00														
CB reserves to total assets	-0.08	0.26	1.00													
ROA	0.07	-0. 01	0.07	1.00												
loan growth	-0.04	-0. 07	0.04	0.10	1.00											
cost to income	0.06	0.01	0.05	-0.43	0.07	1.00										
Non-interest income	-0.10	-0.15	-0.03	-0.03	0.03	0.02	1.00									
Equity to assets	0.05	0.26	0.15	0.18	-0.02	-0.02	-0.13	1.00								
customer deposits to assets	0.14	0.08	0.15	0.03	0.11	0.20	-0.12	0.02	1.00							
liquidity	-0.18	0.03	0.31	0.05	0.14	0.13	0.14	0.05	0.04	1.00						
NPLs	-0.29	0.02	-0.07	-0.38	-0.19	0.06	0.01	0.00	-0.11	-0.13	1.00					
bank size	0.06	-0.03	0.13	0.04	0.01	-0.13	0.26	-0.41	-0.20	0.06	-0.21	1.00				
GDP growth	0.07	0.01	0.38	0.18	0.12	0.03	0.00	0.00	0.16	0.16	-0.20	0.21	1.00			
inflation	-0.09	0.33	0.36	-0.04	0.04	-0.06	-0.11	0.11	0.00	0.11	0.00	0.04	-0.07	1.00		
private credit to GDP	0.06	-0.25	-0.12	-0.08	-0.08	0.01	0.09	-0.13	-0.16	0.00	-0.03	0.09	-0.23	-0.30	1.00	
creditor info	0.28	0.02	-0.10	-0.03	0.04	0.11	0.00	0.04	0.15	-0.17	-0.03	-0.08	-0.02	0.03	-0.14	1.00
legal rights	0.24	0.33	0.44	0.05	-0.03	0.07	-0.11	0.05	0.12	0.14	-0.20	0.19	0.18	0.29	-0.01	0.06

4.4 Empirical results and discussion

4.4.1 Do negative interest rates increase risk-taking?

4.4.1.1 Z score, risk weighted assets and central bank reserves

Table 4.6 presents the empirical results of our DiD model for the Z-Score. The treat2014 to treat2019 variables represent the NIPR treatment variable for respective years from 2014 to 2019. Column 1 shows the results of the baseline model stated in Equation 1. As shown in column 1, the coefficient of treat2014 is 4.711 and significant at 1%. This result implies that the change in the treatment variable from 0 to 1 gives rise to a 4.71-unit change in the value of Z-Score. Therefore, this indicates that the Z-Score of banks has increased with the adoption of negative policy rates. This positive impact has grown stronger over the next two years in treat2015 and treat2016. Therefore, we can say that NIPR has helped in minimising bank risk-taking. This risk-reducing impact of NIPR also stayed over the next few years, from 2017 to 2019, with little reduction in the magnitude of the positive coefficients from 5.956 to 3.813.

These results are consistent with the findings of Boungou (2020), Bongiovanni et al. (2021) and Nucera et al. (2017). Similar to Boungou (2020) and Boungiovanni et al. (2021), we find a positive association between Z-Score and NIPR. While they focus on the global sample (Boungou, 2020) and OECD countries (Boungiovanni et al., 2021), our analysis revolves only around the European sample. On the basis of sample selection, our results can be more reliable. The list of countries that adopted NIPR is mainly dominated by European countries. Therefore, the sample selection of European banks over the global sample or OECD countries can produce authentic results. In addition to this, since European countries face similar economic and regulatory conditions, such as the Eurozone crisis, it removes any potential bias that the global sample or OECD countries sample might have due to heterogenous economic conditions. Nucera et al. (2017) studied the impact of negative rates on bank's systemic risk in Euro-area countries. However, their sample includes only 111 banks from 2012 to 2015 period. Our sample size and sample period are bigger than Nucera et al. (2017). However, interestingly, our results are in contrast to Carbo-Valverde et al. (2021), which is also based on European countries. Two important factors can explain these differences. First, the use of dependent variables. In particular, the main dependent variable in Carbo-Valverde et al. (2021) is the net interest margin, whereas we use the Z-score. As we have discussed earlier, we do not think that the net interest margin is an appropriate measure of bank risk in a negative interest rate environment. In brief, a decrease in net interest margin is not necessarily a sign of banking stability but is a likely result of the negative interest rate policy. The second explanation may be linked to the fact that we have constrained our sample to contain countries that have adopted negative interest rates in the same year. This is to avoid any econometric bias. Countries in the sample of Carbo-Valverde et al. (2021) contain countries that have different adoption dates.

The decrease in insolvency risk (measured by Z-score) with the implementation of NIPR can be explained by the "de-leverage" view proposed by Boungiovanni et al. (2021). European banks employed the excess liquidity from programs such as quantitative easing to buy safer, liquid assets such as government bonds instead of investing in risky projects in "search of yield". The sovereign debt is considered risk-free as per European Union capital requirements. Therefore, this was the safest option for European banks to strengthen their capital positions when they have excess liquidity and also when they are recovering from the Eurozone crisis. As shown in column 1 of Table 4.6, the risk-reducing impact is strongest and increased from the 2014 to 2016 period when the Eurozone crisis was at its peak. Some research papers, such as Acharya and Steffen (2015) and Becker and Ivashina (2018), document that the banking sectors of European countries increased the share of sovereign debt during the Eurozone crisis. Our sample is also dominated by PIIGS countries; therefore, these results make sense if banks turned towards sovereign debt to appear safer.

The deleveraging hypothesis is supported by the results in Table 4.6 on risk-weighted assets. The results also serve as a robustness check for the results based on the Z score. While the effects of negative interest rates on risk-weighted asset is not felt significantly in the first year of implementation, we observe a very significant decrease in risk-weighted assets in the following years. Thus, banks appear to be decreasing their holdings of risky assets, reinforcing the results from the Z score that banks are taking less risk after the implementation of negative interest rates.

The final robustness checks are provided with the use of central bank reserves. We provide these results with the appreciation that central bank reserves might not be the most appropriate measure of banking stability in the context of negative interest rates. As discussed earlier, negative interest rates will decrease the profitability of banks as they face a penalty on their reserves at central banks. To avoid significant losses, banks will be incentivised to use those reserves for more profitable options, such as increasing their loan supply. Similar to the results of risk-weighted assets, we do not observe any significant impact of negative interest rates on central bank reserves in the first year. However, there is a drop in central bank reserve in the second year of implementation, which is significant at the 10% level. As discussed earlier, this effect was expected in the context of banks trying to reduce their losses associated with incurring a negative interest rate on their central bank reserve. Whilst such behaviour has been considered to be a sign of banking instability in previous years, in this context, we actually view this as a sign of good governance that is ultimately designed to preserve the profitability of banks. In fact, towards the end of the sample, we observe that banks increase their central bank reserve. This could indicate that banks have been successful at generating profits in the years following the negative interest rate and, as a result, have to increase their reserve at the central bank to meet the minimum reserve requirement. We view the evolution of the central bank reserves as a sign of banking stability. Overall, therefore, we provide three sets of results based on three different measures that suggest that banking instability or risk-taking has fallen since the implementation of negative interest rates.

Table 4-5 DiD regression results of baseline model against Z-Score, Risk Weighted Assets and CB Reserves.

The table shows DiD regression using panel dataset across 27 European countries over the period 2012-2019. Columns 1,2 and 3 are presenting baseline model results against Z-Score, Risk Weighted Assets and CB reserves respectively. Z-Score is measured as return on assets (ROA) plus capital to assets ratio divided by standard deviation of return on assets (σROA). Risk weighted Assets is measured as the ratio of average risk weighted assets to total assets. Central bank reserve is measured as the ratio of central bank reserves to total assets. The main explanatory variable is NIPR treatment presented as treat2014, treat2015, treat2016, treat2017, treat2018 and treat2019 respectively for each year from 2014 to 2019. Bank level controls used are ROA, loan growth, cost-income, non-interest income, equity-assets, customer deposits-assets, liquidity, NPLs and bank size. Banking industry controls are credit information index and legal rights index. Whereas GDP growth, inflation and private credit-GDP are macro-economic controls. Year fixed effects are used. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

	Baseline regression	Baseline regression	Baseline regression
	(1)	(2)	(3)
VARIABLES	Z-Score	Risk-Weighted Assets	CB Reserves
1.treat2014	4.711[a]	0.046	0.081
	(1.173)	(4.147)	(0.304)
1.treat2015	4.745[a]	-19.689[a]	-0.682[c]
	(1.192)	(5.298)	(0.385)
1.treat2016	5.956[a]	-15.380[a]	0.018
	(1.595)	(5.565)	(0.436)
1.treat2017	3.673[b]	-6.736	0.099
	(1.449)	(4.266)	(0.420)
1.treat2018	2.251	-5.313	0.422
	(1.713)	(5.027)	(0.415)
1.treat2019	3.813[b]	-6.531	1.259[a]
	(1.623)	(5.137)	(0.477)
ROA	0.465[c]	-0.228	0.095[c]
	(0.247)	(0.909)	(0.055)
Loan growth	-0.018[c]	-0.027	-0.004[b]
	(0.010)	(0.017)	(0.002)
Cost-Income	0.008	0.066	0.007
	(0.017)	(0.041)	(0.004)
Non-interest income	0.046[b]	-0.024	0.013[b]
	(0.018)	(0.051)	(0.006)
Equity-Assets	2.311[a]	1.542[a]	0.044
	(0.243)	(0.269)	(0.032)
Customer dep-Assets	0.040	0.216[a]	0.010
	(0.041)	(0.076)	(0.008)
Liquidity	-2.294[a]	-1.156[c]	0.358[a]
	(0.426)	(0.646)	(0.085)
NPLs	-0.098[a]	0.173	0.007
	(0.037)	(0.145)	(0.010)
Bank size	-2.848[b]	1.422	0.235
	(1.373)	(2.103)	(0.291)
GDP growth	-1.209[a]	-1.554[b]	-0.053
	(0.243)	(0.618)	(0.053)
Inflation	-0.013	-0.956[b]	-0.024

	(0.117)	(0.415)	(0.032)
Private credit	0.025	0.088	0.023
	(0.027)	(0.112)	(0.014)
Credit info	-0.128[a]	-0.506[b]	0.019
	(0.045)	(0.221)	(0.018)
Legal rights	-0.133[a]	0.620[a]	-0.022[b]
	(0.041)	(0.179)	(0.010)
Constant	97.612[a]	23.387	-6.619
	(21.625)	(36.475)	(4.830)
Year FE	Yes	Yes	Yes
Observations	5,217	4,265	5,217
R-squared	0.333	0.246	0.108
Number of Banks	761	658	761

4.4.1.2 Control variables

Table 4.6 also presents the results of the control variables. Looking at the control variables for the Z score, we find that ROA is helping banks to minimize their bank risk. This result is in line with the view that high-profit banks are less encouraged to search for yield and have fewer information asymmetry issues (Holmstrom and Tirole, 1997). Second, the coefficient of loan growth is negative and significant at 10%. It supports the view that credit growth strategies are usually associated with risks such as high default rates (Keeton, 1999). Further, the coefficients of non-interest income are showing the risk-reducing impact. Non-interest income helps banks generate additional income and diversify the overall risk of their portfolios (Lee et al., 2014). The coefficient of equity to assets also shows a strong, positive impact on reducing the insolvency risk of banks. Banks with high equity to assets present low risk and strong financial position (Myers, 1977). These banks are more likely to overcome any financial downturns and produce more returns by investing the equity they have in various projects compared to banks with less equity-assets ratio.

On the other hand, the results of liquidity, NPLs and bank size support the risk-inducing stance. First, the risk-inducing effect of liquidity supports the agency theory assumptions and presents that managers are more likely to divert funds to private interests or invest funds in risky projects when large amounts of liquid funds are available (Dinger and Kaat, 2020). Second, the risk of banks increases under high NPLs when banks tighten their lending standards due to highly impaired loans, which results in a decrease in the loan book of banks. High NPLs also mean that these banks have less funds to grant further loans. Further, large banks end up having involvement in high-risk activities due to the principle of "too big to fail" (Laeven and Levine, 2009). Lastly, the coefficients of cost to income and customer deposits to assets are not significant.

For banking industry controls, both credit information index and legal rights increase the risk-taking behaviour of banks. These findings are in line with Guerineau and Leon (2019) and Houston et al. (2010).

Banks are more likely to lend to risky borrowers in the presence of greater information sharing and strong loan recovery rights. Regarding macroeconomic controls, while GDP growth results show that higher GDP growth encourages risk-taking in banks, the coefficients of inflation and private credit are insignificant. Stronger economic conditions attract more investment funds to the economy and, hence, also the banks. The availability of these funds can encourage managers to invest in risky projects to maximize shareholder wealth (McDonald and Siegal, 1986).

There are some differences for the control variables between the results of the Z score and those of risk-weighted assets and central bank reserves, but these are to be expected given that differences exist among our dependent with regard to what they actually exactly represent.

4.4.1.3 Further robustness checks

In addition to providing results from different measures of bank risk-taking, we also perform further analysis. In particular, we perform some analysis by excluding banks from Italy as it is the dominant country in our primary sample, with observations around 40%. We perform this robustness test to check that our primary results are not driven by the dominant country in the sample. (ii) We perform a robustness test by removing Portugal, Italy, Ireland, Greece, and Spain (PIIGS) from the sample. During the European debt crisis of the late 2000s, PIIGS countries suffered the most and had to be bailed out by European lenders and the IMF. The bailout agreement was attached with conditions of structural reform. Therefore, to dissociate the impact of those structural reforms, which is likely to have had a positive impact on banking stability, we perform some analysis by excluding PIIGS countries. The final robustness check is to cluster the standard errors at the country level.

Results obtained by excluding Italy and PIIGS countries are given in Tables 4.7 and 4.8, respectively. In both cases, the results are qualitatively similar to our findings in Table 4.6 earlier. These results suggest that our findings have not been influenced by the biggest country in the sample nor the reforms that PIIGS have had to undergo. Results that are based on clustering standard errors for estimation conducted in section 4.3.6.1. are given in Appendix 14. Once again, our results are largely qualitatively similar.

Similar to our previous two empirical chapters, we used banking regulation as a control measure to check if regulations have an impact on the relationship between negative rates and banking stability. We employed capital stringency index as a proxy for banking regulation. The results remain qualitatively similar and are presented in Appendix 18.

Table 4-6 Robustness test: DiD regression analysis by using sample without Italy.

The table shows DiD regression using panel dataset across 26 European countries over the period 2012-2019. Columns 1,2 and 3 are presenting baseline model results against Z-Score, Risk Weighted Assets and CB reserves respectively. Z-Score is measured as return on assets (ROA) plus capital to assets ratio divided by standard deviation of return on assets (σROA). Risk weighted Assets is measured as the ratio of average risk weighted assets to total assets. Central bank reserve is measured as the ratio of central bank reserves to total assets. The main explanatory variable is NIPR treatment presented as treat2014, treat2015, treat2016, treat2017, treat2018 and treat2019 respectively for each year from 2014 to 2019. Bank level controls used are ROA, loan growth, cost-income, non-interest income, equity-assets, customer deposits-assets, liquidity, NPLs and bank size. Banking industry controls are credit information index and legal rights index. Whereas GDP growth, inflation and private credit-GDP are macro-economic controls. Year fixed effects are used. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

	Baseline regression	Baseline regression	Baseline regression
	(1)	(2)	(3)
VARIABLES	Z-Score	Risk Weighted Assets	CB Reserves
1.treat2014	3.239[a]	1.409	-0.198
	(1.022)	(4.404)	(0.318)
1.treat2015	4.421[a]	-16.196[a]	-0.723[c]
	(1.139)	(5.373)	(0.380)
1.treat2016	8.296[a]	-11.578[b]	0.279
	(1.600)	(5.717)	(0.433)
1.treat2017	8.487[a]	0.912	0.458
	(1.801)	(4.157)	(0.445)
1.treat2018	8.229[a]	1.398	1.568[a]
	(1.935)	(5.394)	(0.478)
1.treat2019	10.376[a]	1.963	3.071[a]
	(2.091)	(5.577)	(0.499)
ROA	0.113	-0.655	0.115[c]
	(0.277)	(1.716)	(0.062)
Loan growth	-0.002	-0.007	0.000
	(0.013)	(0.050)	(0.003)
Cost-Income	0.033	0.125	0.009[c]
	(0.028)	(0.088)	(0.005)
Non-interest income	0.029	0.032	0.009
	(0.026)	(0.121)	(0.011)
Equity-Assets	2.038[a]	2.060[a]	0.014
	(0.301)	(0.573)	(0.044)
Customer dep-Assets	0.100	0.412[b]	0.025[c]
	(0.065)	(0.201)	(0.013)
Liquidity	-2.510[a]	-3.529[c]	1.021[a]
	(0.885)	(2.008)	(0.191)
NPLs	-0.080[c]	0.087	-0.011
	(0.045)	(0.296)	(0.012)
Bank size	0.813	6.556	0.163
	(2.069)	(7.837)	(0.436)
GDP growth	-0.926[a]	-0.639	-0.050
	(0.245)	(0.634)	(0.064)
Inflation	-0.042	-0.790[c]	-0.031
	(0.112)	(0.425)	(0.032)

Private credit	-0.125[b]	-0.025	-0.005
	(0.049)	(0.091)	(0.011)
Credit info	-0.188[a]	-0.466[b]	0.002
	(0.043)	(0.186)	(0.015)
Legal rights	-0.007	0.866[a]	-0.007
	(0.039)	(0.209)	(0.012)
Constant	78.259[b]	-88.537	-2.553
	(34.982)	(137.487)	(7.196)
Year FE	Yes	Yes	Yes
Observations	2,185	1,298	2,185
R-squared	0.308	0.252	0.215
Number of Banks	315	212	315

Table 4-7 Robustness test: DiD Regression analysis by removing PIIGS countries.

The table shows DiD regression using panel dataset across 22 European countries over the period 2012-2019. Columns 1,2 and 3 are presenting baseline model results against Z-Score, Risk Weighted Assets and CB reserves respectively. Z-Score is measured as return on assets (ROA) plus capital to assets ratio divided by standard deviation of return on assets (σROA). Risk weighted Assets is measured as the ratio of average risk weighted assets to total assets. Central bank reserve is measured as the ratio of central bank reserves to total assets. The main explanatory variable is NIPR treatment presented as treat2014, treat2015, treat2016, treat2017, treat2018 and treat2019 respectively for each year from 2014 to 2019. Bank level controls used are ROA, loan growth, cost-income, non-interest income, equity-assets, customer deposits-assets, liquidity, NPLs and bank size. Banking industry controls are credit information index and legal rights index. Whereas GDP growth, inflation and private credit-GDP are macro-economic controls. Year fixed effects are used. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

PIIGS	(1)	(2)	(3)
VARIABLES	Z-Score	Risk Weighted Assets	CB Reserves
1.treat2014	2.502[b]	1.891	-0.184
	(1.003)	(4.504)	(0.323)
1.treat2015	4.204[a]	-16.074[a]	-0.707[c]
	(1.155)	(5.585)	(0.380)
1.treat2016	8.474[a]	-11.425[c]	0.294
	(1.648)	(5.848)	(0.442)
1.treat2017	9.534[a]	0.794	0.489
	(1.971)	(4.100)	(0.452)
1.treat2018	9.177[a]	1.190	1.529[a]
	(2.175)	(5.600)	(0.490)
1.treat2019	11.642[a]	1.146	3.054[a]
	(2.415)	(5.723)	(0.511)
ROA	0.104	-0.915	0.122[c]
	(0.302)	(1.741)	(0.065)
Loan growth	0.003	-0.008	-0.000
	(0.014)	(0.053)	(0.003)
Cost-Income	0.021	0.110	0.010[c]
	(0.029)	(0.091)	(0.005)
Non-interest income	0.013	0.035	0.007
	(0.026)	(0.123)	(0.011)
Equity-Assets	2.183[a]	2.216[a]	0.023
	(0.335)	(0.640)	(0.048)
Customer dep-Assets	0.118[c]	0.395[c]	0.021
	(0.067)	(0.219)	(0.013)
Liquidity	-2.574[a]	-3.335	1.047[a]
	(0.906)	(2.023)	(0.196)
NPLs	-0.045	-0.016	-0.014
	(0.048)	(0.355)	(0.014)
Bank size	1.331	8.028	0.083
	(2.201)	(8.030)	(0.451)
GDP growth	-0.795[a]	-0.619	-0.066
	(0.221)	(0.793)	(0.069)
Inflation	0.015	-0.767[c]	-0.033
	(0.103)	(0.440)	(0.034)

Private credit	-0.191[b]	-0.007	-0.003
	(0.081)	(0.115)	(0.015)
Credit info	-0.208[a]	-0.448[b]	0.003
	(0.046)	(0.186)	(0.015)
Legal rights	0.022	0.864[a]	-0.009
	(0.043)	(0.218)	(0.012)
Constant	76.756[b]	-113.116	-1.302
	(37.587)	(140.167)	(7.415)
Year FE	Yes	Yes	Yes
Observations	2,101	1,246	2,101
R-squared	0.316	0.251	0.213
Number of Banks	302	201	302

4.4.2 Does the type of bank (commercial, cooperative, savings) influence risk-taking behaviour?

We discussed in the earlier sections that there are differences in terms of the services different types of banks offer and their business models. We wanted to investigate whether those differences contribute to banks' risk-taking behaviour. Our analysis of banks based on their specialization is based on using interaction terms with treatment variables (negative interest rate). More specifically, we create dummy variables to distinguish between the different types of banks. We interact the dummy variable for each type of bank with the treatment variable to observe their effects. Results are presented in Tables 4.9, 4.10 and 4.11 for the Z score, risk-weighted assets, and central bank reserves, respectively. The results in Columns 1, 2 and 3 in Table 4.9 are for commercial, cooperative and savings banks, respectively. Some interesting results emerge from that analysis. Looking at the results for the Z score, we find that there are some differences in the behaviour of the different types of banks. There is a clear distinction between the behaviour of commercial banks and savings banks. Following the implementation of negative interest rates, commercial banks have increased risk-taking, whereas, for savings banks, risk-taking has decreased. Except for the first year of treatment for the savings banks, all results are highly statistically significant. With regard to cooperative banks, the results are somewhat mixed. Starting from a position of reduced risk-taking but not in a statistically significant manner, cooperative banks end up increasing risk-taking very significantly. These results stand when subjected to our robustness checks. In particular, we make similar findings when removing Italy and PIIGS from the sample. Moreover, when we look at the results from risk-weighted assets, once again, we find that commercial banks increase risk-taking. This result is also supported by our robustness checks that exclude Italy and PIIGS. Cooperative banks are found to decrease risk-taking significantly, but in the robustness checks, cooperative banks display mixed results similar to Z score. Savings banks, in contrast to results from the Z score, are found to increase risk-taking. In the robustness checks, however, we find that savings banks decrease risk-taking when samples without Italy and PIIGS are considered. It would thus appear that there may be certain characteristics of Italian banks that may be causing savings banks to increase risk-taking. Finally, looking at the results from central bank reserves. The results are not as clear-cut as in the cases of the z score and risk-weighted assets. This is perhaps not surprising given that we have already acknowledged that central bank reserves may not be the most appropriate measure of banking stability. Cooperative banks are found to decrease their holdings at central banks significantly across most years and in all the different samples- full, excluding Italy and PIIGS. As we discussed earlier, this may be an indication that banks may be trying to avoid incurring negative interest rates to maintain their profitability. With commercial banks, in the first of the treatment, results are not generally significant, but in subsequent years, they appear to increase their reserves at central banks. These results are consistent across all three samples. The impact of the treatment on savings banks appears to be significant and positive only towards the end of the sample. The clear distinction that was observed between the behaviour of commercial banks and savings banks with the Z score results and risk-weighted assets results is not apparent here. Nevertheless, one may argue that results from the central bank reserves are indeed supportive of the earlier results that commercial banks are more risk-taking, whereas savings banks are less risk-taking. One may argue that commercial banks increased their central bank reserves earlier as they took on more risks, e.g. borrowing more from other banks and selling commercial paper to generate higher profits.

By and large, our results suggest that commercial banks are more risk-taking than savings banks. The risk-taking approach of commercial banks in response to NIPR makes sense as they are more likely to be involved in risky lending activities to cover up the costs increased by NIPR over saving banks that are involved only in deposit activities. Commercial banks are usually profit-oriented organizations that are focused on high-risk and high-return activities. Also, they are owned by shareholders who have the intention to safeguard bank value when negative rates can affect the profit margins. Savings banks serve the needs of their principal stakeholders and do not follow wealth maximization as their primary objective.

Table 4-8 DiD model regression result against Z-Score for different type of banks.

The table shows DiD regression results using panel dataset across 27 European countries over the period 2012-2019. Columns 1, 2 and 3 are presenting interaction term results of commercial, cooperative and savings banks respectively. Risk weighted Assets is the dependent variable. Risk weighted Assets is measured as the ratio of average risk weighted assets to total assets. The main explanatory variable is NIPR treatment presented as treat2014, treat2015, treat2016, treat2017, treat2018 and treat2019 respectively for each year from 2014 to 2019. Bank level controls used are ROA, loan growth, cost-income, non-interest income, equity-assets, customer deposits-assets, liquidity, NPLs and bank size. Banking industry controls are credit information index and legal rights index. Whereas GDP growth, inflation and private credit-GDP are macro-economic controls. Year fixed effects are used. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

	With commercial bank interaction	With cooperative bank interaction	With savings bank interaction
	(1)	(2)	(3)
VARIABLES	Z-Score	Z-Score	Z-Score
1.treat2014	5.242[a]	4.211[a]	3.720[a]
	(1.223)	(1.195)	(1.017)
1.treat2015	5.420[a]	4.768[a]	3.569[a]
	(1.290)	(1.319)	(0.996)
1.treat2016	7.090[a]	6.888[a]	3.857[a]
	(1.737)	(1.891)	(1.333)
1.treat2017	4.685[a]	5.722[a]	1.754
	(1.644)	(1.838)	(1.274)
1.treat2018	3.183[c]	4.532[b]	0.284
	(1.920)	(2.022)	(1.533)
1.treat2019	4.908[a]	6.155[a]	1.622
	(1.837)	(2.090)	(1.410)
ROA	0.513[b]	0.422[c]	0.481[c]
	(0.250)	(0.245)	(0.245)
Loan growth	-0.019[c]	-0.015	-0.013
	(0.010)	(0.010)	(0.010)
Cost-Income	0.008	0.008	0.012
	(0.017)	(0.018)	(0.017)
Non-interest income	0.042[b]	0.041[b]	0.038[b]
	(0.018)	(0.018)	(0.018)
Equity-Assets	2.310[a]	2.284[a]	2.257[a]
	(0.245)	(0.238)	(0.240)
Customer dep-Assets	0.030	0.056	0.039
	(0.043)	(0.041)	(0.040)
Liquidity	-2.242[a]	-2.257[a]	-2.165[a]
	(0.425)	(0.436)	(0.401)
NPLs	-0.094[b]	-0.109[a]	-0.099[a]
	(0.037)	(0.038)	(0.037)
Bank size	-2.945[b]	-2.755[c]	-2.334[c]
	(1.362)	(1.424)	(1.356)
GDP growth	-1.214[a]	-1.202[a]	-0.926[a]
	(0.236)	(0.239)	(0.182)
Inflation	-0.011	-0.018	0.034
	(0.116)	(0.118)	(0.113)

Private credit	0.032	0.009	0.013
	(0.028)	(0.026)	(0.027)
Credit info	-0.107[b]	-0.151[a]	-0.099[b]
	(0.044)	(0.047)	(0.042)
Legal rights	-0.139[a]	-0.123[a]	-0.103[a]
	(0.041)	(0.040)	(0.038)
1.treat2014#1.commercial	-1.301[a]		
	(0.492)		
1.treat2015#1.commercial	-1.945[a]		
	(0.718)		
1.treat2016#1.commercial	-3.428[a]		
	(1.001)		
1.treat2017#1.commercial	-2.905[b]		
	(1.353)		
1.treat2018#1.commercial	-2.554[c]		
	(1.464)		
1.treat2019#1.commercial	-3.227[b]		
	(1.471)		
1.treat2014#1.cooperative		0.447	
		(0.550)	
1.treat2015#1.cooperative		-0.367	
		(0.838)	
1.treat2016#1.cooperative		-1.992	
		(1.238)	
1.treat2017#1.cooperative		-3.839[b]	
		(1.533)	
1.treat2018#1.cooperative		-4.394[a]	
		(1.553)	
1.treat2019#1.cooperative		-4.372[b]	
		(1.718)	
1.treat2014#1.savings			1.666
			(1.232)
1.treat2015#1.savings			5.138[b]
			(2.183)
1.treat2016#1.savings			12.271[a]
			(3.655)
1.treat2017#1.savings			15.238[a]
			(4.155)
1.treat2018#1.savings			16.268[a]
			(4.430)
1.treat2019#1.savings			17.610[a]
			(4.855)
Constant	97.404[a]	98.805[a]	88.096[a]
	(21.347)	(22.242)	(21.208)
Year FE	Yes	Yes	Yes
Observations	5,217	5,217	5,217
R-squared	0.336	0.341	0.377
Number of Banks	761	761	761

Table 4-9 DiD model regression result against Z-Score for different type of banks.

The table shows DiD regression results using panel dataset across 27 European countries over the period 2012-2019. Columns 1, 2 and 3 are presenting interaction term results of commercial, cooperative and savings banks respectively. Z-Score is the dependent variable. It is measured as return on assets (ROA) plus capital to assets ratio divided by standard deviation of return on assets (σROA). The main explanatory variable is NIPR treatment presented as treat2014, treat2015, treat2016, treat2017, treat2018 and treat2019 respectively for each year from 2014 to 2019. Bank level controls used are ROA, loan growth, cost-income, non-interest income, equity-assets, customer deposits-assets, liquidity, NPLs and bank size. Banking industry controls are credit information index and legal rights index. Whereas GDP growth, inflation and private credit-GDP are macro-economic controls. Year fixed effects are used. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

	(1)	(2)	(3)
VARIABLES	Risk Weighted Assets	Risk Weighted Assets	Risk Weighted Assets
1.treat2014	-1.986	5.801	-0.952
	(4.122)	(4.218)	(4.179)
1.treat2015	-21.758[a]	-13.407[b]	-20.564[a]
	(5.361)	(5.223)	(5.301)
1.treat2016	-17.591[a]	-9.025	-16.294[a]
	(5.584)	(5.497)	(5.605)
1.treat2017	-8.789[b]	-1.000	-7.542[c]
	(4.326)	(4.180)	(4.308)
1.treat2018	-7.245	-0.237	-5.828
	(5.043)	(5.034)	(5.061)
1.treat2019	-8.263	-1.827	-7.135
	(5.167)	(5.125)	(5.205)
ROA	-0.411	-0.448	-0.246
	(0.916)	(0.918)	(0.911)
Loan growth	-0.027	-0.025	-0.027
	(0.017)	(0.017)	(0.017)
Cost-Income	0.063	0.063	0.066
	(0.041)	(0.041)	(0.041)
Non-interest income	-0.008	0.000	-0.020
	(0.051)	(0.052)	(0.051)
Equity-Assets	1.576[a]	1.552[a]	1.531[a]
	(0.267)	(0.268)	(0.270)
Customer dep-Assets	0.230[a]	0.230[a]	0.217[a]
	(0.076)	(0.076)	(0.076)
Liquidity	-1.228[c]	-1.252[c]	-1.178[c]
	(0.653)	(0.655)	(0.651)
NPLs	0.161	0.161	0.173
	(0.147)	(0.147)	(0.146)
Bank size	1.756	2.139	1.655
	(2.110)	(2.106)	(2.107)
GDP growth	-1.616[a]	-1.411[b]	-1.453[b]
	(0.621)	(0.610)	(0.623)
Inflation	-0.968[b]	-0.945[b]	-0.945[b]
	(0.419)	(0.411)	(0.413)
Private credit	0.079	0.080	0.087

	(0.110)	(0.108)	(0.114)
Credit info	-0.535[b]	-0.524[b]	-0.499[b]
	(0.212)	(0.210)	(0.221)
Legal rights	0.627[a]	0.647[a]	0.631[a]
	(0.178)	(0.179)	(0.179)
1.treat2014#1.commercial	9.250[a]		
	(1.303)		
1.treat2015#1.commercial	10.134[a]		
	(1.491)		
1.treat2016#1.commercial	10.496[a]		
	(1.644)		
1.treat2017#1.commercial	8.597[a]		
	(1.643)		
1.treat2018#1.commercial	8.332[a]		
	(1.867)		
1.treat2019#1.commercial	7.403[a]		
	(1.911)		
1.treat2014#1.cooperative		-9.640[a]	
		(1.024)	
1.treat2015#1.cooperative		-10.007[a]	
		(1.176)	
1.treat2016#1.cooperative		-10.319[a]	
		(1.283)	
1.treat2017#1.cooperative		-9.192[a]	
		(1.277)	
1.treat2018#1.cooperative		-7.956[a]	
		(1.406)	
1.treat2019#1.cooperative		-7.514[a]	
		(1.536)	
1.treat2014#1.savings			5.753[a]
			(1.005)
1.treat2015#1.savings			5.226[a]
			(1.162)
1.treat2016#1.savings			5.239[a]
			(1.137)
1.treat2017#1.savings			5.865[a]
			(1.239)
1.treat2018#1.savings			3.944[a]
			(1.374)
1.treat2019#1.savings			4.315[a]
			(1.574)
Constant	20.412	13.418	19.218
	(36.611)	(36.653)	(36.579)
Year FE	Yes	Yes	Yes
Observations	4,265	4,265	4,265
R-squared	0.262	0.267	0.249
Number of Banks	658	658	658

Table 4-10 DiD model regression result against central bank reserves to total assets for different type of banks.

The table shows DiD regression using panel dataset across 27 European countries over the period 2012-2019. Columns 1, 2 and 3 are presenting interaction term results of commercial, cooperative and savings banks respectively Central bank reserve is the dependent variable. It is measured as the ratio of central bank reserves to total assets. The main explanatory variable is NIPR treatment presented as treat2014, treat2015, treat2016, treat2017, treat2018 and treat2019 respectively for each year from 2014 to 2019. Bank level controls used are ROA, loan growth, cost-income, non-interest income, equity-assets, customer deposits-assets, liquidity, NPLs and bank size. Banking industry controls are credit information index and legal rights index. Whereas GDP growth, inflation and private credit-GDP are macro-economic controls. Year fixed effects are used. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

	With commercial bank interaction	With cooperative bank interaction	With savings bank interaction
	(1)	(2)	(3)
VARIABLES	CB Reserves	CB Reserves	CB Reserves
1.treat2014	0.020	0.013	0.047
	(0.304)	(0.313)	(0.305)
1.treat2015	-0.806[b]	-0.611	-0.709[c]
	(0.385)	(0.394)	(0.388)
1.treat2016	-0.267	0.401	-0.046
	(0.436)	(0.443)	(0.440)
1.treat2017	-0.346	0.876[c]	-0.016
	(0.416)	(0.454)	(0.425)
1.treat2018	-0.060	1.087[b]	0.355
	(0.406)	(0.447)	(0.420)
1.treat2019	0.724	2.444[a]	1.035[b]
	(0.472)	(0.515)	(0.481)
ROA	0.076	0.077	0.099[c]
	(0.053)	(0.053)	(0.054)
Loan growth	-0.004[b]	-0.003[c]	-0.004[b]
	(0.002)	(0.002)	(0.002)
Cost-Income	0.007	0.007[c]	0.008[c]
	(0.004)	(0.004)	(0.004)
Non-interest income	0.013[b]	0.013[c]	0.013[b]
	(0.006)	(0.007)	(0.006)
Equity-Assets	0.041	0.035	0.041
	(0.031)	(0.031)	(0.032)
Customer dep-Assets	0.016[b]	0.017[b]	0.011
	(0.008)	(0.008)	(0.007)
Liquidity	0.350[a]	0.364[a]	0.364[a]
	(0.083)	(0.083)	(0.085)
NPLs	0.004	0.002	0.006
	(0.010)	(0.010)	(0.010)
Bank size	0.237	0.285	0.283
	(0.283)	(0.287)	(0.294)
GDP growth	-0.069	-0.051	-0.039
	(0.054)	(0.053)	(0.053)
Inflation	-0.030	-0.027	-0.021
	(0.032)	(0.032)	(0.031)
Private credit	0.018	0.016	0.021

	(0.013)	(0.012)	(0.014)
Credit info	0.009	0.011	0.021
	(0.017)	(0.016)	(0.018)
Legal rights	-0.020[b]	-0.018[c]	-0.020[c]
	(0.010)	(0.010)	(0.010)
1.treat2014#1.commercial	0.121		
	(0.155)		
1.treat2015#1.commercial	0.345[c]		
	(0.189)		
1.treat2016#1.commercial	0.876[a]		
	(0.227)		
1.treat2017#1.commercial	1.305[a]		
	(0.314)		
1.treat2018#1.commercial	1.333[a]		
	(0.298)		
1.treat2019#1.commercial	1.613[a]		
	(0.350)		
1.treat2014#1.cooperative		-0.045	
		(0.118)	
1.treat2015#1.cooperative		-0.252[c]	
		(0.142)	
1.treat2016#1.cooperative		-0.809[a]	
		(0.176)	
1.treat2017#1.cooperative		-1.467[a]	
		(0.259)	
1.treat2018#1.cooperative		-1.334[a]	
		(0.245)	
1.treat2019#1.cooperative		-2.139[a]	
		(0.294)	
1.treat2014#1.savings			-0.125
			(0.121)
1.treat2015#1.savings			-0.082
			(0.147)
1.treat2016#1.savings			0.130
			(0.217)
1.treat2017#1.savings			0.844[c]
			(0.446)
1.treat2018#1.savings			0.411
			(0.329)
1.treat2019#1.savings			1.864[a]
			(0.430)
Constant	-5.693	-6.354	-7.356
	(4.570)	(4.627)	(4.879)
Year FE	Yes	Yes	Yes
Observations	5,217	5,217	5,217
R-squared	0.133	0.151	0.120
Number of Banks	761	761	761

4.5 Conclusion and recommendations

In this chapter, we have examined the relationship between negative interest rates and bank risk-taking. The literature on the impact of negative rates on bank risk-taking behaviour is scant. Also, the existing empirical evidence provides mixed evidence (Boungou, 2020; Bebeck et al., 2020). Therefore, we are motivated to conduct this research to provide additional insights into this literature. We empirically examine the impact of NIPR on bank risk by employing the sample of active commercial banks, cooperative banks and savings banks across 36 European countries from the period 2012 to 2019. We use DID methodology to analyse our empirical model of treated and control group countries. We use three dependent variables: Z-Score, risk-weighted assets and CB reserves to assets.

There are contradictory views on the relationship between negative rates and bank risk (Bongiovanni et al., 2019; Rajan, 2006). Our results correspond to Boungou (2020) and Bongionvanni et al. (2021). In particular, we find that, by and large, negative interest rates reduce risk-taking among banks. Of interest is the fact that we employed European data, similar to Carbo-Valverde et al. (2021), but made contrasting findings. The primary reason is the selection of the dependent variable that measures bank risk-taking. The primary variable used in Carbo-Valverde et al. 2021 is net interest margin. We argue that although net interest margin and variables such as loan growth and nonperforming loans have been used in the literature as a measure of banking stability, they are not appropriate in the context of negative interest rates. This is because what is generally considered a sign of banking instability may not have anything to do with banking stability but rather an expected consequence of the negative interest rate environment. The other main difference with the study of Carbo-Valverde et al. 2021 is that in our treatment group (those affected by negative interest rates), we only employ countries that adopted negative interest rates in the same year. Having multiple adoption dates presents econometric challenges, as discussed in the data and methodology section. We subject our analysis to a number of robustness checks, and by and large, the main results remain unchanged.

Another contribution of this study was to investigate whether the types of banks – commercial, cooperative and savings have any impact on the risk-taking behaviour of banks. This is motivated by the fact these banks have different business models and ownership structures. Generally, we find that commercial banks tend to take more risks, whereas savings banks display more prudent behaviour. The behaviour of cooperative banks is less clear-cut as they display the characteristics of both risk-seeking and risk-avoidance. Such results can, indeed, be related to the business models and ownership structures.

Following the implementation of negatives, there were worries that it may threaten the financial sector's stability. There were fears that banks may engage in risky behaviour to protect their profitability following the cost they were going to incur on their reserves. Our results, however, suggest that banks generally have not increased their risk-taking across European countries. Moreover, our analysis of the central bank reserves suggests that banks are lending more. Overall, our results indicate that the negative interest rate policy serves the purpose policy it was designed to do and, in the process, is not putting the financial system at risk.

Chapter 5 Conclusion

The financial crisis exposed the weaknesses of existing banking regulations and supervisory systems. This failure of policies and regulations has raised concerns and the need to evaluate its effectiveness. Therefore, we have assessed the impact of creditor rights, banking regulations, institutional environment, and negative interest rates on bank risk-taking behaviour. This chapter outlines the findings of this thesis, proposes policy implications of our findings, and highlights the limitations of our study.

5.1 Research contribution, empirical findings, and policy implications

5.1.1 Research objective 1

This thesis has examined three main research objectives, which are addressed in Chapter 2, Chapter 3 and Chapter 4, respectively. In Chapter 2, we have analysed the research objective "What is the impact of various bank regulatory measures and creditor rights on risk-taking in banks?". We contribute to empirical literature in two ways. First, there is a gap in the literature on how creditor rights and bank regulations shaped banks' risk-taking behaviour after the global financial crisis. Second, we contribute to literature based on data samples and methodology. While other studies focused individually on European, developed or developing nations (Agoraki et al., 2011; Bermpei et al., 2018), only a handful of studies have analysed the impact of creditor rights and bank regulations on bank risk-taking globally (Ashraf et al., 2020; Houston et al., 2010; Hoque et al., 2015; Laeven and Levine, 2009).

We have found that creditor rights encourage risk-taking in banks. Creditor rights continued to increase banks' risk-taking after the crisis, but the impact of risk was reduced significantly. We used three bank regulatory measures: activity restrictions, capital stringency and official supervisory powers. All of the three regulatory measures promote risk-taking behaviour in banks. While evaluating the regulatory measure's impact after the global financial crisis period, we find that the risk-taking effect of bank regulations reversed in the post-crisis period.

These findings have several policy implications. Creditor rights might positively influence bank credit supply and economic growth (Acharya et al., 2011). However, regulators must balance these pros with the adverse effects of stronger creditor rights. Stronger creditor rights increase bank competition and risk by promoting poor lending standards when banks have stronger recovery rights. Regulators put in place tight regulatory measures to control bank risk-taking. However, they failed to manage risk for banks even during the crisis (Beltratti and Stulz, 2012). Our results also prove that tightening banking regulations is inadequate to control bank risk-taking. Strict activity restrictions limit the income diversification of banks; stringent capital requirements are associated with limiting the efficient asset investment by banks, and higher supervisory powers also increase bank risk by interfering in the loan sanction process and increasing competition in the market. Therefore, policymakers should undertake to find the right balance of regulatory policies that help in managing bank risk.

5.1.2 Research objective 2

Chapter 3 examined the research question, "What is the relationship between the different measures of the institutional environment and the risk-taking behaviour of banks?". We contribute to empirical literature in the following ways. First, we contribute to scant literature as only a few studies have explored institutions' role in shaping bank risk-taking behaviour on a global scale (Houston et al., 2010; Bui and Bui, 2019). Second, our study differs from Houston et al. (2010) and Bui and Bui (2019) regarding data and methodology. We used more extensive data and a more prolonged period than these studies. We employed more advanced econometric methodologies (fixed effects and system GMM) as compared to Houston et al. (2010), who have used OLS and Bui and Bui (2019), who have applied GLS. Finally, we contribute an in-depth analysis of the contrary effect of political stability based on major economic events (global crisis in our case) and country subsamples.

We find the varying impact of six institutional quality measures on bank risk-taking based on different methodologies and subsamples. Using FE, while we find that government effectiveness (GE), regulatory quality (RQ), and rule of law (RL) help mitigate the risk-taking, voice and accountability (V&A), political stability (PS), and control of corruption (CC) do not show significant coefficients. The extent to which these three world governance indicators (WGIs) mitigate price volatility also varies. For example, one unit increase in the GE index decreases price volatility by 260% on one side, and on the other side, one unit increase in RQ decreases price volatility by 670%. Further, we investigated whether specific countries or periods influence the relationship between WGIs and bank risk-taking. We find that while PS reduced price volatility before and after the crisis in the US banks, PS induced volatility in share prices during the global crisis. Regarding European banks, we find that PS helped lower the price volatility before the crisis, but this effect was opposed after the global crisis (when sovereign debt started in European countries).

These findings have some policy implications. While we find that all WGIs (V&A, RQ, GE, RL, and CC) mitigate bank risk, PS induces risk-taking behaviour in banks. The policy implication of these general findings is that governments worldwide should improve their institutional environments, which will lead to less bank risk-taking and, therefore, reduce the risks of a financial sector collapse, which, as the financial crisis of 2007/8 showed, can have a long-lasting and devasting impact on economies. The results also suggest that despite having a risk-reducing effect of the overall institutional environment, these should not be taken for granted. As we find that PS is leading to more competition in the banking sector and, therefore, more risk-taking, a close eye on individual WGIs should be kept, and corrective actions should be taken as per requirements.

5.1.3 Research objective 3

Chapter 4 addresses the research objective “What is the relationship between negative interest policy rates (NIPR) and bank risk-taking?”. We contribute to empirical literature in several ways. First, existing papers have used countries that applied negative interest rates in 2015, 2014 and 2016 while evaluating the impact of bank risk-taking (Boungou, 2020; Boungiovanni et al., 2021; Carbo-Valverde et al., 2021). However, our study distinguishes by only considering countries that adopted negative interest rates in the same year, which is 2014. Finally, we contribute by investigating whether the different types of banks – commercial, cooperative and savings - display any difference in their behaviour towards risk in a negative interest rate environment.

Against the Z-score, we find that negative rates increase the Z-score by almost 470%, and this effect increases in the following two years of implementation and declines by little margin in a further three years. With risk-weighted assets, we find that risk-weighted assets are reduced significantly (almost 1900%) when negative rates are introduced. With central bank reserves, the positive coefficient sign shows that risk is reduced with negative rates, but the coefficients are not statistically significant. For different types of banks, although we find that commercial banks take on higher risk in the presence of negative rates, savings banks exhibited more prudent behaviour.

Regarding policy implications, our results suggest that despite the risk-reducing effect of NIPR, we cannot ignore the fact that if negative rates remain for prolonged periods, then bank's profitability will be adversely affected. Therefore, central banks must consider the adverse effects of NIPR and reverse it after a certain implementation period. Further, commercial banks were more affected as compared to cooperative and savings banks. Therefore, these findings suggest that implementing monetary policies should also consider the type of banks on which these policies are focused.

Banks are important institutions for an economy as they help in capital allocation and the smooth functioning of the economy. Banks were involved in excessive risk-taking before the crisis despite having regulatory standards and policies in place. Supervisors and policymakers must evaluate their current policies designed to prevent excessive risk-taking by banks. In this context, the existing literature has examined bank risk-taking from different aspects (from bank-level determinants, internal governance to government policies). We also contributed to the literature by exploring the three major dimensions. Our results present the differing impact of these standards. While both creditor rights and bank regulations were insufficient to tackle excessive risk-taking, the institutional environment emerged as promoting risk-averse behaviour in banks. Negative rate policies also helped in mitigating the risk-taking behaviour of banks. It is clear from our findings that a better institutional environment setting is better than banking regulations and legal environment (creditor rights) in tackling the excessive risk-taking behaviour of banks. In other words, banking regulations and other risk-taking determinants of banks might be more efficient in the presence of a strong institutional environment. Therefore, we suggest that the interaction between different risk-taking determinants and the institutional environment can be explored in future studies.

Further, our thesis findings also have some implications for bank managers. An increase in bank loans is helping banks to minimize the risk, but bank managers need to be cautious and follow responsible lending practices. Regarding the European bank sample, bank managers can reduce bank risk by following ways. First, they can diversify the sources of bank income by extending more into non-interest activities. This helps stabilize the operating income of banks and diversify the risk of portfolios. Further, bank managers can maintain the liquidity of banks, which helps banks to recover well during financially challenging times.

5.2 Limitations of this research

As per our knowledge, there are a few studies that have evaluated the risk-taking determinants globally with respect to banking regulation and institutional environment. Our study adds to this gap in the literature. However, this research has some limitations. First, we can extend the risk-taking model by employing other factors such as deposit insurance, alternative measures of banking industry competition. However, the data availability is limited for other competition measures such as the Lerner index and Boone indicator. For example, in Chapter 4, we did not control for bank competition because of data unavailability. These variables data are unavailable for all years we have used in our third empirical chapter. Second, the period of the research data used in Chapters 2 and 3 can be extended to further years. The further extended period might help in evaluating the impact of creditor rights, bank regulations and institutional environment on bank risk-taking in a better way.

Further, while there are different kinds of risks associated with the banking industry, we have used various risk-taking measures such as price volatility (representing market risk), Z-score (measuring distance to default) and risk-weighted assets ratio (presenting the bank's capital risk). The study has not explored other potential risk measures, such as liquidity risk, or other forms of default risk, such as non-performing loans. Therefore, our study is also limited in using the types of risk-taking measures. Finally, we did not explore the impact of regulatory measures, creditor rights, institutional environment, and negative rates on bank risk in interaction with bank characteristics. Bank characteristics such as bank size, banking industry competition might affect the relationship between all these explanatory variables and bank risk.

5.3 Directions for future research

This section discusses potential ways that future researchers can consider while evaluating the bank risk-taking behaviour determinants. First, we employed different methodologies in each empirical chapter, from fixed effects to more advanced ones such as system GMM and DiD methods. However, there is always the potential to use more advanced or alternative methodologies to evaluate the impact of various factors on bank risk-taking. Future researchers can employ the Probit/Tobit model or alternative instrumental variable methods other than system-GMM to evaluate these research questions.

Second, we mainly used the 2004 to 2014 data covering the global and Eurozone crisis periods. Future researchers might use an extended period after 2020, which also captures the COVID period and evaluates how bank risk-taking was shaped during this time. Also, they can divide the sample between the global and Eurozone crises and evaluate the impact of various determinants on bank risk-taking behaviour during each crisis. Further, our study has focused broadly on the global sample. Most countries follow similar bank regulations and institutional environments but have varying index values. Also, the global crisis impacted banks across the world, irrespective of developed or developing nations. Therefore, it makes sense to study the entire sample simultaneously. Future researchers may consider the subsamples based on developed and developing countries, which capture some cross-country variations.

Finally, in Chapter 3, we find the risk-reducing impact of five WGIs and the risk-inducing impact of PS. Future researchers can investigate this variation in the results of six WGIs by using alternative measures of the institutional environment. For example, they can use alternative PS indices, such as political constraints used by Ashraf (2017). They can also investigate further by dividing the sample into developed and developing countries. This can help in finding the impact of cross-country variation of institutional quality on banks' risk-taking behaviour. This can also help examine if the same results hold for developed and developing nations.

Chapter 6 References

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Chapter 7 Appendices

7.1 Appendix 1: List of countries with the number of banks used in the main sample.

Appendix 1.1: List of Countries with number of banks used in the sample

S no.	Country	Number of banks	Income Group	S no.	Country	Number of banks	Income Group
1	Argentina	5	Upper middle income	34	Morocco	5	Lower middle income
2	Australia	12	High income	35	Namibia	2	Upper middle income
3	Bangladesh	16	Lower middle income	36	Netherlands	4	High income
4	Belgium	3	High income	37	Nigeria	10	Lower middle income
5	Botswana	3	Upper middle income	38	North Macedonia	1	Upper middle income
6	Brazil	13	Upper middle income	39	Norway	2	High income
7	Canada	13	High income	40	Pakistan	12	Lower middle income
8	Chile	7	High income	41	Panama	1	High income
9	China	27	Upper middle income	42	Peru	5	Upper middle income
10	Columbia	7	Upper middle income	43	Philippines	10	Lower middle income
11	Costa Rica	1	Upper middle income	44	Poland	9	High income
12	Croatia	1	High income	45	Portugal	1	High income
13	Czech Republic	1	High income	46	Romania	2	Upper middle income
14	Denmark	9	High income	47	Russia	10	Upper middle income
15	Ecuador	3	Upper middle income	48	Singapore	4	High income
16	Egypt	6	Lower middle income	49	Slovakia	3	High income
17	Finland	3	High income	50	South Africa	5	Upper middle income
18	France	4	High income	51	South Korea	5	High income
19	Germany	3	High income	52	Spain	6	High income
20	Greece	5	High income	53	Sri Lanka	4	Lower middle income
21	Hongkong	6	High income	54	Sweden	3	High income
22	India	33	Lower middle income	55	Switzerland	6	High income
23	Indonesia	19	Lower middle income	56	Taiwan	25	High income
24	Ireland	3	High income	57	Thailand	10	Upper middle income
25	Israel	7	High income	58	Togo	1	Low income
26	Italy	15	High income	59	Tunisia	8	Lower middle income
27	Japan	73	High income	60	Turkey	12	Upper middle income
28	Jordan	9	Upper middle income	61	Ukraine	3	Lower middle income
29	Kazakhstan	5	Upper middle income	62	United Kingdom	7	High income
30	Kenya	1	Lower middle income	63	United States	176	High income
31	Lebanon	5	Upper middle income	64	Venezuela	4	Upper middle income
32	Malaysia	10	Upper middle income	65	Vietnam	7	Lower middle income
33	Mexico	4	Upper middle income	66	Zimbabwe	1	Low income

7.2 Appendix 2: Definition and description of variables

Variable	Definitions and descriptions	Data Source
Dependent variables		
Price Volatility	It is an average annual price movement (high and low) of stock from its average price for each year.	Bankscope
Log *Z*-score	It is the distance to default measured as the sum of the return on assets (ROA) and the capital-asset ratio (CAR) divided by the standard deviation of asset returns (ROA). We are using natural log of *Z*-score.	Bankscope
NPL (%)	It is measured as division of non-performing loans to total loans of a bank and multiplied by 100.	Bankscope
Bank-level controls		
Deposits (%)	It is the ratio of deposits of banks to total assets and presented in %.	Bankscope
Loans (%)	It is the ratio of total loans of banks to total assets and presented in %.	Bankscope
Liquid Assets (%)	It is the ratio of liquid assets of banks to total assets and presented in %.	Bankscope
Non-interest Income (%)	It is the share of operating income other than interest income and presented in %.	Bankscope
Bank size	It presents the size of a bank and measured as natural log of total assets.	Bankscope
Explanatory variables		
Creditor Rights Index	Strength of legal rights index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index has a range of 0 (weak rights) to 10 (strong rights).	World Bank Doing Business Data Set in World Bank Database
Activity Restrictions	It is an index of regulatory restrictions on the activities of banks, consisting, for example, of limitations in the ability of banks to engage in securities market activities, insurance activities, real estate activities, and to own nonfinancial firms. The index value ranges from 0 (lower restrictions) to 16 (greater restrictions).	World Bank Database
Capital Stringency	It is an index of regulatory oversight of bank capital, including indicators for whether the sources of funds that count as regulatory capital can include assets other than cash and government securities, and whether authorities verify the source of capital; It also measures capital stringency whether the capital requirement reflects certain risk elements and deducts certain market value losses from capital adequacy is determined. Higher values indicate greater stringency. The index value ranges from 0 (lower stringency) to 10 (higher stringency).	World Bank Database
Official Supervisory Power	The index measures the power of the commercial bank supervisory agency, including elements such as the rights of the supervisor to meet with and demand information from auditors, to force a bank to change the internal organizational structure, to supersede the rights of shareholders, and to intervene in a bank. The index value ranges from 0 (lower power) to 16 (higher power).	World Bank Database
Country-level controls		
Quality of Government	The Quality of Government Index is due to Houqe et al. (2012), based on the aggregate of the six operationalized dimensions of Worldwide Governance Indicators (WGIs), available at the World Bank for around 200 countries. Houqe et al. (2012) construct the index based on World Governance Indicators of World Bank. The indicator value ranges from approximately -2.5 to 2.5. A high score indicates high government quality.	www.govindicators.org
GDP per capita	Per capita gross domestic product (GDP) is a metric that breaks down a country's economic output per person and is calculated by dividing the GDP of a country by its population. We are using natural log of GDP per capita.	World Bank Database
Current Account (%)	Current account is the sum of net exports of goods and services, net primary income, and net secondary income.	World Bank Database
Bank Concentration (%)	Following Houston et al. (2010) and Beltratti and Stulz (2012), bank concentration is based on the fraction of the assets of the three largest commercial banks of a country.	Global Financial Development (2018) database.

7.3 Appendix 3: Hausman test results

Variables	(b)	(B)	(b-B)	sqrt(diag(V_b-V_B))
	fixed	random	Difference	S.E.
Creditor rights	1.54	1.05	0.49	0.09
CR*Year_dum	0.11	0.16	-0.05	.
Bank Regulation	0.49	0.52	-0.03	0.02
BR*Year_dum	-0.59	-0.57	-0.02	.
Government quality	-1.47	-1.28	-0.20	0.72
Deposits	-0.02	-0.04	0.02	0.01
Loans	-0.18	-0.18	-0.01	0.01
Liquid assets	-0.13	-0.12	-0.01	0.01
Non-interest income	-0.02	-0.02	0.00	0.00
Bank size	-3.38	-0.85	-2.53	0.28
Log GDP-capita	-7.57	-8.75	1.18	1.07
Bank concentration	0.10	0.09	0.01	0.00
Current account	0.22	0.24	-0.02	0.01
Year_dum	10.43	8.89	1.54	.

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic
chi2(14) = (b-B)'[(V_b-V_B)^(-1)](b-B) = 1663.60
Prob>chi2 = 0.0000
(V_b-V_B is not positive definite)

7.4 Appendix 4a: Fixed effect regression estimates for regulatory measures against price volatility (risk-taking): "a" for Sample excluding the US and "b" for standard errors clustered at country level.

Appendix 4a: Robustness tests: Instrument variable estimates against price volatility (risk-taking measure).

VARIABLES	(1) Price volatility	(2) Price volatility	(3) Price volatility
Creditor Rights (CR)	0.620[a]	0.375[a]	0.518[a]
	(0.100)	(0.093)	(0.096)
CR*Year_Dum	0.184	0.355[a]	0.283[b]
	(0.127)	(0.120)	(0.123)
Restrict	0.296[a]		
	(0.107)		
Restrict*Year_Dum	-0.276[b]		
	(0.116)		
Capital		1.074[a]	
		(0.149)	
Capital*Year_Dum		-0.727[a]	
		(0.174)	
Official			0.179[c]
			(0.094)
Official*Year_Dum			0.007
			(0.139)
Deposits	-0.148[a]	-0.139[a]	-0.144[a]
	(0.011)	(0.010)	(0.010)
Loans	-0.097[a]	-0.092[a]	-0.083[a]
	(0.030)	(0.031)	(0.030)
Liquid Assets	-0.092[a]	-0.090[a]	-0.084[a]
	(0.030)	(0.031)	(0.030)
Non-int Income	-0.089[a]	-0.088[a]	-0.087[a]
	(0.015)	(0.015)	(0.015)
Bank size	0.444[a]	0.450[a]	0.493[a]
	(0.089)	(0.089)	(0.094)
Log GDP-capita	-6.643[a]	-5.833[a]	-6.839[a]
	(0.550)	(0.530)	(0.502)
Bank Concentration	-0.098[a]	-0.102[a]	-0.095[a]
	(0.013)	(0.013)	(0.013)
Current Account	0.117[a]	0.188[a]	0.106[a]
	(0.030)	(0.032)	(0.031)
Year_Dum	3.352[b]	3.121[b]	-0.123
	(1.521)	(1.342)	(1.703)
Constant	68.035[a]	62.550[a]	67.897[a]
	(3.309)	(3.444)	(3.503)
Observations	3,860	3,853	3,860
R-squared	0.247	0.243	0.250
Tests of endogeneity			
Durbin statistic	80.40	94.20	79.14
p-vale	0.00	0.00	0.00
Wu-Hausman statistic	81.77	96.16	80.47
p-value	0.00	0.00	0.00

7.5 Appendix 4b: Fixed effect regression estimates for regulatory measures against price volatility (risk-taking): "a" for Sample excluding the US and "b" for standard errors clustered at country level.

The table shows fixed effect regression using panel dataset across 66 countries over the period 2004-2014. Price volatility is the dependent variable which is measured as a stock's average annual price (high and low) from its average price for each year. The main explanatory variables are creditor rights, Activity Restrictions (Restrict), Capital Stringency (Capital) and Official Supervisory Power (Official). While regression 1, 2 and 3 represents estimations for restrict, capital and official respectively, a and b denote respective estimations for sample excluding the US and standard errors clustered at country level. Quality of Government is used to control for the legal environment (Kaufman et al., 2008). Bank level controls used are Deposits, Loans, Liquid Assets, Non-interest Income and bank size. Whereas Log GDP-capita, bank concertation and current account are macro-economic controls. Year_dum is a dummy variable for years 2009 to 2014. CR*Year_dum is interaction between creditor rights and year_dum whereas BR*Year_dum is interaction between each of the regulatory measure and year_dum. Robust standard errors are in the parentheses. [a], [b], and [c] denote statistical significance at a 1-, 5-, and 10% level, respectively.

	Sample excluding the US			Clustering at country level		
Variables	Restrict	Capital	Official	Restrict	Capital	Official
	(1a)	(2a)	(3a)	(1b)	(2b)	(3b)
Creditor rights	1.876[a]	1.418[a]	1.507[a]	1.540[a]	1.191[a]	1.313[a]
	(0.345)	(0.356)	(0.310)	(0.393)	(0.399)	(0.377)
CR*Year_dum	-0.185	-0.027	-0.010	0.114	0.229	0.255
	(0.184)	(0.171)	(0.176)	(0.291)	(0.255)	(0.255)
Bank Regulation	0.534[a]	1.123[a]	0.368[b]	0.494[b]	0.998[b]	0.243
	(0.153)	(0.263)	(0.144)	(0.209)	(0.392)	(0.204)
BR*Year_dum	-0.725[a]	-0.999[a]	-0.588[a]	-0.592[a]	-0.853[a]	-0.373[c]
	(0.142)	(0.211)	(0.147)	(0.177)	(0.317)	(0.203)
Government quality	-2.429	-4.844[b]	-2.293	-1.475	-3.521	-1.490
	(1.859)	(1.933)	(1.986)	(3.402)	(3.571)	(3.761)
Deposits	-0.024	0.002	-0.012	-0.016	0.001	-0.010
	(0.028)	(0.027)	(0.028)	(0.025)	(0.027)	(0.027)
Loans	-0.171[a]	-0.157[a]	-0.144[a]	-0.181[a]	-0.167[a]	-0.161[a]
	(0.046)	(0.053)	(0.050)	(0.050)	(0.058)	(0.058)
Liquid assets	-0.132[a]	-0.105[c]	-0.101[c]	-0.129[b]	-0.110[c]	-0.110[c]
	(0.048)	(0.056)	(0.053)	(0.049)	(0.056)	(0.055)
Non-interest income	0.015	0.005	0.008	-0.017	-0.021	-0.019
	(0.022)	(0.021)	(0.022)	(0.029)	(0.027)	(0.028)
Bank size	-2.371[b]	-2.011[c]	-2.235[b]	-3.376[a]	-3.169[b]	-3.288[b]
	(1.043)	(1.041)	(1.105)	(1.215)	(1.209)	(1.263)
Log GDP-capita	-10.421[a]	-11.625[a]	-11.577[a]	-7.573	-8.525[c]	-8.890[c]
	(3.167)	(3.263)	(3.218)	(4.558)	(4.895)	(4.887)
Bank concentration	0.085[a]	0.073[a]	0.088[a]	0.101[a]	0.089[a]	0.101[a]
	(0.016)	(0.017)	(0.017)	(0.028)	(0.029)	(0.028)
Current account	0.155[a]	0.223[a]	0.142[b]	0.216[b]	0.272[b]	0.195[c]
	(0.055)	(0.063)	(0.057)	(0.098)	(0.113)	(0.105)
Year_dum	12.958[a]	10.168[a]	11.174[a]	10.426[a]	8.382[a]	7.759[b]
	(2.360)	(1.778)	(2.384)	(3.254)	(2.213)	(3.316)
Constant	102.776[a]	101.631[a]	105.035[a]	108.672[a]	110.079[a]	114.306[a]
	(12.581)	(13.488)	(14.532)	(13.034)	(17.035)	(17.693)
Observations	2,816	2,809	2,816	3,909	3,902	3,909
R-squared	0.278	0.285	0.258	0.321	0.327	0.308

7.6 Appendix 5: Robustness tests: Fixed effect regression estimates against price volatility (risk-taking measure) to check for any variable biases.

Appendix 5: Robustness tests: Fixed effect regression estimates against price volatility (risk-taking measure) to check for any variable biases.

VARIABLES	(1) Price volatility	(2) Price volatility	(3) Price volatility	(4) Price volatility
Creditor Rights (CR)	1.427[a]			
	(0.249)			
CR*Year_Dum	0.184			
	(0.150)			
Restrict		0.609[a]		
		(0.141)		
Restrict* Year_Dum		-0.559[a]		
		(0.136)		
Capital			1.082[a]	
			(0.250)	
Capital*Year_Dum			-0.950[a]	
			(0.208)	
Official				0.350[a]
				(0.135)
Official*Year_Dum				-0.365[b]
				(0.143)
Government Quality	-1.832	-1.527	-3.768[b]	-1.411
	(2.017)	(1.824)	(1.863)	(1.903)
Deposits	-0.014	-0.017	0.009	0.001
	(0.024)	(0.025)	(0.025)	(0.025)
Loans	-0.157[a]	-0.176[a]	-0.177[a]	-0.173[a]
	(0.047)	(0.043)	(0.046)	(0.045)
Liquid Assets	-0.107[b]	-0.131[a]	-0.121[b]	-0.123[a]
	(0.049)	(0.045)	(0.048)	(0.047)
Non-int Income	-0.013	-0.024	-0.032	-0.028
	(0.022)	(0.022)	(0.022)	(0.022)
Bank size	-3.168[a]	-3.226[a]	-3.017[a]	-3.086[a]
	(0.810)	(0.770)	(0.759)	(0.803)
Log GDP-capita	-9.661[a]	-6.351[b]	-8.235[a]	-8.430[a]
	(2.928)	(2.699)	(2.728)	(2.810)
Bank Concentration	0.097[a]	0.100[a]	0.083[a]	0.093[a]
	(0.016)	(0.015)	(0.016)	(0.016)
Current Account	0.171[a]	0.195[a]	0.271[a]	0.190[a]
	(0.054)	(0.051)	(0.061)	(0.055)
Year_Dum	3.815[a]	10.814[a]	10.582[a]	9.495[a]
	(1.172)	(1.640)	(1.285)	(1.824)
Constant	117.845[a]	110.356[a]	115.009[a]	117.594[a]
	(11.719)	(10.481)	(11.058)	(12.210)
Observations	3,909	3,909	3,902	3,909
R-squared	0.303	0.297	0.308	0.285
Number of Banks	449	449	447	449

7.7 Appendix 6: Robustness tests: Fixed effect regression estimates against log Z-Score (risk-taking measure) to check for any variable biases.

Appendix 6: Robustness tests: Fixed effect regression estimates against log Z-Score (risk-taking measure) to check for any variable biases.

	(1)	(2)	(3)	(4)
VARIABLES	Log Z-Score	Log Z-Score	Log Z-Score	Log Z-Score
Creditor Rights (CR)	-0.018[c]			
	(0.010)			
CR*Year_Dum	0.021[a]			
	(0.007)			
Restrict		0.005		
		(0.006)		
Restrict* Year_Dum		0.005		
		(0.005)		
Capital			-0.002	
			(0.009)	
Capital*Year_Dum			0.017[b]	
			(0.008)	
Official				-0.012[c]
				(0.007)
Official*Year_Dum				-0.002
				(0.006)
Government Quality	0.077	0.081	0.103	0.057
	(0.095)	(0.097)	(0.100)	(0.095)
Deposits	-0.006[a]	-0.005[a]	-0.005[a]	-0.006[a]
	(0.002)	(0.001)	(0.002)	(0.001)
Loans	-0.001	-0.001	-0.002	-0.001
	(0.002)	(0.002)	(0.003)	(0.002)
Liquid Assets	-0.003	-0.003	-0.004[c]	-0.003
	(0.002)	(0.002)	(0.002)	(0.002)
Non-int Income	-0.001	-0.001	-0.001	-0.001
	(0.001)	(0.001)	(0.001)	(0.001)
Bank size	-0.115[a]	-0.105[a]	-0.103[a]	-0.111[a]
	(0.034)	(0.035)	(0.035)	(0.035)
Log GDP-capita	0.602[a]	0.513[a]	0.460[a]	0.470[a]
	(0.129)	(0.129)	(0.131)	(0.130)
Bank Concentration	-0.002[b]	-0.002[a]	-0.002[a]	-0.002[a]
	(0.001)	(0.001)	(0.001)	(0.001)
Current Account	0.001	0.003	0.003	0.003
	(0.002)	(0.003)	(0.003)	(0.003)
Year_Dum	-0.106[b]	-0.023	-0.077	0.055
	(0.052)	(0.049)	(0.051)	(0.075)
Constant	2.817[a]	2.871[a]	3.177[a]	3.378[a]
	(0.425)	(0.457)	(0.464)	(0.450)
Observations	4,408	4,400	4,378	4,400
R-squared	0.046	0.040	0.043	0.042
Number of Banks	515	515	511	515

7.8 Appendix 7: Robustness tests: Fixed effect regression estimates against price volatility (risk-taking measure) by using 2010-2014 as a post-crisis period.

Appendix 7: Robustness tests: Fixed effect regression estimates against price volatility (risk-taking measure) by using 2010-2014 as a post-crisis period.

VARIABLES	(1) Price volatility	(2) Price volatility	(3) Price volatility	(4) Price volatility
Creditor Rights (CR)	1.708[a]			
	(0.245)			
CR*Year_Dum	0.066			
	(0.139)			
Restrict		0.608[a]		
		(0.129)		
Restrict*Year_Dum		-0.545[a]		
		(0.131)		
Capital			1.016[a]	
			(0.223)	
Capital*Year_Dum			-0.899[a]	
			(0.184)	
Official				0.330[a]
				(0.120)
Official*Year_Dum				-0.375[b]
				(0.155)
Government Quality	-4.287[b]	-3.988[b]	-5.511[a]	-3.698[c]
	(2.024)	(1.908)	(1.906)	(1.951)
Deposits	0.025	0.021	0.049[c]	0.038
	(0.025)	(0.026)	(0.026)	(0.026)
Loans	-0.158[a]	-0.171[a]	-0.171[a]	-0.166[a]
	(0.048)	(0.045)	(0.048)	(0.047)
Liquid Assets	-0.092[c]	-0.108[b]	-0.098[c]	-0.098[c]
	(0.052)	(0.048)	(0.051)	(0.050)
Non-int Income	-0.044[c]	-0.057[b]	-0.061[a]	-0.060[b]
	(0.023)	(0.023)	(0.023)	(0.023)
Bank size	-1.492[c]	-1.426[c]	-1.289[c]	-1.322
	(0.814)	(0.778)	(0.775)	(0.814)
Log GDP-capita	-8.398[a]	-4.106	-5.765[b]	-6.138[b]
	(3.132)	(2.975)	(2.917)	(3.001)
Bank Concentration	0.106[a]	0.115[a]	0.096[a]	0.106[a]
	(0.016)	(0.016)	(0.016)	(0.016)
Current Account	0.252[a]	0.252[a]	0.321[a]	0.256[a]
	(0.056)	(0.051)	(0.058)	(0.055)
Year_Dum	2.595[b]	8.402[a]	8.051[a]	7.347[a]
	(1.131)	(1.617)	(1.219)	(1.947)
Constant	82.549[a]	70.028[a]	74.706[a]	77.660[a]
	(12.026)	(11.556)	(11.310)	(12.327)
Observations	3,909	3,909	3,902	3,909
R-squared	0.210	0.199	0.210	0.187
Number of Banks	449	449	447	449

7.9 Appendix 8: FE results against price volatility by clustering standard errors at country level.

Appendix 8: Robustness tests: Fixed effect regression estimates against price volatility (risk-taking) by standard errors clustered at country level.

VARIABLES	(1) Price vol	(2) Price vol	(3) Price vol	(4) Price vol	(5) Price vol	(6) Price vol
WGI	0.157	-0.123	-2.027	-4.669[a]	-2.401	1.594
	(2.214)	(1.297)	(2.044)	(1.501)	(3.151)	(1.093)
Capital string. Index	0.442[c]	0.442[c]	0.473[c]	0.502[b]	0.449[c]	0.442[c]
	(0.245)	(0.232)	(0.246)	(0.232)	(0.236)	(0.234)
Deposits	0.024	0.024	0.020	0.018	0.024	0.028
	(0.032)	(0.032)	(0.032)	(0.032)	(0.033)	(0.032)
Loans	-0.088[a]	-0.087[a]	-0.086[a]	-0.084[a]	-0.089[a]	-0.087[a]
	(0.020)	(0.020)	(0.020)	(0.019)	(0.019)	(0.020)
Non-int. income	0.006	0.006	0.006	0.009	0.005	0.007
	(0.027)	(0.026)	(0.027)	(0.026)	(0.026)	(0.027)
Bank size	-4.891[a]	-4.890[a]	-4.923[a]	-4.618[a]	-4.993[a]	-4.853[a]
	(0.886)	(0.887)	(0.919)	(0.908)	(0.903)	(0.847)
Bank concentration	0.080[a]	0.081[a]	0.079[a]	0.062[a]	0.081[a]	0.084[a]
	(0.021)	(0.021)	(0.022)	(0.021)	(0.021)	(0.021)
GDP growth	0.175[c]	0.176	0.166	0.118	0.161[c]	0.196[c]
	(0.096)	(0.116)	(0.103)	(0.098)	(0.096)	(0.104)
Current account	0.083	0.084	0.091	0.104	0.090	0.057
	(0.094)	(0.093)	(0.095)	(0.093)	(0.093)	(0.088)
Constant	99.985[a]	100.033[a]	102.805[a]	100.451[a]	103.792[a]	97.556[a]
	(13.798)	(14.104)	(14.461)	(14.343)	(14.330)	(13.183)
Observations	4,555	4,555	4,555	4,555	4,555	4,555
R-squared	0.319	0.319	0.321	0.329	0.321	0.321
Year FE	Yes	Yes	Yes	Yes	Yes	Yes

7.10 Appendix 9: Hausman test results

Hausman test 2:

	(b) fe	(B) re	(b-B) Difference	sqrt(diag(V_b - V_B)) S.E.
polstability	-0.0367326	-1.46549	1.428757	0.1750944
deposits	0.0239322	0.0091345	0.0147977	0.004903
loans	-0.0877541	-0.0945777	0.0068237	0.0022885
nonint	0.0061799	-0.0036823	0.0098621	0.0020465
bnksize	-4.891295	-1.397967	-3.493328	0.2190657
capital	0.4430718	0.4935657	-0.0504939	.
bankconc	0.0803959	0.0848166	-0.0044208	0.0023372
currentacc	0.174303	0.2743845	-0.1000815	0.0084816
gdpgrwth	0.0834293	0.1516615	-0.0682322	.
year				
2005	0.110128	-0.0336765	0.1438044	.
2006	0.1529938	-0.190347	0.3433408	.
2007	0.8259632	-0.2190092	1.044972	0.0570108
2008	4.251421	3.281128	0.9702932	0.0928624
2009	6.987274	5.736818	1.250456	0.1122126
2010	6.003415	4.032356	1.971059	0.129256
2011	6.336767	4.452548	1.884218	0.1498989
2012	5.562317	3.522347	2.039971	0.1620403
2013	4.952065	2.756286	2.195779	0.1720965
2014	3.821903	1.513282	2.308621	0.1812163

b = consistent under Ho and Ha; obtained from xtreg

B = inconsistent under Ha, efficient under Ho; obtained from xtreg

Test: Ho: difference in coefficients not systematic

chi2(19) = (b-B)'[(V_b-V_B)^(-1)](b-B)

616.41

Prob>chi2 = 0.0000

(V_b-V_B is not positive definite)

7.11 Appendix 10: Fixed Effect baseline results of voice and accountability against price volatility

Appendix 10: Fixed Effect baseline results of voice and accountability against price volatility

VARIABLES	(1) Price Volatility	(2) Price Volatility	(3) Price Volatility	(4) Price Volatility
Voice & Accountability	-1.568	-0.763	-0.726	0.157
	(1.306)	(1.231)	(1.191)	(1.080)
Deposits		0.023	0.035	0.024
		(0.025)	(0.024)	(0.024)
Loans		-0.089[a]	-0.097[a]	-0.088[a]
		(0.020)	(0.019)	(0.018)
Non-interest Income		0.010	0.006	0.006
		(0.021)	(0.020)	(0.020)
Bank Size		-5.690[a]	-5.219[a]	-4.891[a]
		(0.730)	(0.719)	(0.722)
Capital Stringency Index			0.379[b]	0.442[a]
			(0.154)	(0.156)
Bank Concentration			0.088[a]	0.080[a]
			(0.016)	(0.015)
Current Account				0.175[a]
				(0.053)
GDP Growth				0.083
				(0.051)
2005.year	-0.594[a]	-0.023	-0.034	0.111
	(0.152)	(0.188)	(0.187)	(0.197)
2006.year	-1.294[a]	0.219	0.045	0.169
	(0.296)	(0.327)	(0.323)	(0.328)
2007.year	-1.589[a]	1.079[a]	0.813[b]	0.842[b]
	(0.302)	(0.395)	(0.392)	(0.405)
2008.year	1.154[a]	4.194[a]	3.905[a]	4.263[a]
	(0.308)	(0.459)	(0.454)	(0.512)
2009.year	3.777[a]	6.991[a]	6.686[a]	6.999[a]
	(0.347)	(0.547)	(0.540)	(0.671)
2010.year	3.209[a]	6.939[a]	6.182[a]	6.019[a]
	(0.356)	(0.636)	(0.588)	(0.592)
2011.year	3.009[a]	7.003[a]	6.302[a]	6.345[a]
	(0.374)	(0.694)	(0.636)	(0.657)
2012.year	1.857[a]	6.116[a]	5.495[a]	5.566[a]
	(0.394)	(0.751)	(0.684)	(0.700)
2013.year	0.985[b]	5.629[a]	4.986[a]	4.958[a]
	(0.414)	(0.782)	(0.713)	(0.728)
2014.year	-0.200	4.669[a]	3.943[a]	3.832[a]
	(0.426)	(0.791)	(0.727)	(0.748)
Constant	25.711[a]	120.649[a]	106.125[a]	99.985[a]
	(1.005)	(12.211)	(11.802)	(11.858)
Observations	5,390	4,562	4,555	4,555
R-squared	0.175	0.283	0.311	0.319
Number of Banks	571	493	491	491

7.12 Appendix 11: Fixed Effect baseline results of political stability against price volatility

Appendix 11: Fixed Effect baseline results of political stability against price volatility

VARIABLES	(1) Price Volatility	(2) Price Volatility	(3) Price Volatility	(4) Price Volatility
Political Stability	0.700	0.403	0.289	-0.037
	(0.687)	(0.673)	(0.628)	(0.661)
Deposits		0.022	0.034	0.024
		(0.025)	(0.024)	(0.024)
Loans		-0.090[a]	-0.098[a]	-0.088[a]
		(0.020)	(0.019)	(0.018)
Non-interest Income		0.012	0.008	0.006
		(0.021)	(0.020)	(0.020)
Bank Size		-5.697[a]	-5.229[a]	-4.891[a]
		(0.737)	(0.724)	(0.722)
Capital Stringency Index			0.377[b]	0.443[a]
			(0.149)	(0.152)
Bank Concentration			0.088[a]	0.080[a]
			(0.016)	(0.015)
Current Account				0.174[a]
				(0.060)
GDP Growth				0.083[c]
				(0.050)
2005.year	-0.620[a]	-0.049	-0.046	0.110
	(0.163)	(0.210)	(0.208)	(0.218)
2006.year	-1.228[a]	0.231	0.086	0.153
	(0.295)	(0.367)	(0.359)	(0.356)
2007.year	-1.492[a]	1.114[a]	0.869[b]	0.826[b]
	(0.274)	(0.427)	(0.422)	(0.412)
2008.year	1.205[a]	4.201[a]	3.940[a]	4.251[a]
	(0.332)	(0.528)	(0.516)	(0.537)
2009.year	3.886[a]	7.034[a]	6.748[a]	6.987[a]
	(0.356)	(0.607)	(0.596)	(0.662)
2010.year	3.289[a]	6.972[a]	6.238[a]	6.003[a]
	(0.392)	(0.712)	(0.641)	(0.617)
2011.year	3.002[a]	6.984[a]	6.316[a]	6.337[a]
	(0.467)	(0.801)	(0.717)	(0.701)
2012.year	1.809[a]	6.075[a]	5.488[a]	5.562[a]
	(0.495)	(0.856)	(0.767)	(0.750)
2013.year	0.966[c]	5.596[a]	4.988[a]	4.952[a]
	(0.521)	(0.897)	(0.805)	(0.779)
2014.year	-0.209	4.648[a]	3.961[a]	3.822[a]
	(0.547)	(0.915)	(0.821)	(0.794)
Constant	24.545[a]	120.296[a]	105.810[a]	100.088[a]
	(0.292)	(12.126)	(11.733)	(11.790)
Observations	5,390	4,562	4,555	4,555
R-squared	0.175	0.283	0.311	0.319
Number of Banks	571	493	491	491

7.13 Appendix 12: Fixed Effect baseline results of government effectiveness against price volatility

Appendix 12: Fixed Effect baseline results of government effectiveness against price volatility				
	(1)	(2)	(3)	(4)
VARIABLES	Price Volatility	Price Volatility	Price Volatility	Price Volatility
Government Effectiveness	-2.837[a]	-2.121[b]	-2.215[b]	-2.027[b]
	(1.065)	(1.015)	(1.014)	(0.982)
Deposits		0.018	0.031	0.020
		(0.025)	(0.024)	(0.024)
Loans		-0.086[a]	-0.094[a]	-0.086[a]
		(0.020)	(0.019)	(0.018)
Non-interest Income		0.010	0.006	0.006
		(0.021)	(0.020)	(0.020)
Bank Size		-5.717[a]	-5.249[a]	-4.923[a]
		(0.732)	(0.719)	(0.721)
Capital Stringency Index			0.403[a]	0.473[a]
			(0.155)	(0.157)
Bank Concentration			0.086[a]	0.079[a]
			(0.016)	(0.015)
Current Account				0.166[a]
				(0.055)
GDP Growth				0.091[c]
				(0.052)
2005.year	-0.848[a]	-0.243	-0.266	-0.130
	(0.194)	(0.215)	(0.211)	(0.219)
2006.year	-1.168[a]	0.241	0.057	0.044
	(0.215)	(0.271)	(0.275)	(0.282)
2007.year	-1.429[a]	1.128[a]	0.856[b]	0.760[b]
	(0.231)	(0.365)	(0.369)	(0.378)
2008.year	1.233[a]	4.183[a]	3.887[a]	4.144[a]
	(0.265)	(0.442)	(0.441)	(0.491)
2009.year	3.748[a]	6.910[a]	6.593[a]	6.842[a]
	(0.328)	(0.542)	(0.534)	(0.653)
2010.year	3.259[a]	6.925[a]	6.130[a]	5.850[a]
	(0.345)	(0.644)	(0.584)	(0.582)
2011.year	2.945[a]	6.915[a]	6.172[a]	6.134[a]
	(0.387)	(0.702)	(0.635)	(0.649)
2012.year	1.700[a]	5.969[a]	5.304[a]	5.318[a]
	(0.417)	(0.755)	(0.680)	(0.691)
2013.year	0.934[b]	5.558[a]	4.872[a]	4.769[a]
	(0.436)	(0.795)	(0.717)	(0.724)
2014.year	-0.142	4.685[a]	3.915[a]	3.695[a]
	(0.441)	(0.807)	(0.731)	(0.740)
Constant	27.489[a]	122.931[a]	108.481[a]	102.805[a]
	(1.169)	(12.416)	(12.029)	(12.073)
Observations	5,390	4,562	4,555	4,555
R-squared	0.179	0.285	0.314	0.321
Number of Banks	571	493	491	491

7.14 Appendix 13: Fixed Effect baseline results of regulatory quality against price volatility

Appendix 13: Fixed Effect baseline results of regulatory quality against price volatility				
VARIABLES	(1) Price Volatility	(2) Price Volatility	(3) Price Volatility	(4) Price Volatility
Regulatory Quality	-8.432[a]	-6.107[a]	-5.210[a]	-4.669[a]
	(1.125)	(1.094)	(1.014)	(1.025)
Deposits		0.010	0.025	0.018
		(0.025)	(0.024)	(0.024)
Loans		-0.080[a]	-0.089[a]	-0.084[a]
		(0.019)	(0.019)	(0.018)
Non-interest Income		0.013	0.009	0.009
		(0.021)	(0.020)	(0.020)
Bank Size		-5.085[a]	-4.797[a]	-4.618[a]
		(0.715)	(0.694)	(0.700)
Capital Stringency Index			0.449[a]	0.502[a]
			(0.149)	(0.151)
Bank Concentration			0.065[a]	0.062[a]
			(0.015)	(0.015)
Current Account				0.118[b]
				(0.056)
GDP Growth				0.104[b]
				(0.051)
2005.year	-0.294[c]	0.131	0.105	0.198
	(0.156)	(0.182)	(0.183)	(0.189)
2006.year	-0.680[a]	0.475[c]	0.319	0.309
	(0.208)	(0.273)	(0.279)	(0.283)
2007.year	-1.411[a]	0.850[b]	0.697[c]	0.683[c]
	(0.234)	(0.378)	(0.372)	(0.378)
2008.year	1.413[a]	3.981[a]	3.807[a]	4.139[a]
	(0.266)	(0.459)	(0.452)	(0.495)
2009.year	3.678[a]	6.534[a]	6.381[a]	6.830[a]
	(0.327)	(0.566)	(0.548)	(0.650)
2010.year	3.175[a]	6.482[a]	5.785[a]	5.647[a]
	(0.343)	(0.656)	(0.581)	(0.579)
2011.year	3.046[a]	6.553[a]	5.896[a]	5.996[a]
	(0.376)	(0.715)	(0.635)	(0.647)
2012.year	1.481[a]	5.335[a]	4.781[a]	4.946[a]
	(0.406)	(0.775)	(0.682)	(0.695)
2013.year	0.552	4.760[a]	4.203[a]	4.290[a]
	(0.427)	(0.813)	(0.715)	(0.724)
2014.year	-0.499	3.907[a]	3.253[a]	3.244[a]
	(0.427)	(0.817)	(0.721)	(0.732)
Constant	32.166[a]	116.180[a]	104.309[a]	100.451[a]
	(1.074)	(11.799)	(11.404)	(11.553)
Observations	5,390	4,562	4,555	4,555
R-squared	0.218	0.304	0.325	0.329
Number of Banks	571	493	491	491

7.15 Appendix 14: Fixed Effect baseline results of Rule of law against price volatility

Appendix 14: Fixed Effect baseline results of Rule of law against price volatility				
	(1)	(2)	(3)	(4)
VARIABLES	Price Volatility	Price Volatility	Price Volatility	Price Volatility
Rule of Law	-1.213	-2.839[c]	-2.881[c]	-2.401
	(1.873)	(1.688)	(1.607)	(1.548)
Deposits		0.023	0.034	0.024
		(0.025)	(0.024)	(0.024)
Loans		-0.090[a]	-0.098[a]	-0.089[a]
		(0.020)	(0.019)	(0.018)
Non-interest Income		0.009	0.005	0.005
		(0.021)	(0.020)	(0.020)
Bank Size		-5.793[a]	-5.322[a]	-4.993[a]
		(0.741)	(0.728)	(0.727)
Capital Stringency Index			0.380[b]	0.449[a]
			(0.151)	(0.154)
Bank Concentration			0.088[a]	0.081[a]
			(0.016)	(0.015)
Current Account				0.161[a]
				(0.054)
GDP Growth				0.090[c]
				(0.050)
2005.year	-0.503[a]	0.114	0.102	0.197
	(0.151)	(0.194)	(0.197)	(0.203)
2006.year	-0.953[a]	0.574[c]	0.396	0.338
	(0.232)	(0.311)	(0.317)	(0.314)
2007.year	-1.264[a]	1.435[a]	1.166[a]	1.029[b]
	(0.248)	(0.406)	(0.409)	(0.407)
2008.year	1.466[a]	4.548[a]	4.256[a]	4.463[a]
	(0.284)	(0.491)	(0.491)	(0.517)
2009.year	4.088[a]	7.328[a]	7.019[a]	7.222[a]
	(0.334)	(0.590)	(0.588)	(0.663)
2010.year	3.533[a]	7.341[a]	6.581[a]	6.251[a]
	(0.378)	(0.706)	(0.640)	(0.625)
2011.year	3.276[a]	7.340[a]	6.634[a]	6.546[a]
	(0.407)	(0.757)	(0.686)	(0.681)
2012.year	2.093[a]	6.466[a]	5.844[a]	5.797[a]
	(0.443)	(0.820)	(0.744)	(0.735)
2013.year	1.245[a]	5.980[a]	5.333[a]	5.180[a]
	(0.464)	(0.853)	(0.774)	(0.762)
2014.year	0.190	5.280[a]	4.553[a]	4.251[a]
	(0.544)	(0.913)	(0.831)	(0.813)
Constant	25.488[a]	124.214[a]	109.739[a]	103.792[a]
	(1.571)	(12.530)	(12.003)	(11.981)
Observations	5,390	4,562	4,555	4,555
R-squared	0.175	0.286	0.314	0.321
Number of Banks	571	493	491	491

7.16 Appendix 15: Fixed Effect baseline results of control of corruption against price

Appendix 15: Fixed Effect baseline results of control of corruption against price volatility

VARIABLES	(1) Price Volatility	(2) Price Volatility	(3) Price Volatility	(4) Price Volatility
Corruption Control	-0.633	0.138	0.951	1.594[c]
	(0.915)	(0.930)	(0.858)	(0.824)
Deposits		0.024	0.038	0.028
		(0.025)	(0.024)	(0.024)
Loans		-0.089[a]	-0.097[a]	-0.087[a]
		(0.020)	(0.019)	(0.018)
Non-interest Income		0.010	0.007	0.007
		(0.022)	(0.020)	(0.020)
Bank Size		-5.709[a]	-5.239[a]	-4.853[a]
		(0.734)	(0.721)	(0.716)
Capital Stringency Index			0.371[b]	0.442[a]
			(0.150)	(0.152)
Bank Concentration			0.091[a]	0.084[a]
			(0.016)	(0.015)
Current Account				0.196[a]
				(0.056)
GDP Growth				0.057
				(0.050)
2005.year	-0.606[a]	0.022	0.109	0.293
	(0.190)	(0.228)	(0.219)	(0.225)
2006.year	-1.129[a]	0.380	0.341	0.400
	(0.271)	(0.332)	(0.323)	(0.324)
2007.year	-1.442[a]	1.237[a]	1.114[a]	1.069[b]
	(0.295)	(0.421)	(0.415)	(0.418)
2008.year	1.308[a]	4.343[a]	4.170[a]	4.391[a]
	(0.298)	(0.481)	(0.477)	(0.515)
2009.year	3.904[a]	7.154[a]	7.013[a]	7.122[a]
	(0.367)	(0.590)	(0.582)	(0.674)
2010.year	3.328[a]	7.093[a]	6.503[a]	6.266[a]
	(0.379)	(0.678)	(0.612)	(0.605)
2011.year	3.097[a]	7.139[a]	6.605[a]	6.557[a]
	(0.408)	(0.734)	(0.662)	(0.668)
2012.year	1.932[a]	6.225[a]	5.735[a]	5.714[a]
	(0.419)	(0.781)	(0.704)	(0.708)
2013.year	1.074[b]	5.756[a]	5.259[a]	5.128[a]
	(0.447)	(0.817)	(0.736)	(0.737)
2014.year	-0.066	4.820[a]	4.225[a]	3.962[a]
	(0.451)	(0.825)	(0.746)	(0.748)
Constant	25.075[a]	120.142[a]	104.584[a]	97.556[a]
	(0.920)	(12.167)	(11.722)	(11.697)
Observations	5,390	4,562	4,555	4,555
R-squared	0.174	0.283	0.312	0.321
Number of Banks	571	493	491	491

7.17 Appendix 16: Definition and description of variables

Appendix 16: Definition and description of variables

Variable	Definitions and descriptions	Data Source
Dependent variables		
Z-Score	It is the distance to default measured as the sum of the return on assets (ROA) and the capital-asset ratio (CAR) divided by the standard deviation of asset returns (ROA). Standard deviation of ROA is calculated three years in a row.	Orbis Bank Focus
Risk Weighted Assets (%)	It is calculated as the ratio of average risk-weighted assets to total assets, and it is expressed in percentage.	Orbis Bank Focus
CB Reserves at central banks (%)	It is the ratio of reserves at central banks to total assets. It is presented in %.	Orbis Bank Focus
Bank-level controls		
ROA (%)	It is defined as return on average assets of banks. It is presented in %.	Orbis Bank Focus
Bank size	It presents the size of a bank and measured as natural log of total assets.	Orbis Bank Focus
Liquidity	It is the ratio of liquid assets to total assets. It is presented in natural log form.	Orbis Bank Focus
Cost to income ratio (%)	It is the ratio of bank's cost to income. It is presented in %.	Orbis Bank Focus
Equity to Assets (%)	It is the ratio of total equity to total assets of banks. It is presented in %.	Orbis Bank Focus
Loan growth (%)	It is the annual growth in gross customer loans and advances. It is presented in %.	Orbis Bank Focus
Customer deposits-assets (%)	It is the ratio of customer deposits of banks to total assets. It is presented in %.	Orbis Bank Focus
Non-interest Income (%)	It is the ratio of non-interest income to operating revenue. It is presented in %.	Orbis Bank Focus
NPLs	It is the ratio of impaired loans to gross loans and is presented in %.	Orbis Bank Focus
Explanatory variables		
Negative Interest Rate	It is dummy variable. It takes value 1 for countries who adopted negative interest rate and 0 otherwise.	
Banking industry controls		
Creditor Rights Index (Legal rights)	Strength of legal rights index measures the degree to which collateral and bankruptcy laws protect the rights of borrowers and lenders and thus facilitate lending. The index has a range of 0 (weak rights) to 10 (strong rights) from 2005 to 2012 and 0 (weak rights) to 12 (strong rights) from 2013 to 2021. The index values are converted to percentage to make them equivalent.	The World Bank Database

Credit information index	Depth of credit information index measures rules affecting the scope, accessibility, and quality of credit information available through public or private credit registries. The index has a range of 0 (availability of less credit information) to 6 (availability of more credit information) from 2005 to 2012 and 0 (availability of less credit information) to 8 (availability of more credit information) from 2013 to 2021. The index values are converted to percentage to make them equivalent.	The World Bank Database
Macroeconomic controls		
GDP growth (%)	Annual percentage growth rate of GDP at market prices based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources. It is presented in %.	The World Bank Database
Inflation (%)	Inflation as measured by the consumer price index reflects the annual percentage change in the cost to the average consumer of acquiring a basket of goods and services in a year. It is presented in %.	The World Bank Database
Domestic credit to GDP (%)	Domestic credit to private sector by banks refers to financial resources provided to the private sector by other depository corporations (deposit taking corporations except central banks), such as through loans, purchases of nonequity securities, and trade credits and other accounts receivable, that establish a claim for repayment. It is presented in %.	The World Bank Database

7.18 Appendix 17: Robustness test: DiD Regression analysis by clustering standard errors at country level

Appendix 17: Robustness test: DiD Regression analysis by clustering standard errors at country level

VARIABLES	(1) Z-Score	(2) Risk Weighted Assets	(3) CB Reserves
1.treat2014	4.711[c]	0.046	0.081
	(2.311)	(6.331)	(0.325)
1.treat2015	4.745[c]	-19.689	-0.682
	(2.526)	(12.015)	(0.484)
1.treat2016	5.956	-15.380	0.018
	(4.003)	(12.389)	(0.498)
1.treat2017	3.673	-6.736	0.099
	(3.196)	(4.679)	(0.419)
1.treat2018	2.251	-5.313	0.422
	(3.697)	(4.254)	(0.530)
1.treat2019	3.813	-6.531	1.259[c]
	(3.917)	(4.939)	(0.682)
ROA	0.465[b]	-0.228	0.095
	(0.178)	(0.406)	(0.062)
Loan growth	-0.018	-0.027[b]	-0.004[b]
	(0.015)	(0.012)	(0.002)
Cost-Income	0.008	0.066[c]	0.007[b]
	(0.021)	(0.034)	(0.003)
Non-interest income	0.046[c]	-0.024	0.013[a]
	(0.026)	(0.031)	(0.004)
Equity-Assets	2.311[a]	1.542[a]	0.044
	(0.483)	(0.411)	(0.031)
Customer dep-Assets	0.040	0.216[a]	0.010
	(0.050)	(0.073)	(0.008)
Liquidity	-2.294[b]	-1.156	0.358[b]
	(0.853)	(0.993)	(0.158)
NPLs	-0.098[c]	0.173	0.007
	(0.048)	(0.124)	(0.012)
Bank size	-2.848[c]	1.422	0.235
	(1.574)	(1.352)	(0.206)
GDP growth	-1.209[c]	-1.554	-0.053
	(0.689)	(1.015)	(0.075)
Inflation	-0.013	-0.956[b]	-0.024
	(0.090)	(0.409)	(0.020)
Private credit	0.025	0.088	0.023
	(0.066)	(0.117)	(0.018)
Credit info	-0.128	-0.506	0.019
	(0.087)	(0.427)	(0.022)
Legal rights	-0.133[c]	0.620	-0.022[c]
	(0.078)	(0.463)	(0.012)
Constant	97.612[a]	23.387	-6.619
	(17.678)	(35.191)	(4.137)
Observations	5,217	4,265	5,217
R-squared	0.333	0.246	0.108
Number of Banks	761	658	761

7.19 Appendix 18: Robustness test: DiD Regression analysis by using banking regulation as a control measure.

Appendix 18: Robustness test: DiD Regression analysis by using banking regulation as a control measure. The capital stringency index has been used as a regulatory control measure.

VARIABLES	(1) Z-Score	(2) Risk-Weighted Assets	(3) CB Reserves
1.treat2014	4.474[a]	3.395	0.232
	(1.185)	(4.390)	(0.292)
1.treat2015	4.468[a]	-16.267[a]	-0.505
	(1.175)	(5.293)	(0.363)
1.treat2016	5.753[a]	-12.282[b]	0.148
	(1.578)	(5.568)	(0.422)
1.treat2017	3.458[b]	-3.896	0.236
	(1.417)	(4.374)	(0.410)
1.treat2018	2.032	-2.320	0.562
	(1.674)	(5.195)	(0.414)
1.treat2019	3.594[b]	-3.621	1.398[a]
	(1.562)	(5.231)	(0.481)
ROA	0.473[c]	-0.251	0.091[c]
	(0.249)	(0.906)	(0.053)
Loan growth	-0.018[c]	-0.027	-0.004[b]
	(0.010)	(0.017)	(0.002)
Cost-Income	0.008	0.069[c]	0.007[c]
	(0.017)	(0.041)	(0.004)
Non-interest income	0.044[b]	-0.020	0.014[b]
	(0.018)	(0.051)	(0.006)
Equity-Assets	2.321[a]	1.434[a]	0.038
	(0.247)	(0.250)	(0.031)
Customer dep-Assets	0.039	0.208[a]	0.011
	(0.041)	(0.074)	(0.007)
Liquidity	-2.305[a]	-1.080[c]	0.364[a]
	(0.430)	(0.642)	(0.084)
NPLs	-0.099[a]	0.183	0.008
	(0.037)	(0.146)	(0.010)
Bank size	-2.875[b]	1.431	0.253
	(1.370)	(2.096)	(0.290)
GDP growth	-1.232[a]	-1.613[a]	-0.039
	(0.255)	(0.578)	(0.051)
Inflation	-0.028	-0.894[b]	-0.015
	(0.116)	(0.377)	(0.030)
Private credit	0.025	0.135	0.022
	(0.027)	(0.115)	(0.014)
Credit info	-0.133[a]	-0.428[b]	0.022
	(0.046)	(0.204)	(0.018)
Legal rights	-0.134[a]	0.599[a]	-0.021[b]
	(0.041)	(0.178)	(0.010)
Capital Stringency	-0.260	2.303[a]	0.166[b]
	(0.279)	(0.710)	(0.065)
Constant	100.182[a]	-1.026	-8.260[c]
	(21.660)	(37.588)	(4.905)
Year FE	Yes	Yes	Yes
Observations	5,217	4,265	5,217
R-squared	0.333	0.254	0.113
Number of Banks	761	658	761