How does monetary policy impact the risk-taking behavior of banks, and to what extent do differences across banks influence this relationship?

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HOW DOES MONETARY POLICY IMPACT THE RISK-TAKING BEHAVIOR OF BANKS, AND TO WHAT EXTENT DO DIFFERENCES ACROSS BANKS INFLUENCE THIS RELATIONSHIP?

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Sincerely,

Thomas Longueville

Contents

List of abbreviations

- EA-MPD: Euro Area Monetary Policy Database
- FOMC: Federal Open Market Committee
- GFC: Great Financial Crisis
- HFI: High-Frequency Identification
- IRF: Impulse Response Function
- LP: Local Projections
- LTA ratio: Loan to Asset ratio
- MRO: Main Refinancing Operations
- MP: Monetary Policy
- NPL ratio: Non-Performing Loans ratio
- OIS: Overnight Indexed Swap
- QE: Quantitative Easing
- RTC: Risk-Taking Channel
- UMP: Unconventional Monetary Policy
- VAR model: Vector AutoRegressive model
- ZLB: Zero Lower Bound

1 Introduction

With the onset of the Global Financial Crisis (GFC) in 2007-2008, there was a growing interest among researchers and policymakers in examining and understanding the interrelations between the real economy and financial markets. Considering that the "excessive" risk-taking behavior of commercial banks is recognized as a significant factor contributing to the outbreak of the GFC, there is a particular emphasis on investigating the impacts of monetary policy (MP) on banks' risk behavior.

The financial crisis has shed light on the relationship between interest rates and bank risk-taking, commonly called the "risk-taking channel of monetary policy" (RTC). This concept suggests that monetary policy, through its influence on interest rates, not only affects the quantity of bank credit but also its quality. Many authors argue that leading up to the crisis, interest rates were kept too low for too long (Taylor, 2009). This prolonged period of low interest rates is believed to have contributed to financial institutions engaging in excessively risky behavior. The first appearances and demonstrations of this phenomenon were discussed by Borio and Zhu (2012) and Adrian and Shin (2009).

Borio and Zhu (2012) explain how changes in monetary policy rates affect either risk perceptions or risk tolerance, thereby influencing the behavior of financial institutions. On the other hand, Adrian and Shin (2009) study the effects of the transmission of monetary policy on the risk-taking of banks through financial markets. They both highlight how the complex network of financial intermediaries can amplify the impact of monetary policy actions on the overall risk profile of the banking sector.

With the recent context of crisis and long periods of low interest rates, literature rapidly grew around this phenomenon. The risk-taking channel of monetary policy is defined as the transmission of monetary policy through bank's risk-taking behavior. But more particularly, how low interest rates influence bank risk-taking. In such an environment of low policy interest rates, the incentives for banks to take on more risk into their balance sheets increase for two main reasons: the search for yield effect and the valuation effect.

The search for yield effect can be understood as what happens on the asset side of banks when observing a reduction in interest rates. When interest rates fall, banks experience a squeeze of their margins. To compensate for the reduced income from traditional lending, banks must look for yield in other areas, which often involves considering riskier opportunities. That is, a reduction in interest rates can cause banks to increase risky investments and supply riskier loans to meet expected high rates of return (Rajan, 2006).

Low returns on investments create strong incentives for banks to take on more risks due to various institutional, contractual, or behavioral factors. One example of behavioral factor is the money illusion, where investors overlook the fact that nominal interest rates may decline to adjust for lower inflation, leading them to seek higher returns without fully accounting for the associated risks. Regulatory constraints also play a role, as life insurance companies and pension funds typically manage their assets with an eye on their liabilities.

In some countries, these liabilities are linked to a minimum guaranteed nominal rate of return or long-term actuarial assumptions, rather than the current yield levels. During times of declining interest rates, the yields on highly-rated government bonds may fall short of these obligations, giving incentives to financial institutions to look for higher-yield and thus higher-risk investments to close the gap. Furthermore, financial institutions often engage in long-term contracts that commit them to deliver relatively high nominal rates of return, intensifying the pressure to seek out riskier opportunities. The relationship between low interest rates and increased risk-taking is finally influenced by competition, the structure of managerial bonus schemes, and weaknesses in supervision and regulation (Ackermann et al., 1999; Salas and Saurina, 2003). For instance, managers' compensations could be linked to absolute returns, increasing the incentives for managers to move to riskier assets when rates are low.

Low policy interest rates also affect the liabilities side of banks, a phenomenon known as the valuation effect. When interest rates decrease, it affects valuations, incomes, and cash flows of banks, which in turn influences risk-taking behavior (Adrian and Shin, 2009). Low policy rates and increased money supply tend to elevate the value of both real and financial collateral. This reduces banks' perceived risk and encourages greater leverage. As asset and collateral values rise, banks adjust their estimates of the probability of default, loss given default, and volatilities.

For instance, low interest rates can boost asset prices, which generally reduces asset price volatility and perceived risk. A higher stock price increases the value of equity relative to corporate debt, thereby reducing corporate leverage and potentially decreasing the risk of holding stocks. This effect is particularly relevant in the context of Value-at-Risk methodologies used for economic and regulatory capital purposes (Danielsson et al., 2004). As volatility declines in rising markets, it frees up risk budgets for financial firms, encouraging them to take on more positions. Adrian and Shin (2009) also show that changes in measured risk prompt adjustments in bank balance sheets and leverage conditions, amplifying business cycle movements.

Moreover, a decrease in interest rates lowers the cost of banks' liabilities, which increases their excess capital and alter their leverage ratios. Banks typically aim to maintain a specific leverage ratio, so they may deploy their excess capital to seek additional returns, thereby taking more risks. This is a self-reinforcing mechanism: increased demand for assets drives up their prices, which further increases leverage. To manage this leverage, banks may either raise capital through short-term funding or grant loans to riskier projects, thus increasing excess capital and the cycle starts again. Basically, lower interest rates give incentives to banks to continue seeking higher returns by acquiring more assets, reinforcing a cycle of increased demand and rising asset prices.

Besides the search-for-yield and valuation effects, the risk-taking channel of monetary policy can also be explained through the concept of habit formation. According to Campbell and Cochrane (1999), during periods of economic expansion, investors' consumption levels rise compared to their usual levels. As their consumption increases and they become accustomed to a higher standard of living, they tend to become less risk-averse. This reduced aversion to risk makes them more willing to take riskier investments. In other words, as people get used to better economic conditions and increased consumption, they are more likely to pursue riskier financial opportunities, believing that the positive economic environment will continue. For instance, consider a loosening of monetary policy with Quantitative Easing (QE), the price of assets (stocks and bonds) will increase. As the value of these assets increases, investors experience a wealth effect, where their wealth grows due to the appreciation of their investment portfolios. Feeling wealthier, investors become more confident and less risk-averse, as their financial situation grows. Consequently, they are more inclined to invest in riskier assets (such as emerging market stocks or riskier bonds), looking for higher returns. This reduction in risk aversion due to increased wealth is another way in which monetary policy can influence investor's behavior, similar to the mechanisms described in asset-pricing models.

Another important reason of this transmission of risk is the impact of communication policies from central banks and the moral hazard problem coming from such announcements. An expansion of the monetary policy can lead to more risk-shifting in lending practices. For example, when central banks maintain a high degree of predictability regarding future policy decisions, it can reduce market uncertainty. This predictability can lead banks to take more risks, as they feel reassured that the central bank will intervene to support the economy in case of adverse outcomes. This point of view creates an insurance effect, where agents believe that the central bank will ease monetary policy during economic downturns, which reduces the perceived probability of large downside risks. Moreover, the central bank's communication strategies can reinforce this effect, as clear signals from the central bank about its willingness to support financial markets during downturns can lead to complacency among banks (Montes and Scarpari, 2015). They may engage in riskier loans and investment practices, knowing that potential losses might be mitigated by future monetary policy actions.

Overall, understanding the risk-taking channel of monetary policy is fundamental for maintaining the financial stability and ensure a stable economic environment. This channel highlights ways in which monetary policy, especially through its impact on interest rates, affects the risk behavior of banks. Given the significant role that excessive risk-taking by banks played in precipitating the Global Financial Crisis of 2007-2008, understanding how low interest rates can give incentives to banks to take on more risk is essential for policymakers. It enables them to design more effective regulatory frameworks and monetary policies that can mitigate such behaviors and prevent future crises.

Moreover, understanding the risk-taking channel has other implications than financial stability. It affects the overall health of the economy by influencing the availability of credits and the quality of loans granted by banks. As banks engage in riskier lending practices in response to prolonged low interest rates, the likelihood of non-performing loans increases, which can impact bank balance sheets and restrict credit flow to productive sectors. Therefore, a good understanding of the risk-taking channel helps to develop policies that not only stabilize the financial system but also support sustainable economic growth by ensuring that credit is allocated efficiently and safely. This knowledge is vital for central banks and regulators in their role of balancing monetary easing with the need to monitor excessive risk-taking, thereby promoting a healthier and more robust economic environment.

My thesis aims to deepen the understanding of the risk-taking channel of monetary policy, with a particular focus on the period of Unconventional Monetary Policy (UMP) following the GFC. While the relationship between monetary policy and bank risk-taking has been extensively studied, existing literature often isolates the impacts of UMP from the influence of specific bank characteristics. This creates a significant gap in understanding how these two factors interact to shape the risk behaviors of financial institutions. My research addresses this gap by integrating the analysis of UMP with bank-specific characteristics, providing a more nuanced view of how different types of banks respond to unconventional monetary policies in terms of their risk-taking behavior. This approach is particularly relevant given the complex dynamics introduced by prolonged periods of low interest rates and the introduction of unconventional monetary tools, which have reshaped the traditional mechanisms of monetary policy transmission.

To achieve this, my thesis will employ a methodological framework that combines High-Frequency Identification (HFI) with Local Projections (LP), supplemented by the use of the shadow rate. This combination is inspired by recent advancements in econometric techniques, which are well-suited to address endogeneity issues and capture the dynamic effects of UMP over time. By applying this approach, my research not only fills a gap in the literature but also provides insights that are directly relevant for policymakers and financial regulators. Understanding these interactions is important for designing monetary policies and regulatory frameworks that mitigate excessive risk-taking by banks, thereby promoting financial stability and sustainable economic growth.

The structure of my research thesis is organized as follows: Section 2 covers the literature review, Section 3 details the methodology, Section 4 develops the models, Section 5 presents the analysis, Section 6 conducts the robustness tests, Section 7 outlines paths for future research, and Section 8 provides the conclusion.

2 Literature review

Studying the risk-taking channel is a relatively recent area of research that was neglected before the GFC for two main reasons. On one hand, financial innovation was considered as a stabilizing factor for the financial cycle, under the hypothesis that it permitted better risk sharing. On the other hand, financial stability was not seen as a threat since most central banks had slowly shifted towards tight inflation-targeting, which they considered their best means of fostering economic growth (Altunbas et al., 2018; Svensson and Woodford, 2004).

The first researchers who started assessing the impact of policy interest rates on bank risk-taking were Adrian and Shin (2009), following the work of Borio and Zhu (2008). Borio and Zhu (2008) studied the ways in which changes in monetary policy rates affect risk perceptions and risk tolerance among financial institutions. They highlighted that lower interest rates could lead to an underestimation of risk or an increase in risk tolerance, prompting banks to engage in riskier behavior.

Following this paper and the growing interest, Adrian and Shin (2009) developed a model to assess the transmission of monetary policy on banks' risk-taking via financial markets. Their main findings were that low-interest rates influence banks' risk-taking by increasing the value of financial and real collateral, reducing perceived risks, and encouraging greater leverage. They emphasized how the connections of financial intermediaries can amplify the effects of monetary policy actions, leading to significant shifts in the risk profiles of banks. Their model demonstrated that changes in measured risk due to monetary policy adjustments lead to corresponding changes in bank balance sheets and leverage, thereby amplifying the cyclical nature of financial markets and potentially increasing systemic risk. As a result of these foundational studies, the literature on the risk-taking channel of monetary policy expanded rapidly.

Researchers began to explore various mechanisms through which low interest rates incentivize banks to pursue higher-yield and riskier assets. Altunbas et al. (2010) were among the pioneering economists to dive into the risk-taking channel. Initially, they developed an econometric model to examine if and how monetary policy impacted bank risk-taking. Their research then extended to analyze the effects of specific bank characteristics on this relationship. These two papers have since become foundational works in the literature on the risk-taking channel, alongside the contributions of Adrian and Shin (2009) and Borio and Zhu (2008).

The initial findings of Altunbas et al. (2010) revealed that lower interest rates indeed led to increased risk-taking among banks. They observed that banks were more likely to extend riskier loans and invest in higher-yield assets when monetary policy was accommodative. When examining bank characteristics, their research found that larger banks and those with lower capital buffers were particularly prone to increased risk-taking in a low-interest-rate environment. These banks appeared to exploit their size and capital structure to maximize returns, even at the expense of greater risk exposure.

Their work underscored the importance of considering both macroeconomic policy settings and individual bank traits when assessing financial stability. The findings from their studies highlighted the need for tailored regulatory measures that account for the diverse responses of banks to monetary policy. By demonstrating how bank size and capital adequacy influence risk-taking behavior, Altunbas et al. (2010) gave important evidence for the development of financial regulation and supervision practices.

Further extending the investigation into the risk-taking channel, Jiménez et al. (2014) also made important contributions by examining the empirical effects of monetary policy on bank risk-taking within a more granular context. Their research focused on the Spanish banking sector, using a dataset of loan-level information that allowed for an analysis of the impact of monetary policy on the quality and risk profile of bank lending. Jiménez et al. (2014) also found that low-interest rates increased the propensity of banks to lend to riskier borrowers. Their findings showed that during periods of low interest rates, banks were more inclined to approve loans to borrowers with weaker credit histories and lower creditworthiness. This behavior was particularly pronounced for banks with less capital and those facing competitive pressures, agreeing with the earlier findings of Altunbas et al. (2010) regarding the influence of bank characteristics on risk-taking.

One of the key contributions of Jiménez et al. (2014) was their ability to empirically demonstrate the causal relationship between monetary policy and bank risk-taking. Using loan-level data allowed them to control for various confounding factors and provide clear evidence that the observed increase in risk-taking was indeed driven by changes in monetary policy. This empirical rigor strengthened the argument for the existence of the risk-taking channel and highlighted its significance in shaping banking sector dynamics.

However, there was a lull in the literature for a few years, but research interest revived from 2017 to 2020 and continued through 2020. This new era of research focused more on the bank characteristics influencing the excessive risk taken by banks when interest rates are low. While the general consensus remained that lower interest rates lead to higher risk-taking, researchers began to dive deeper into the specific bank characteristics that amplify this behavior. This area of concern became the main point of research during this period, with several authors making important contributions.

Bonfim and Soares (2018) examined the Portuguese banking sector and found that banks with lower capital ratios and higher levels of non-performing loans were more likely to engage in risky lending when interest rates were low. Their findings complemented the earlier work of Altunbas et al. (2010), which also emphasized the importance of capital adequacy in determining a bank's risk tolerance in a low-interest-rate environment.

Similarly, Neuenkirch and Nöckel (2018) explored the German banking sector and identified that smaller banks and those with higher loan-to-deposit ratios were particularly prone to increased risk-taking under low interest rates. This complemented the findings of Jiménez et al. (2014), who also noted the impact of bank size and liquidity constraints on risk-taking behavior, but them in the context of the Spanish banking sector.

Expanding the geographical scope, Alzuabi et al. (2021) focused on the Middle Eastern banking sector and demonstrated that banks with a high reliance on short-term funding and lower regulatory oversight were more susceptible to take excessive risks when interest rates declined. This research paralleled the observations of Jiménez et al. (2014) regarding the significance of the regulatory environment and funding structures.

Delis et al. (2017) provided a comprehensive analysis of the European banking sector, showing that banks with diversified income streams and higher management efficiency were less likely to engage in excessive risk-taking in low-interest-rate periods. Their findings offered a broader perspective on the determinants of bank risk-taking, aligning with the earlier work of Altunbas et al. (2010) and extending it by emphasizing the role of income diversification and operational efficiency.

Brana et al. (2019) investigated the French banking sector and found that banks with higher competition levels and greater market share tended to take on more risk when interest rates were low. This research highlighted the impact of competitive pressures and market dynamics on bank risk behavior, building on the themes of market structure and competition explored by Neuenkirch and Nöckel (2018) in Germany.

Dell'Ariccia et al. (2017) developed a theoretical model and tested it using data from the US banking sector. Their model revealed that banks with weaker governance structures and more aggressive compensation schemes for executives were more likely to increase risk-taking in response to lower interest rates. This study studied the governance and incentive structures that drive bank behavior, complementing the findings of earlier research by offering a theoretical foundation and empirical validation in the US context.

Each of these studies developed different models and utilized various datasets, with a significant focus on the US and individual countries, while research covering the entire European banking sector was relatively sparse. Despite the geographical and methodological diversity, these studies collectively enhanced our understanding of how specific bank characteristics influence the risk-taking channel of monetary policy. By identifying factors such as capital adequacy, liquidity constraints, funding structures, income diversification, competitive pressures, and governance, this body of research dived further into the mechanisms through which low interest rates affect bank risk-taking.

Following this growing interest, some economists wanted to assess the risk-taking behaviors in specific countries, highlighting the unique economic contexts and regulatory environments. Özşuca and Akbostancı (2016) examined the Turkish banking sector, finding that low interest rates led to increased risk-taking, particularly among banks with lower capital reserves and higher exposure to foreign exchange risk. Their study showed the importance of capital adequacy and currency risk management in mitigating excessive risk-taking in Turkey's volatile economic environment. Similarly, Montes and do Nascimento Valladares (2024) observed that Brazilian banks with aggressive growth strategies and higher levels of non-performing loans took on more risk when interest rates were low, emphasizing the significance of robust risk management practices.

In China, Wang and Zhuang (2022) focused on the relationship between monetary policy and bank risk-taking. They found that Chinese banks, influenced by government policies and state ownership, were more likely to engage in risky lending practices when interest rates were low. This finding paralleled the situation in India, where Sarkar and Sensarma (2019) discovered that public sector banks, under political pressures and less stringent regulatory scrutiny, exhibited similar risk-taking behaviors. In both countries, state influence and regulatory environments played important roles in shaping the risk profiles of banks.

Kamta et al. (2020) analyzed the banking sector in Cameroon, revealing that low interest rates encouraged banks to increase their risk exposure by extending credit to less creditworthy borrowers. This behavior was exacerbated by the lack of robust regulatory oversight and the high levels of informality in the Cameroonian economy. These findings were echoed in Turkey's context, where regulatory weaknesses similarly led to increased risk-taking under low-interest conditions. Both studies highlighted the critical need for stronger regulatory frameworks to curb excessive risk-taking in developing economies.

In contrast, Montes and do Nascimento Valladares (2024) found that in Brazil, the drive for higher returns under low-interest rates was particularly pronounced among banks with aggressive growth strategies, reflecting a different dimension of risk-taking influenced by competitive pressures and market dynamics. This was somewhat akin to the findings of Sarkar and Sensarma (2019) in India, where competitive dynamics between public and private sector banks influenced their risk-taking behaviors differently.

Despite the diverse economic contexts and regulatory environments of these countries, a common theme emerged: low interest rates generally led to increased risk-taking among banks. However, the specific characteristics of each country's banking sector influenced how this risk-taking manifested. For instance, the role of state ownership in China, the political pressures in India, and the high levels of informality in Cameroon all shaped the ways in which banks responded to monetary policy changes. These country-specific studies further enriched the understanding of the risk-taking channel of monetary policy, demonstrating that while the underlying mechanisms might be similar, the outcomes are significantly influenced by local factors. By comparing findings across different countries, it becomes clear that although low interest rates universally incentivize risk-taking, the extent and nature of this risk-taking are deeply affected by each country's unique regulatory, political, and economic environment.

During the 2020s, attention shifted towards analyzing the risk-taking channel during times of unconventional monetary policy. With the Zero Lower Bound (ZLB) on interest rates, central banks increasingly relied on UMP to stimulate economies after the crisis. This shift brought new dynamics in the relationship between monetary policy and bank risk-taking, prompting further investigation by several researchers.

Brana et al. (2019) explored how UMP, such as QE and negative interest rates, impacted bank risk-taking in the Eurozone. Their study found that these unconventional measures also led to significant increases in risk-taking, especially among banks with weaker capital positions and higher exposure to sovereign debt. Similarly, Dhital et al. (2023) analyzed the effects of UMP in the United States, focusing on the period following the Global Financial Crisis. They discovered that QE and other unconventional measures encouraged banks to expand their lending to riskier borrowers, particularly in the mortgage and corporate lending sectors. Their findings highlighted the role of asset purchases in compressing risk premia and altering banks' risk perceptions, leading to increased risk-taking behaviors, as explained in my intro section.

Kandrac and Schlusche (2021) studied the impact of UMP on bank risk-taking in both advanced and emerging economies. They found that while UMP generally led to increased risk-taking across the board, the magnitude and nature of this risk-taking varied a lot between regions. For instance, banks in emerging markets were more likely to engage in foreign currency lending and other high-risk activities, reflecting their unique vulnerabilities and regulatory environments.

These studies collectively showed the complexity of the risk-taking channel in the context of UMP. Brana et al. (2019) and Dhital et al. (2023) both noted that UMP could amplify financial stability risks by encouraging banks to seek higher yields through riskier assets. Meanwhile, Kandrac and Schlusche (2021) showed that the effects of UMP were not uniform across different economies, suggesting that local factors such as regulatory frameworks and market structures play a crucial role in moderating the impact of UMP on bank risk-taking.

Despite research on the risk-taking channel during conventional monetary policy periods, gaps persist regarding its assessment under UMP. While various forms of UMP, such as QE and negative interest rates, have been implemented, the literature often treats these tools collectively rather than examining their distinct impacts. Each UMP tool may affect bank risk-taking differently due to variations in transmission mechanisms. Therefore, disaggregating these tools in empirical studies would provide clearer insights into their specific effects on bank risk behavior. Additionally, assessing the long-term implications of UMP on bank risk-taking will require several years of observation, as most studies have focused on immediate or short-term effects. Studying the sustainability of risk-taking behaviors implied by prolonged periods of UMP is crucial for anticipating potential risks associated with the normalization of monetary policy for future financial stability challenges.

Moreover, there is a notable gap in the literature regarding the combination of UMP analysis with specific bank characteristics influencing risk-taking. While some research has considered bank heterogeneity, more detailed analysis is needed to understand how different types of banks respond to UMP based on size, capital structure, business model, and ownership. This gap is important because bank characteristics can amplify or mitigate the risk-taking effects of UMP. Addressing this gap will require innovative research approaches, including the use of more precise and broad data and advanced econometric techniques. These efforts are essential for developing effective and targeted regulatory policies to ensure financial stability in an era of unconventional monetary practices.

Furthermore, while discussions on the links between monetary policy and bank risk-taking have increased, foundational elements such as realistic macroeconomic models and time-series evidence are lacking. Gaining an understanding of the risk-taking channel during UMP periods necessitates addressing these gaps. However, proving causality between monetary policy and bank risk-taking remains challenging, partly due to difficulties in fully addressing endogeneity concerns and the real-time attribution of risk-taking behaviors to monetary policy. Nonetheless, recent attempts by economists to address these challenges shows the ongoing efforts to better understand the complex interplay between monetary policy, bank characteristics, and risk-taking behavior.

Endogeneity issues arise from the principle that changes in risk-taking can also influence policy decisions, creating a feedback loop that makes it difficult to isolate the true causal impact of monetary policy on bank risk-taking. This bidirectional relationship complicates the analysis, as it is challenging to determine whether changes in risk-taking are a cause or an effect of monetary policy adjustments. To address endogeneity issues, many economists have developed techniques. For instance, Altunbas et al. (2012) posit that the measurement of risk can only be accurately gauged during extreme events, such as financial crises. While this approach can mitigate endogeneity, it is too restrictive for analyzing periods involving the ZLB or UMPs, where risk dynamics may differ significantly from crisis periods.

Delis et al. (2017) tackle endogeneity by using various measures, notably the Taylor rule residuals. These residuals are obtained by regressing the shadow short rate on output gap and inflation, which helps isolate the impact of monetary policy from other economic factors. Other authors also use Romer and Romer (2004) residuals, which incorporate real-time information, providing a more accurate reflection of the policymakers' perspective at the time decisions were made. Another strategy to counter endogeneity involves selecting a specific sample. Dell'Ariccia et al. (2017) focus on a sample of new loans granted, assuming that this subset is less likely to inform Federal Open Market Committee (FOMC) decisions compared to a bank's entire portfolio. To further address endogeneity concerns, they conduct a series of four robustness tests. Their findings remain consistent across these tests, suggesting that their results are unlikely to be driven by monetary policy rates reacting to their measures of bank risk-taking.

I will aim to address the identified gaps by exploring the risk-taking channel of monetary policy during periods of unconventional monetary policy, while also considering specific bank characteristics and addressing endogeneity issues. This research will contribute to a deeper understanding of how (unconventional) monetary policies influence bank risk-taking behaviors, helping policymakers and regulators to ensure financial stability.

3 Method

3.1 Context

The primary objective of this master thesis is to assess the risk-taking channel of monetary policy during periods of UMP, with a focus on addressing endogeneity issues and studying specific bank characteristics. Various econometric models have been developed to study these aspects separately; some models focus on the impacts of bank characteristics on risk-taking behaviors, while others analyze the effects of UMP. However, there is a notable gap in the literature where these two areas intersect. No existing studies comprehensively combine the analysis of bank characteristics with the effects of UMP, making this research particularly valuable for providing a deep understanding of how unconventional monetary policies influence bank risk-taking behaviors in the context of different bank profiles.

Econometric models like Vector Autoregressive (VAR) models have often been used in the literature to study the impact of monetary policy on bank risk-taking. For instance, Neuenkirch and Nöckel (2018) employ a structural VAR model to analyze the influence of UMP on bank risk in the Eurozone. Similarly, Alzuabi et al. (2021) use a Global VAR (GVAR) model to assess how monetary policy shocks propagate across different countries and impact bank risk-taking. These VAR models are particularly useful for capturing the dynamic relationships between multiple time-series variables and for understanding the transmission mechanisms of monetary policy shocks over time.

On the other hand, several studies utilize alternative econometric approaches to explore the risk-taking channel. For example, Bonfim and Soares (2018) employ a Probit model to analyze the probability of a loan being classified as risky, while Altunbas et al. (2010) use a similar Probit model to determine the likelihood of a bank belonging to the group of riskier institutions during a financial crisis. Delis et al. (2017) use regression techniques, incorporating Taylor rule residuals to account for endogeneity and measure the effects of UMP. Dell'Ariccia et al. (2017) adopt a two-stage approach to mitigate endogeneity concerns by focusing on new loans granted, assuming this subset is less likely to inform the FOMC decisions.

Despite the strengths of these individual approaches, there remains an important gap in the literature. Specifically, the existing studies tend to either focus on the general effects of UMP or on bank characteristics under conventional monetary policy, without integrating the two. This master thesis aims to bridge this gap by developing a comprehensive model that combines the study of UMP with an analysis of bank-specific characteristics, thus providing a more nuanced understanding of how different types of banks respond to unconventional monetary policies in terms of risk-taking behavior.

To address the identified gaps in the literature, my approach will combine high-frequency identification and local projections, supplemented by the use of the shadow rate. This combined methodology is inspired by the insights from Rossi's 2021 paper, "Identifying and Estimating the Effects of Unconventional Monetary Policy: How to Do It and What Have We Learned?" The robustness and effectiveness of this methodology are further supported by the findings from several key papers in the field, including Jordà (2005), Nakamura and Steinsson (2018), and Barnichon and Brownlees (2019).

3.2 Econometric method

3.2.1 High-Frequency Identification (HFI)

High-Frequency Identification exploits the immediate market reactions to central bank announcements, using high-frequency financial data to isolate the impact of monetary policy shocks. This method allows for precise quantification of how asset prices (such as stock prices, bond yields, and exchange rates) respond to unexpected changes in monetary policy instruments, effectively addressing the issue of endogeneity by focusing on real-time data. Nakamura and Steinsson (2018) demonstrate the effectiveness of HFI in their study, "High-Frequency Identification of Monetary Non-Neutrality: The Information Effect," where they show how market responses to policy announcements can reveal the underlying non-neutrality of monetary policy. By focusing on narrow event windows around policy announcements, HFI reduces the influence of other concurrent economic events, providing a clear picture of the policy's impact.

The process involves selecting key dates and times of monetary policy announcements. Narrow event windows around these announcements—ranging from a few minutes to a few hours before and after—are defined to isolate the effects of the policy changes from other economic events. By analyzing these narrow windows, I can capture the immediate impact of policy announcements on financial variables.

3.2.2 Local Projections (LP) with Shadow Rate and Identified Shocks

Following the identification of immediate market reactions using HFI, I will use Local Projections to analyze the dynamic response of bank risk-taking measures to the identified monetary policy shocks. This approach is particularly suited for estimating Impulse Response Functions (IRFs) without imposing strong structural assumptions, allowing for a flexible and robust framework for estimating dynamic relationships between variables.

Jordà (2005) in "Estimation and Inference of Impulse Responses by Local Projections" argues for the advantages of using LP over traditional VAR models, particularly in its flexibility and robustness. LP allows for direct estimation of impulse responses and is better at handling model misspecification and structural breaks, which are common in macroeconomic data. This makes LP a highly suitable method for capturing the dynamic impacts of monetary policy shocks on bank risk-taking behaviors.

My LP model will incorporate the HFI-identified monetary policy shocks as dependent variables and other relevant control variables such as macroeconomic indicators and bank-specific characteristics. This setup facilitates the assessment of how bank risk measures evolve over time in response to policy shocks, enabling me to study the medium- to long-term effects of (unconventional) monetary policy on bank risk-taking behavior.

Further enhancing this analysis, the shadow rate is integrated in the LP framework to address the monetary policy stance during periods when traditional interest rates are constrained by the ZLB. As discussed in Rossi's work and further elaborated by Barnichon and Brownlees (2019) in "Impulse Response Estimation by Smooth Local Projections", the inclusion of the shadow rate, offers a continuous measure of monetary policy intensity under ZLB conditions. The use of local projections refines the impulse response estimation, particularly when dealing with high-frequency financial data, thereby improving the accuracy and reliability of the results.

To measure the bank lending behavior, a two-step analytical approach will be set up. The first step evaluates how changes in monetary policy affect the overall volume of loans, measured by the Loan to Asset (LTA) ratio. This ratio indicates how aggressively banks are lending relative to their total assets. This step incorporates control variables such as economic growth rate and inflation rate to account for external economic influences on lending.

Following this, if a significant impact on lending volumes is detected, the analysis will shift focus to the quality of these loans using the "Non-performing loans to total gross loans ratio" (NPL). This ratio measures the proportion of loans in a bank's portfolio that are considered non-performing, relative to the total amount of loans issued, reflecting the risk profile of the loan portfolio. This phase examines whether an observed increase in lending correlates with deteriorating loan quality, employing a consistent LP model framework with the inclusion of monetary policy shocks and control variables to measure their effects on loan quality.

My methodical approach, inspired by the insights from Rossi's 2021 paper and supported by the works of Jordà (2005), Nakamura and Steinsson (2018), and Barnichon and Brownlees (2019), leverages the strengths of HFI, LP, and the shadow rate. My model fills a gap in the literature and shed light on how different types of banks respond to (unconventional) monetary policies in terms of risk-taking behavior.

3.3 Endogeneity concern

One of the biggest challenges in assessing the impact of monetary policy on bank risk-taking is the endogeneity concern. Endogeneity arises when policy changes are systematically related to other economic variables, making it difficult to isolate the true effect of monetary policy from other influencing factors.

High-frequency identification helps to counter the endogeneity problem, as it examines the exact reactions of the markets to an announcement. This approach captures the immediate impact of monetary policy shocks by isolating unexpected changes in policy instruments from other economic variables. By focusing on high-frequency data around policy announcements, HFI mitigates the simultaneity bias typically associated with endogenous monetary policy responses.

However, local projections do not fully eliminate the endogeneity problem. LP helps by incorporating lagged values and control variables to address some endogeneity concerns, capturing the evolution of risk measures over time and accounting for potential confounding factors. Yet, LP alone does not completely resolve the endogeneity issues arising from the potential feedback between monetary policy and economic conditions.

To further address endogeneity concerns, as a robustness test, I will use Taylor's residuals. Taylor's residuals, derived from the Taylor rule, measure the deviation of actual policy rates from the rates predicted by the rule, accounting for systematic monetary policy responses to economic conditions. In comparison, the Romer and Romer (2004) approach identifies exogenous policy changes by examining the intentions and motivations behind policy decisions, thereby isolating true policy shocks from endogenous responses to economic conditions. While the Romer and Romer (2004) approach is valuable for historical analysis, Taylor's residuals provide a more practical and straightforward method for contemporary data, especially when high-frequency data is available. As highlighted by Bernanke et al. (2019) in their paper "Measuring the Macroeconomic Impact of Monetary Policy at the Zero Lower Bound," Taylor's residuals provide a more efficient and robust framework for contemporary monetary policy evaluation.

Given that my research question focuses on the risk-taking behavior of banks under unconventional monetary policy, and considering the HFI approach used to capture immediate market reactions, Taylor's residuals are more adapted to effectively address endogeneity concerns and enhance the validity of my findings.

3.4 Database

My thesis uses a set of data gathered from multiple specialized sources. To conduct the High-Frequency Identification of monetary policy shocks, I will utilize the Euro Area Monetary Policy Database (EA-MPD), sourced from Altavilla et al. (2019). This database is specifically designed to capture immediate market reactions to central bank announcements, providing high-frequency financial data that allows for precise isolation of the impacts of monetary policy changes. The EA-MPD Database enables the analysis of financial variables within narrow event windows (typically 30 minutes before and after policy announcements) ensuring that the effects of the policy changes are accurately captured while minimizing the influence of other concurrent economic events. Specifically, I will use data from Sheet 4: Monetary Event Window. This sheet tracks changes in the median quote from 13:25-13:35 before the press release to 15:40-15:50 after the press conference, thereby encompassing the full spectrum of market responses to both the press release and the subsequent press conference. This approach makes sure that the HFI model accounts for the immediate and comprehensive impact of monetary policy announcements.

Additional detailed financial metrics such as Loan to Asset and Non-Performing Loans ratios, alongside other bank control variables like total assets and capital ratios, are sourced from the Orbis Europe Database. This data helps in analyzing bank-specific risk-taking behaviors. This dataset contains quarterly financial data for 88 banks operating in the 20 countries of the Eurozone, spanning from Q1 2017 to Q3 2023.

Furthermore, macroeconomic indicators and policy interest rates from the ECB's statistical data warehouse are included to control for broader economic conditions and to contextualize the monetary policy environment, particularly important for analyses that incorporate the shadow rate during periods of zero lower bound. The european shadow rate was computed by Jing Cynthia Wu and is available on her website, following the methodology she developed in her research Wu and Xia (2016).

4 Models

4.1 HFI model

The integration of HFI with LP constitutes the core of my methodology for assessing the impact of UMP on bank risk-taking. HFI plays a pivotal role by capturing immediate market reactions to central bank announcements, thereby isolating exogenous monetary policy shocks from other economic variables. This step is crucial to reduce endogeneity issues that could be problematic for the interpretation of policy effects. By pinpointing unexpected policy changes through HFI, I derive cleaner shock measures that are less susceptible to simultaneous economic responses. These exogenous monetary policy shocks identified through HFI will be incorporated into the LP model to analyze their dynamic effects on bank risk-taking behaviors.

The HFI model, as explained before, aims to isolate and obtain MP shocks. Mathematically, the model can be expressed as the one from Nakamura and Steinsson (2018):

$$\Delta s_t = \alpha + \gamma \Delta i_t + \epsilon_t \tag{1}$$

where Δs_t represents the change in an outcome variable of interest from the median quote between 13:25 and 13:35 prior to the press release, to the median quote between 15:40 and 15:50 following the press conference. In this context, Δs_t could exemplify the yield on a five-year zero-coupon Treasury bond, Δi_t represents a measure of monetary policy during the ECB announcement, ϵ_t is an error term, and α and γ are parameters. The parameter of interest is γ, which quantifies the effect of the announcement on Δs_t.

To identify a pure monetary policy shock, I focus on the changes in the policy indicator Δi_t during a narrow window around the scheduled ECB announcements. Specifically, I consider the change in the policy indicator from the median quote in the 13:25-13:35 window before the press release to the median quote in the 15:40-15:50 window after the press conference. This approach assumes that the changes in the policy indicator during these windows predominantly reflect the anticipations of future monetary policy as communicated in the ECB announcements. Assuming this holds true, I can then estimate the equation using Ordinary Least Squares (OLS).

4.2 LP model

The local projection methodology, introduced by Jordà (2005) and refined by Barnichon and Brownlees (2019), offers several advantages over traditional VAR models by providing flexibility in the model specification, robustness against model misspecification, easy incorporation of nonlinearities, and clear interpretability of impulse responses.

The LP model is specified as follows:

$$\begin{aligned} y_{i,k,t+h} = {} & \alpha_i + \beta_h MP\_Shock_t + \lambda_h Shadow\_Rate_t + \gamma_h \log(Size_{i,k,t}) \\ & + \delta_h Equity_{i,k,t} + \theta_h GDP_{k,t} + \phi_h Inflation_{k,t} + \epsilon_{i,t+h} \end{aligned} \tag{2}$$

Where:

- $y_{i,k,t+h}$ represents the measure of bank risk-taking for bank i at horizon h, initially as the LTA ratio to assess lending behavior and subsequently as the NPL ratio to evaluate the quality of the loan portfolio.
- MP_Shock_t is the exogenous monetary policy shock identified through HFI.
- $Shadow\_Rate_t$ provides a measure of the effective stance of monetary policy during periods when traditional policy rates are at or near the ZLB.
- $\log(Size_{i,k,t})$ is the log of the total assets of bank i at time t, used to normalize the data and reduce skewness.
- $Equity_{i,k,t}$ is the ratio of bank's equity to total assets, indicating the bank's capital adequacy.
- $GDP_{k,t}$ is the GDP growth rate of bank i's country.
- $Inflation_{k,t}$ is the inflation rate of bank i's country.

Bank size and equity ratios are frequently emphasized in financial research due to their significant impact on a bank's risk tolerance and stability. A bank's size generally reflects its market presence and diversification potential, which are important for risk management. On the other hand, equity ratios are vital indicators of a bank's financial robustness and its ability to manage risks. These factors are commonly analyzed in studies exploring the risk-taking channel of monetary policy, highlighting concerns among economists about their influence on the risk behaviors of banks.

Unlike other studies in the literature, incorporating the Main Refinancing Operations (MRO) rate into the analysis might not significantly enhance the model given its lack of variability for most of the study period (2017-2022), where it remained at zero before rising in 2023. Since the focus of the study is on understanding bank behaviors during low interest rate periods, the static nature of the MRO rate during these years offers limited explanatory power. Instead, the model benefits from emphasizing the shadow rate, which captures the nuances of UMP even when nominal rates are at their lower bound.

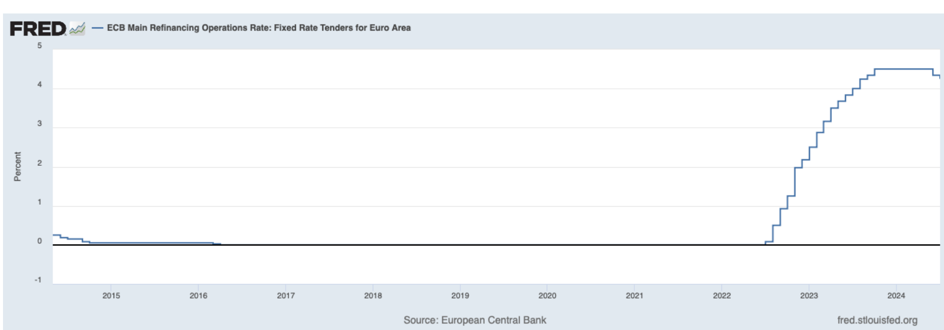

Figure 1: ECB's Main Refinancing Operations
Source: Federal Reserve Economic Data

5 Analysis

5.1 High-Frequency Identification of Monetary Policy Shocks

The traditional approach to overcoming endogeneity issues in monetary policy research involves controlling for confounding variables. This method is evident in VAR studies, such as those conducted by Christiano et al. (1999) and Bernanke et al. (2005), and in the work of Romer and Romer (2004). However, despite efforts to account for key confounders, residual endogeneity bias often persists, as highlighted by Rudebusch (1998). An alternative, which I adopt in my thesis, focuses on the movements in various prices and indexes within a narrow window around ECB meetings, a method pioneered by Cook and Hahn (1989), Kuttner (2001), and Cochrane and Piazzesi (2002). This approach exploits the manner in which monetary news is disseminated during ECB meetings each year, allowing for an identification scheme that cleanly addresses the endogeneity concern.

In this context, I construct my monetary shocks using unexpected changes in interest rates over a 30-minute window surrounding scheduled ECB announcements. All information that is public at the start of this window is already factored into market prices, thus avoiding spurious variations in the shock measurements. This issue of spurious variation is a significant concern in VAR studies, exemplified by incidents like the misinterpretation of the interest rate drop in September 2001 as a monetary shock in the aftermath of the 9/11 terrorist attacks, rather than as a reaction to the attacks themselves. One major limitation of this high-frequency identification approach, however, is the reduced statistical power due to the typically small size of the monetary shocks estimated, often only about 5 basis points. This limitation makes it challenging to directly estimate the effects of these shocks on future output, as output is influenced by numerous other factors that dilute the clarity of the monetary policy's impact in regression analyses.

This study uses the HFI approach inspired by Nakamura and Steinsson (2018). Their influential model, formulated as follows:

$$\Delta s_t = \alpha + \gamma \Delta i_t + \epsilon_t$$

guides my analysis of the immediate effects of monetary policy announcements on financial variables. Here, Δs_t captures the change in financial variables of interest immediately following policy announcements, and Δi_t is the change in a policy indicator like Overnight Indexed Swap OIS rates, representing the immediate market reaction to news of monetary policy decisions.

My empirical analysis begins with the EA-MPD, which captures high-frequency data on financial variables around ECB policy announcements. The financial variables are for instance different maturities of bonds, currency exchange rates, etc. Given the nature of this dataset, I faced the challenge of unevenly spaced announcements: some months featured multiple announcements while others had none. To address this, I adopted a pragmatic approach: for months without any announcements, I assumed no change in the policy stance, attributing a zero variation to these periods. This assumes market stability in the absence of new policy information. For months with multiple announcements, I calculated the average change across all relevant financial variables and OIS rates. This averaging serves to smooth out the volatility and provide a more stable measure of policy impact over each month. These preparations ensured that my dataset was consistent and gave more accuracy in the analysis of policy impacts.

After preparing the dataset, I conducted OLS regressions for each combination of OIS rates and financial variables. It assessed how effectively each OIS rate explained the variations in financial responses following ECB announcements. This evaluated the capacity of each OIS rate to reflect the monetary policy shocks by measuring their impact on immediate financial market responses. For each regression, I calculated and recorded key metrics such as adjusted R-squared values and p-values to evaluate the explanatory power and statistical significance. I then averaged these metrics for each OIS rate and performed a comparative analysis to determine which OIS rate most robustly captured the dynamics of monetary policy impacts.

The decision on the most appropriate OIS rate was based on a combination of high explanatory power (high adjusted R-squared) and statistical significance (low p-values). This double criterion ensured that the chosen OIS rate not only accurately reflected the immediate financial market reactions to policy announcements but also was robust in its statistical validity. Table 1 shows the results for all OIS rates.

Table 1: Summary of OIS Rates

Rates	Avg Est	Significance	Avg Adj R Sq
OIS_2Y	0.278	**	0.488
OIS_3Y	0.348	**	0.472
OIS_1Y	0.224	***	0.408
OIS_7Y	0.423	*	0.338
OIS_6Y	0.411	*	0.335
OIS_8Y	0.446	**	0.334
OIS_5Y	0.389	*	0.329
OIS_9Y	0.448	*	0.324
OIS_4Y	0.361	**	0.318
OIS_10Y	0.442	*	0.308
OIS_6M	0.220	***	0.278
OIS_15Y	0.431	*	0.235
OIS_20Y	0.404	*	0.205
OIS_3M	0.165	**	0.143
OIS_1M	0.0858	*	0.0481
OIS_SW	0.0613	*	0.0277

Source: Author's computations (through RStudio with the EA-MPD)

From the data in table 1, several OIS rates stand out due to their performance across metrics, particularly OIS rates for 6-month, 1-year, 2-year, and 3-year maturities. The 2-year and 3-year OIS rates show higher adjusted R-squared values, suggesting a better model fit and explaining a greater variance in financial variable changes. However, their p-values are higher than other rates, which reduces their statistical appeal. On the other hand, the 1-year OIS rate, despite a slightly lower adjusted R-squared, presents the lowest p-value among the three, which is crucial for establishing the statistical significance of the results. Finally, the 6-month rate presents the highest significance but with a lower adjusted R-squared.

The 1-year OIS rate emerges as a balanced choice. It not only maintains a reasonably high explanatory power as indicated by its adjusted R-squared but also has the lowest p-value across the board, suggesting a statistically significant relationship between the 1-year OIS rate changes and the financial variables. Therefore, the 1-year OIS rate will represent my measure of monetary policy shock, that I will include in my LP model.

5.2 Local Projection Analysis

5.2.1 First Step: Loan to Asset Ratio and Its Response to Monetary Policy

The initial phase of the LP analysis investigates whether monetary policy changes influence the lending behaviors of banks. This is quantified using the Loan to Asset ratio, which indicates the proportion of loans to the total assets held by banks. The model specification for this analysis is as follows:

$$
\begin{aligned}
LTA_{i,k,t+h} = {} & \alpha_i + \beta_h OIS\_1Y_t + \lambda_h Shadow\_Rate_t + \gamma_h \log(Size_{i,k,t}) \\
& + \delta_h Equity_{i,k,t} + \theta_h GDP_{k,t} + \phi_h Inflation_{k,t} + \epsilon_{i,t+h}
\end{aligned}
\tag{3}
$$

Where:

- $LTA_{i,k,t+h}$ represents the measure of bank risk-taking for bank i at horizon h, in this first step the Loan to Asset ratio.
- $OIS\_1Y\_Change_t$ is the OIS rate for 1-year maturity, representing the exogenous monetary policy shock identified through HFI.
- $Shadow\_Rate_t$ provides a measure of the UMP.
- $\log(Size_{i,k,t})$ is the log of the total assets of bank i at time t.
- $Equity_{i,k,t}$ is the ratio of bank's equity to total assets, indicating the bank's capital adequacy.
- $GDP_{k,t}$ is the GDP growth rate of bank i's country.
- $Inflation_{k,t}$ is the inflation rate of bank i's country.

Figure 2 presents the result of Eq. (3), the table containing the coefficients and their significance can be found in the appendices.

The impulse response function for the OIS_1Y_Change variable explains how changes in the OIS rate variation, identified as monetary policy shocks through HFI, affect the Loan to

Asset ratio. At horizon 1, the IRF shows an initial negative coefficient. This indicates that an increase in the OIS rate variation, reflecting a tightening of monetary policy, initially reduces the proportion of loans to total assets. This immediate response can be attributed to several factors. When the OIS rate increases, borrowing costs rise, leading to tighter credit conditions. Banks become more cautious about extending loans due to higher funding costs, reducing overall lending activity. Higher interest rates can also signal an economic slowdown or increased risk, prompting banks to adopt a more conservative lending approach. This heightened risk aversion results in a lower LTA ratio as banks prioritize maintaining liquidity and capital over expanding their loan portfolios.

This coefficient also suggests that reductions in the OIS rate, indicative of an easing of monetary policy and lower interest rates, have a significant positive impact on the LTA ratio. Lower OIS rates decrease the cost of borrowing for banks, encouraging them to extend more credit, as lending becomes more profitable. The lower interest expense allows banks to offer loans at more attractive rates, stimulating demand for credit from businesses and consumers. As borrowing costs decrease, banks' capacity to supply credit improves. They are more willing to take on new lending opportunities, increasing the proportion of loans in their asset portfolios. This expanded credit supply is reflected in the rising LTA ratio over the horizons. Low interest rates hence stimulate economic activity by encouraging investment and consumption. As businesses and consumers borrow more to finance investments and purchases, the overall demand for loans increases. Banks, responding to this heightened demand, expand their lending activities, further boosting the LTA ratio. This is consistent with the findings of Bonfim and Soares (2018), who also emphasize the stimulative effects of low interest rates on bank lending.

Central banks often use interest rate cuts as a tool to stimulate economic activity. By lowering the OIS rate, central banks aim to reduce the cost of borrowing, thereby encouraging banks to lend more. This increased lending activity supports economic growth by providing businesses with the necessary capital to invest and expand, and by enabling consumers to finance significant expenditures such as homes and cars. Lower interest rates improve banks' profit margins on loans. When borrowing costs decrease, the difference between the interest rates banks charge on loans and the rates they pay on deposits (the net interest margin) widens. This increased profitability incentivizes banks to expand their loan portfolios, contributing to a higher LTA ratio. The IRF illustrates the transmission mechanism of monetary policy through the banking sector. Changes in the OIS rate directly influence banks' lending behavior, highlighting the effectiveness of interest rate adjustments in steering economic activity. The observed positive impact of low rates on lending underscores the importance of accommodative monetary policy in supporting financial stability and growth (Neuenkirch and Nöckel, 2018).

The effect of low OIS rates on the LTA ratio is particularly relevant in contemporary low-rate environments, where traditional policy tools may be constrained. When interest rates are already near zero, traditional monetary policy tools (such as further rate cuts) have limited scope. In this context, even small reductions in the OIS rate can have a significant impact on lending, as banks adjust to the new cost of capital.

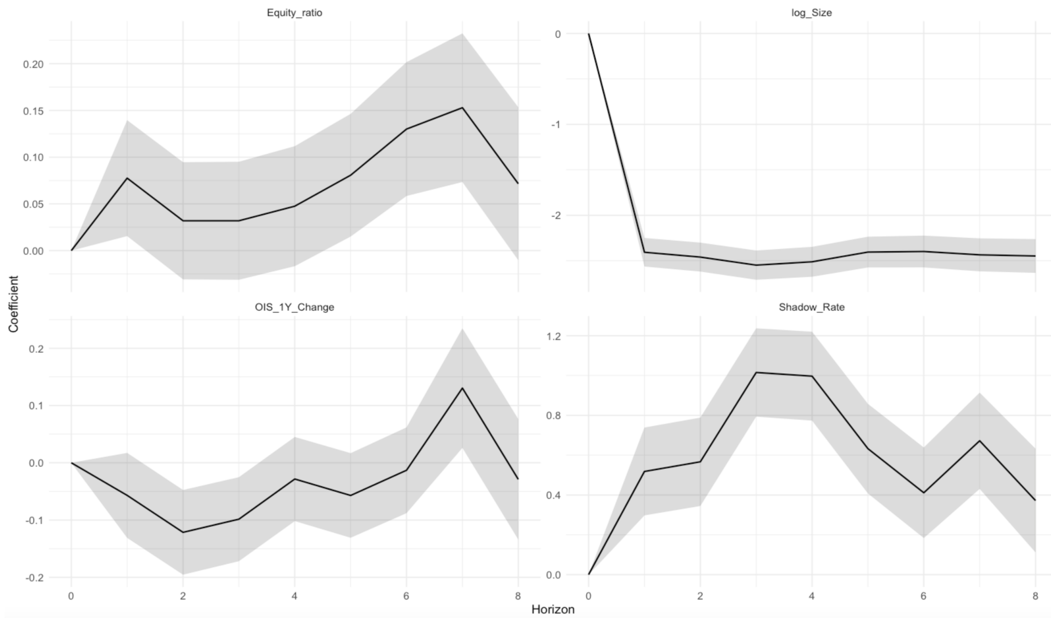

Figure 2: The Effect of Monetary Policy and Bank Characteristics on LTA Ratio
Source: Author's computations (through RStudio with the Orbis Database)

When interest rate cuts are constrained by the ZLB, central banks use unconventional monetary policy tools, such as Quantitative Easing or Forward Guidance. This is measured by the shadow rate. The IRF for the Shadow_Rate reveals a positive effect on the LTA ratio, illustrating the impact of unconventional monetary policy measures on bank lending activities. Initially, the impact is moderate, but it peaks around horizon 4, with a coefficient nearing 1.0. This positive effect suggests that unconventional monetary policies, such as QE, stimulate lending activities within banks.

Quantitative easing involves the central bank purchasing long-term securities in the open market, which increases the money supply and lowers long-term interest rates. This process effectively reduces borrowing costs across the economy, not just for banks but also for businesses and consumers. The lower borrowing costs make it cheaper for banks to obtain funds, which they can then lend out at more attractive rates. As a result, banks are incentivized to expand their loan portfolios, leading to an increase in the LTA ratio.

The sustained nature of the impact observed in the IRF indicates that the effects of unconventional monetary policy measures are not fleeting but rather persistent. Even after the implementation of policies like QE, the positive effects on bank lending continues across multiple horizons. This persistence can be attributed to several factors: by keeping long-term interest rates low, QE ensures that borrowing remains affordable for an extended period. This encourages continued borrowing by businesses for investment and by consumers for big-ticket purchases, thereby maintaining a high demand for loans. The purchase of long-term securities by central banks increases the prices of these assets and reduces yields, which can improve the balance sheets of banks holding these securities. Healthier balance sheets enhance banks' capacity to lend. Unconventional monetary policies can also boost confidence in the financial system. By demonstrating a commitment to maintaining liquidity and supporting economic growth, central banks can reassure banks and other financial institutions, encouraging them to engage in more lending.

The fact that the effect of the shadow rate remains positive across all horizons demonstrates the potency of unconventional monetary policies in maintaining lending growth. This is particularly important when traditional policy tools, such as adjusting short-term interest rates, are constrained (often the case when rates are already near zero). In such low-rate environments, unconventional measures like QE become vital in providing the necessary stimulus to the economy.

Regarding the bank characteristics, the IRFs for the Equity_ratio and log_Size variables will help. The IRF for the Equity_ratio variable reveals a positive and gradually increasing relationship with the LTA ratio. Initially, at horizon 1, the coefficient is around 0.05, suggesting that banks with higher equity ratios, reflecting greater capital adequacy, tend to allocate a higher proportion of their assets to loans. This positive relationship strengthens over time, peaking at horizon 7, indicating that well-capitalized banks are more confident in their ability to absorb potential losses and thus more willing to extend credit.

Key insights include the ability of banks with higher equity ratios to absorb risks, meet regulatory requirements, and lower their funding costs. These advantages enable such banks to offer more competitive loan rates and support larger loan volumes, resulting in a higher LTA ratio. The importance of capital adequacy in promoting lending activities is underscored by the sustained positive impact observed in the IRF.

Conversely, the IRF for the log_Size variable consistently shows a negative impact on the LTA ratio, with an initial coefficient of around -2.50 at horizon 1. This negative relationship suggests that larger banks, characterized by higher total assets, tend to allocate a smaller proportion of their assets to loans. This trend persists across all horizons, highlighting that larger banks, with their diversified business models, rely less on traditional lending.

Larger banks often engage in a broader range of financial activities, such as investment banking and asset management, which reduces their dependence on loans. They also benefit from better access to capital markets, allowing them to raise funds more efficiently and focus on diversified revenue streams. Additionally, stringent regulatory requirements for larger banks influence their cautious lending behavior, further contributing to the lower LTA ratio.

The impacts of the Equity_ratio and log_Size variables on the LTA ratio highlight the banks lending behavior. While higher equity ratios encourage lending by providing banks with the confidence and capacity to extend credit, larger banks allocate a smaller proportion of their assets to loans due to their diversified operations and regulatory constraints. The IRF analysis for the Equity_ratio and log_Size variables shows the importance of capital adequacy and the distinctive lending behavior of larger banks. Well-capitalized banks are more inclined to lend, promoting financial stability and supporting economic growth. In contrast, larger banks, with their diversified business models and regulatory considerations, focus less on traditional lending. Policymakers should emphasize capital adequacy in regulatory frameworks to encourage lending while considering the unique characteristics of larger banks to ensure balanced and effective economic policies.

Table 2: Impulse Response Functions for Key Variables

Horizon	OIS_1Y_Change	Shadow_Rate	Equity_ratio	log_Size
1	-0.0569284	0.5181502	0.0775323	-2.406573
2	-0.1214522	0.5667218	0.0319334	-2.459721
3	-0.0984578	1.0152033	0.0319405	-2.548120
4	-0.0283523	0.9967851	0.0475433	-2.511537
5	-0.0570647	0.6326599	0.0806964	-2.404676
6	-0.0130362	0.4112231	0.1300291	-2.398233
7	0.1304221	0.6723383	0.1528710	-2.435001
8	-0.0289219	0.3719838	0.0715317	-2.447445

Source: Author's computations (through RStudio with the Orbis Database)

The findings are consistent with existing literature, which indicates that (unconventional) monetary policy impacts bank lending behaviors. Similarly, I demonstrated that bank lending behavior is affected by their characteristics, such as size and equity. However, while this analysis provides evidence that monetary policy affects the LTA ratio, it is important to note that an increase in the proportion of loans on a bank's balance sheet does not inherently indicate whether these loans are riskier. The LTA ratio alone reflects the volume of lending relative to total assets but does not capture the underlying risk profile of the loans being issued. Therefore, while banks may be increasing their lending in response to monetary policy, the crucial question of whether this leads to higher risk-taking remains unanswered. This observation naturally leads to the second step of my analysis, where I explore the relationship between monetary policy, bank risk-taking, and the quality of loan through the Non-Performing Loans ratio.

5.2.2 Second Step: Non-Performing Loans Ratio and Its Response to Monetary Policy

Previously, I determined that banks do indeed increase their lending when interest rates are low. The next question to address is whether these additional loans are riskier. To investigate this, I will conduct the same analysis using the Non-Performing Loans ratio as the dependent variable. The NPL ratio is a key indicator of the quality of a bank's loan portfolio. It is calculated by dividing the total amount of non-performing loans by the total gross loans issued by the bank.

$$\begin{aligned} NPL_{i,k,t+h} = \alpha_i + \beta_h OIS\_1Y\_Change_t + \lambda_h Shadow\_Rate_t + \gamma_h \log(Size_{i,k,t}) \\ + \delta_h Equity_{i,k,t} + \theta_h GDP_{k,t} + \phi_h Inflation_{k,t} + \epsilon_{i,t+h} \end{aligned} \quad (4)$$

Where:

- $NPL_{i,k,t+h}$ represents the measure of bank risk-taking for bank i at horizon h.
- $OIS\_1Y\_Change_t$ is the OIS rate for 1-year maturity, representing the exogenous monetary policy shock identified through HFI.
- $Shadow\_Rate_t$ provides a measure of the unconventional monetary policy.
- $\log(Size_{i,k,t})$ is the logarithm of the total assets of bank i at time t.
- $Equity_{i,k,t}$ is the ratio of bank's i equity to total assets, indicating the bank's capital adequacy.
- $GDP_{k,t}$ is the GDP growth rate of bank i's country.
- $Inflation_{k,t}$ is the inflation rate of bank i's country.

Figure 3 presents the result of Eq. (4), the table containing the coefficients and their significance can also be found in the appendix.

The IRF for the OIS_1Y_Change variable reveals that when interest rates are low, there is an initial negative coefficient. This indicates that as the OIS rate decreases, the NPL ratio increases, reflecting that lower interest rates encourage riskier lending practices. As explained previously, in the short term, the decrease in interest rates reduces borrowing costs, making credit more accessible to a broader range of borrowers, including those with higher risk profiles. This accessibility can lead to an increase in the proportion of non-performing loans, as more marginal borrowers are likely to struggle with repayments despite the initially favorable borrowing conditions.

As we move to subsequent horizons, the coefficient for the OIS_1Y_Change fluctuates around zero, indicating no significant long-term impact of OIS rate changes on the NPL ratio, suggesting that the long-term effects of sustained low interest rates might stabilize. This could be due to the initial surge in risk-taking behavior subsiding as banks adjust their lending practices and tighten credit standards over time to manage increased risk exposure.

The overall pattern underscores that while low interest rates can initially promote increased lending and higher risk-taking, resulting in a higher NPL ratio, the effect may not persist in the long term. Banks may implement more stringent risk management strategies and improve credit assessment procedures as they observe the rising default rates, which could mitigate the long-term impact on loan riskiness.

Concerning unconventional monetary policy, initially, the IRF for the shadow rate shows a moderate positive coefficient, indicating that as we use more unconventional monetary policy tools (QE or Forward Guidance), the Non-Performing Loans ratio tends to increase. If central banks use more UMP at the ZLB, the cost of borrowing for banks is reduced, making it easier for them to extend credit to a broader range of borrowers, including those with higher risk profiles. This increased accessibility to credit can lead to a higher proportion of non-performing loans as riskier borrowers may struggle to meet their repayment obligations despite the favorable borrowing conditions. This initial increase in the NPL ratio highlights

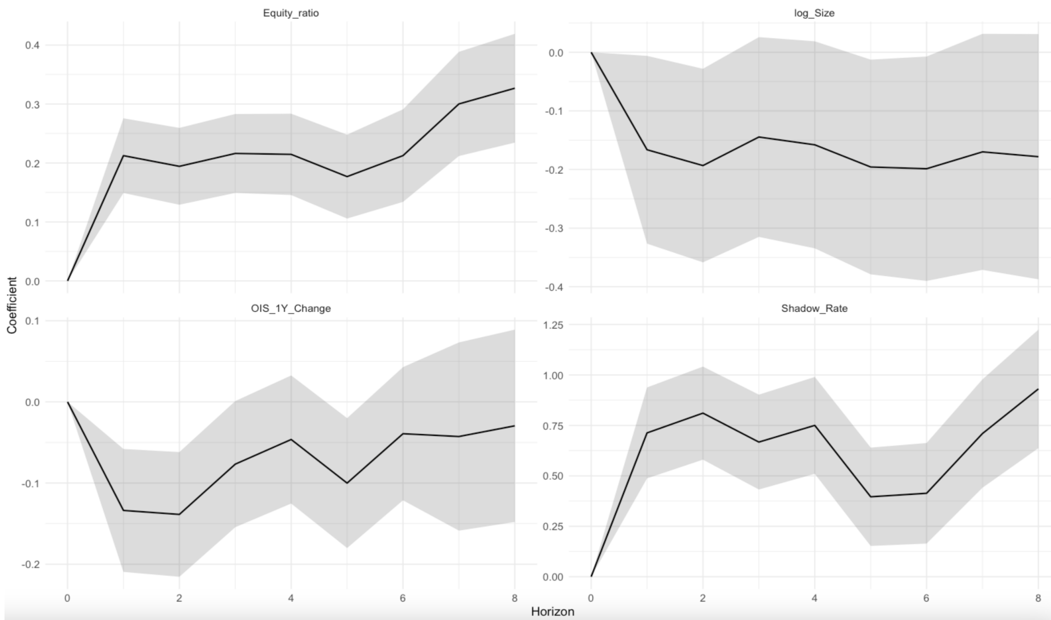

Figure 3: The Effect of Monetary Policy and Bank Characteristics on NPL Ratio
Source: Author's computations (through RStudio with the Orbis Database)

the short-term impact of unconventional monetary policies in promoting lending activities that may involve higher credit risk.

Over subsequent horizons, the coefficient for the shadow rate continues to show a positive impact on the NPL ratio, though with some fluctuations. This sustained positive effect suggests that the influence of unconventional monetary policies on bank risk-taking behavior is not only immediate but also long-lasting. The persistent low borrowing costs and the ample liquidity provided by QE can encourage banks to maintain more relaxed lending standards over an extended period, resulting in a continued increase in the proportion of non-performing loans.

The observed pattern in the IRF for the shadow rate underscores the potential risks associated with prolonged periods of unconventional monetary policy. While such policies are effective in stimulating economic activity by lowering long-term interest rates and increasing the money supply, they also create an environment where banks may be incentivized to take on greater risks. This agrees with the findings showed in my literature review section, which highlighted that unconventional monetary policies could lead to increased risk-taking by banks (Brana et al., 2019; Kandrac and Schlusche, 2021; Dhital et al., 2023).

Furthermore, the sustained positive impact of the shadow rate on the NPL ratio underscores the necessity for robust risk management practices within banks. As unconventional monetary policies are likely to remain a key tool for central banks, especially in low-rate environments, it is important for banks to continuously assess and manage the credit risk associated with their lending activities. This includes tightening lending standards when necessary and ensuring that credit assessments accurately reflect the risk profiles of borrowers. When interest rates increase after a long period of low rates, borrowers who have taken loans under the assumption of continued low rates may struggle to repay them. This is particularly concerning in a context of rising inflation, as it often prompts central banks to raise rates more rapidly. Such a sudden increase in rates can lead to higher default rates, as borrowers face increased repayment burdens. Therefore, proper risk management and accurate credit assessments are important.

Table 3: Impulse Response Functions for Key Variables

Horizon	OIS_1Y_Change	Shadow_Rate	Equity_ratio	log_Size
1	-0.1338	0.7127	0.2124	-0.1663
2	-0.1387	0.8107	0.1943	-0.1933
3	-0.0767	0.6673	0.2162	-0.1446
4	-0.0463	0.7500	0.2146	-0.1579
5	-0.1001	0.3961	0.1769	-0.1957
6	-0.0392	0.4135	0.2125	-0.1987
7	-0.0427	0.7097	0.3001	-0.1699
8	-0.0295	0.9308	0.3268	-0.1782

Source: Author's computations (through RStudio with the Orbis Database)

The IRF for the Equity_ratio variable shows a positive relationship with the NPL ratio, gradually increasing over time. Initially, at horizon 1, the coefficient is around 0.2, indicating that banks with higher equity ratios tend to have higher NPL ratios. This relationship strengthens over time, peaking at horizon 8. This suggests that banks with higher equity ratios, being better capitalized, can absorb more losses and thus might be encouraged to take on more risk, leading to a higher NPL ratio. This aligns with findings of Bonfim and Soares (2018), who suggest that well-capitalized banks have more incentives to lend to riskier clients due to their stronger capital positions.

Higher equity ratios provide a regulatory buffer, allowing banks to extend more credit, including to riskier borrowers, resulting in a higher NPL ratio. Banks with higher equity ratios might feel more secure in their financial standing, prompting them to take on riskier loans. This increased risk tolerance could be due to the perception that their higher equity buffer can protect them against potential loan defaults. Moreover, equity-rich banks often face lower borrowing costs, enabling them to lend more freely, including to riskier segments. The literature on the RTC supports this phenomenon, positing that better-capitalized banks are more inclined to increase their lending to riskier clients during periods of monetary easing (Altunbas et al., 2012; Dell'Ariccia et al., 2014; Jiménez et al., 2014).

Conversely, the IRF for the log_Size variable displays a consistent negative impact on the NPL ratio, with an initial coefficient of around -0.16 at horizon 1. This negative relationship remains relatively stable across all horizons, indicating that larger banks, characterized by higher total assets, tend to have lower NPL ratios. This can be attributed to the diversification of risk, as larger banks typically have more diversified portfolios, which helps in mitigating risk and reducing the NPL ratio. Larger banks engage in a variety of financial activities beyond traditional lending, spreading their risk exposure. This finding is consistent with the notion that larger banks benefit from economies of scale and diversification (Altunbas et al., 2010). Furthermore, larger banks often have better access to capital markets, allowing them to manage their funding more efficiently and maintain a healthier loan portfolio. This access to diverse funding sources helps larger banks stabilize their operations and reduce their dependence on riskier loans.

The diversification benefits of larger banks allow them to distribute their risk across various assets and activities, thereby lowering their overall risk profile. For example, larger banks might have significant investments in securities, real estate, or other financial instruments that offset the risks associated with their loan portfolios. Additionally, these banks typically have more sophisticated risk management systems in place, enabling them to better assess and mitigate the risks associated with their lending activities. This comprehensive risk management capability contributes to their lower NPL ratios.

Larger banks also benefit from better regulatory oversight and stricter compliance requirements, which could contribute to their more conservative lending practices. Regulatory bodies often impose higher capital and liquidity requirements on larger banks, compelling them to adopt more stringent risk management practices. This regulatory pressure ensures that larger banks maintain healthier loan portfolios with lower NPL ratios. Moreover, larger banks have more resources to invest in advanced technology and risk assessment tools, further enhancing their ability to manage and mitigate risks effectively.

Furthermore, larger banks' ability to access capital markets allows them to raise funds more efficiently and at lower costs. This financial advantage enables them to offer more competitive loan rates and terms, attracting a wider range of borrowers, including those with lower risk profiles. By tapping into capital markets, larger banks can also maintain higher liquidity levels, providing them with greater flexibility to manage their loan portfolios and absorb potential losses. This financial agility contributes to their ability to maintain lower NPL ratios compared to smaller banks.

Overall, the first step of the LP analysis shows that changes in the OIS rate and unconventional monetary policies, markedly impact the LTA ratio. Lower OIS rates and measures like QE boost bank lending, thereby increasing the LTA ratio. However, this effect is moderated by banks' equity ratios and size, with well-capitalized banks lending more and larger banks diversifying their assets away from loans. The findings indicate that while lower interest rates and unconventional policies initially lead to riskier lending and higher NPL ratios, the long-term impact stabilizes as banks enhance their risk management practices. Banks with higher equity ratios take on more risk due to their stronger capital positions, whereas larger banks maintain lower NPL ratios thanks to their diversified portfolios and efficient risk management.

6 Robustness tests

To further validate the findings, I will conduct two robustness tests. These tests aim to ensure the reliability and consistency of my results, by examining the sensitivity of the LTA and NPL ratios to various alternative specifications and controls. By pushing the analysis further, I aim to confirm that my conclusions hold under different conditions and assumptions, thereby strengthening the overall credibility of my study.

6.1 Taylor's residuals

In this robustness test, I enhance my initial local projection model by incorporating Taylor's residuals. The Taylor rule is a widely recognized guideline for setting interest rates based on inflation and the output gap. Deviations from the Taylor rule, captured by Taylor's residuals, provide insights into unconventional monetary policy actions or judgmental adjustments made by central banks.

The original model examines the impact of monetary policy and bank characteristics on the Loan to Asset ratio:

$$\begin{aligned} LTA_{i,k,t+h} &= \alpha_i + \beta_h OIS\_1Y_t + \lambda_h Shadow\_Rate_t + \gamma_h \log(Size_{i,k,t}) \\ &\quad + \delta_h Equity_{i,k,t} + \theta_h GDP_{k,t} + \phi_h Inflation_{k,t} + \epsilon_{i,t+h} \end{aligned}$$

To better understand the influence of deviations from standard monetary policy, let's introduce Taylor's residuals into the model:

$$\begin{aligned} LTA_{i,k,t+h} &= \alpha_i + \beta_h OIS\_1Y\_Change_t + \lambda_h Taylor\_Residuals_t + \mu_h Shadow\_Rate_t \\ &\quad + \gamma_h \log(Size_{i,k,t}) + \delta_h Equity_{i,k,t} + \theta_h GDP_{k,t} + \phi_h Inflation_{k,t} + \epsilon_{i,t+h} \end{aligned} \tag{5}$$

Where:

- $Taylor\_Residuals_t$ represent the residuals from the Taylor rule, capturing the deviation of monetary policy from the rule.

The table below presents the coefficients of Taylor's residuals across different horizons, illustrating their impact on the LTA ratio. Overall, the consistently positive coefficients indicate that deviations from the Taylor rule have a significant and positive influence on the LTA ratio. This suggests that unconventional monetary policy actions and judgmental adjustments by central banks lead to an increase in the proportion of loans to assets held by banks.

The initial impact is notable, reflecting how immediate deviations from expected policy affect bank risk-taking behavior. The influence persists over time, with varying intensity, indicating that banks continue to adjust their balance sheets in response to sustained policy deviations. This highlights the importance of considering these residuals when evaluating the effects of monetary policy, as they can have both short-term and long-term implications for bank behavior and financial stability.

Table 4: Coefficients of Taylor's Residuals

Horizon	Taylor_Residuals
1	0.1266
2	0.0590
3	0.0698
4	0.1091
5	0.1096
6	0.0402
7	0.0793
8	0.1013

Source: Author's computations (through RStudio with the Orbis Database)

By comparing the coefficients before and after the inclusion of the Taylor residuals, I can evaluate the robustness of my model and understand how the inclusion of Taylor residuals affects the relationship between the independent variables and the LTA ratio. The coefficients can be found in Appendix. The coefficients for OIS_1Y_Change remained largely consistent between the original and new models. This indicates that the inclusion of Taylor's residuals has minimal impact on the relationship between the change in the OIS rate and the LTA ratio. The robustness of these coefficients suggests that the exogenous monetary policy shock identified through the OIS rate is not significantly confounded by deviations from the Taylor rule. This can be explained by the high frequency identification model used to obtain the monetary shock represented by OIS_1Y_Change. The HFI method isolates exogenous monetary policy shocks by focusing on immediate market reactions to policy announcements, capturing the pure effects of monetary policy changes. As a result, the OIS_1Y_Change accurately reflects the intended policy shocks, ensuring that their impact on the LTA ratio remains consistent even when additional variables, such as Taylor's residuals, are included in the model.

The coefficients for Shadow_Rate increased slightly in the new model compared to the original model. This suggests that Taylor's residuals capture some of the effects initially attributed to the shadow rate, thereby refining the estimates. The shadow rate, which measures unconventional monetary policy, appears to have a more pronounced effect on the LTA ratio when deviations from conventional policy are accounted for through Taylor's residuals.

The coefficients for log(Size) remained relatively stable between the two models. This consistency indicates that the size effect on the LTA ratio is robust to the inclusion of Taylor's residuals. The logarithm of total assets continues to show a significant negative relationship with the LTA ratio, suggesting that larger banks tend to have lower LTA ratios. The coefficients for Equity_ratio also showed minimal changes.

The coefficients for GDP exhibited notable changes, especially in the first few horizons, where they moved from negative to positive. This indicates that part of the GDP effect might have been previously masked by not accounting for deviations in monetary policy captured by Taylor's residuals. By including these residuals, the model reveals a more complex relationship between GDP growth and the LTA ratio, suggesting that economic growth can positively impact bank risk-taking. The coefficients for Inflation increased significantly in magnitude (towards less negative), indicating that some of the inflation effects were captured by Taylor's residuals. This suggests that the relationship between inflation and the LTA ratio might be more complex and influenced by unconventional monetary policy actions. By incorporating Taylor's residuals, the model better isolates the direct impact of inflation on bank risk-taking.

6.2 The 6M OIS rate

For my second robustness test, I will use the 6-month Overnight Index Swap (OIS) rate. The 6M OIS rate is a short-term interest rate that reflects market expectations for the average central bank policy rate over the next six months. By incorporating this rate into my analysis, I aim to verify the robustness of my results against an alternative measure of interest rates. This will help ensure that the findings are not specific to the original interest rate metric used and that they hold under different market conditions and expectations. The 6M OIS rate was one of the rate with the highest significance during my HFI analysis.

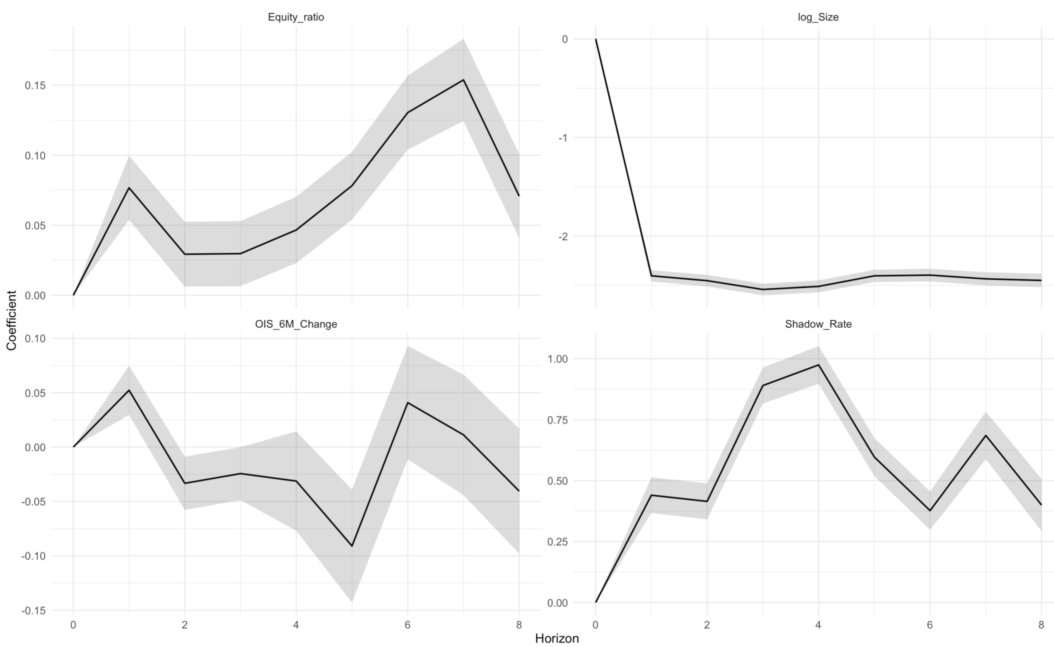

Figure 4: The Effect of MP and Bank Charac. on LTA Ratio (6-Month OIS Rate)
Source: Author's computations (through RStudio with the Orbis Database)

Figure 4 presented here shows the effect of monetary policy and bank characteristics on the LTA ratio using the 6-month OIS rate. The results depicted in this figure align closely with the findings from the analysis that utilized the 1-year OIS rate, indicating robustness in the results.

The coefficient for the Equity Ratio across different horizons shows a positive trend, which is consistent with the earlier results using the 1-year OIS rate. The Equity Ratio maintains its significance, suggesting that banks with higher equity ratios continue to exhibit a stronger LTA ratio response regardless of the OIS rate measure used. Similarly, the log_Size variable demonstrates a negative coefficient across all horizons, similar to the 1-year OIS rate findings. This consistent negative relationship indicates that larger banks tend to have lower LTA ratios, and this relationship holds true whether using a 6-month or 1-year OIS rate.

The OIS_6M_Change variable exhibits fluctuations that are comparable to those observed with the 1-year OIS change. The coefficients show initial volatility, stabilizing towards the later horizons, suggesting that changes in the OIS rate have a similar impact on the LTA ratio over time, regardless of the specific OIS rate term. The shadow rate coefficients also reflect a pattern consistent with the previous analysis. There is a peak around horizon 4, similar to the 1-year OIS rate findings. This suggests that unconventional monetary policy, captured by the shadow rate, has a significant and consistent impact on the LTA ratio. Moreover, the similarity in the impact on the NPL ratio between the 6-month and 1-year OIS rates also shows the robustness of the original findings.

This robustness test confirms that the observed relationships between monetary policy, bank characteristics, and the LTA ratio are not specific to the choice of OIS rate maturity. Instead, they represent stable and reliable insights into the dynamics at play. This further strengthens the validity of the original conclusions and demonstrates that the core findings are resilient to changes in the underlying interest rate metric identified through HFI.

7 Extensions for future works

To build upon the findings of this study, several avenues for future research can be pursued. First, incorporating a macroprudential index, such as the one developed by Cerutti et al. (2017) and updated until 2021, could provide deeper insights into how macroprudential policies interact with monetary policy to influence bank lending behavior and risk-taking.

Second, adding other bank characteristics that could influence risk-taking, such as the rate of return on assets or specific regulatory measures, would enrich the analysis. These factors can shed light on how profitability and regulatory environments impact banks' responses to monetary policy changes.

A crucial area for further study involves using a larger dataset that spans from the end of the great financial crisis until today. This extended time frame would enable an examination of how banks have behaved in response to monetary policy changes over a significant period, capturing various economic cycles and policy environments. Such a dataset would also allow for the analysis of long-term trends and the persistence of effects observed in shorter studies.

Additionally, investigating the effects of rising interest rates following a prolonged period of low rates, as it is the case today in 2024, is critical. Understanding how banks adjust their lending practices and manage risks in such scenarios can provide important lessons for policymakers. This is particularly relevant as central banks may begin to tighten monetary policy after years of accommodative conditions, and the banking sector's response will be crucial for economic stability. Incorporating high-frequency identification with other variables could also enhance the precision of identifying monetary policy shocks and their impacts. By studying these extensions, the findings could help policymakers and financial institutions promoting economic stability and growth while managing the risks in the banking sector.

8 Conclusion

This study employs High-Frequency Identification (HFI) and Local Projections (LP) models to explore the impact of monetary policy on banks' risk-taking behavior. The HFI method isolates exogenous monetary policy shocks by examining immediate market reactions to central bank announcements, allowing for precise identification of policy impacts while minimizing the influence of concurrent economic events.

My key findings reveal that reductions in the Overnight Indexed Swap (OIS) rate and the implementation of unconventional monetary policies, measured through the shadow rate, significantly increase the Loan to Asset (LTA) ratio. This indicates that lower borrowing costs stimulate banks to extend more credit. Banks with higher equity ratios are more likely to increase lending, leveraging their strong capital positions. Conversely, larger banks, with more diversified operations, tend to allocate a smaller proportion of their assets to loans, highlighting the influence of scale and diversification on lending behavior.

In terms of risk, the initial impact of lower interest rates and unconventional monetary policies leads to an increase in the Non-Performing Loans (NPL) ratio, reflecting riskier lending practices. This is particularly evident in the short term as banks extend credit to a broader range of borrowers, including those with higher risk profiles. Over time, however, the impact on the NPL ratio stabilizes, suggesting that banks adjust their risk management strategies in response to the initial surge in defaults, helping to mitigate long-term risks associated with increased lending.

These findings are validated through robustness tests, including the use of Taylor's residuals, which confirm that the observed effects of monetary policy on bank lending and risk-taking are not driven by endogeneity concerns. By isolating the unexpected components of policy changes, I ensure that my results accurately reflect the causal impact of monetary policy on bank behavior.

While this study assesses the risk-taking channel of monetary policy, further analysis is necessary to deepen its understanding. Future research could explore heterogeneous bank responses by investigating how different types of banks (e.g., domestic vs. international) respond to monetary policy changes. Additionally, analyzing the sustained impacts of prolonged low interest rates and unconventional policies on financial stability would be valuable. Examining the interaction between monetary policy and macroprudential regulations could also help identify effective strategies for mitigating systemic risk. Finally, other risk measures exist, and banks can take on more risk through investments in riskier markets for instance, not just through credit risk.

In conclusion, this research explores the critical role of monetary policy in shaping bank lending behavior and risk profiles. By leveraging HFI and LP models, I delivered robust evidence supporting the risk-taking channel of monetary policy, and highlight areas for future exploration to enhance financial stability and economic growth.

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9 Appendices

LTA Ratio and its Response to Monetary Policy

Table 5: Coefficients and their Significance - LTA Model

Horizon	Variable	Coefficient	Significance
1	Intercept	105.2425319	***
1	OIS_1Y_Change	-0.0569284	***
1	Shadow_Rate	0.5181502	***
1	log_Size	-2.4065727	***
1	Equity_ratio	0.0775323	**
1	GDP	-0.0739135	**
1	Inflation	-0.3956297	***
2	Intercept	106.9872829	***
2	OIS_1Y_Change	-0.1214522	**
2	Shadow_Rate	0.5667218	**
2	log_Size	-2.4597207	***
2	Equity_ratio	0.0319334	**
2	GDP	-0.0454834	*
2	Inflation	-0.4254151	**
3	Intercept	111.8806311	***
3	OIS_1Y_Change	-0.0984578	**
3	Shadow_Rate	1.0152033	***
3	log_Size	-2.5481202	***
3	Equity_ratio	0.0319405	**
3	GDP	-0.0462377	**
3	Inflation	-0.8003718	**
4	Intercept	110.2966225	***
4	OIS_1Y_Change	-0.0283523	**
4	Shadow_Rate	0.9967851	**
4	log_Size	-2.5115371	***
4	Equity_ratio	0.0475433	**
4	GDP	-0.0873448	*
4	Inflation	-0.6106721	***
5	Intercept	105.2151408	***
5	OIS_1Y_Change	-0.0570647	*
5	Shadow_Rate	0.6326599	***
5	log_Size	-2.4046762	***
5	Equity_ratio	0.0806964	*
5	GDP	-0.1124839	**
5	Inflation	-0.2502277	*
6	Intercept	103.7211516	***
6	OIS_1Y_Change	-0.0130362	*
6	Shadow_Rate	0.4112231	*

Table 5: Coefficients and their Significance - LTA Model

Horizon	Variable	Coefficient	Significance
6	log_Size	-2.3982334	***
6	Equity_ratio	0.1300291	*
6	GDP	-0.1340774	**
6	Inflation	-0.3010749	*
7	Intercept	105.9985856	***
7	OIS_1Y_Change	0.1304221	**
7	Shadow_Rate	0.6723383	**
7	log_Size	-2.4350010	***
7	Equity_ratio	0.1528710	*
7	GDP	-0.1558936	***
7	Inflation	-0.4961608	**
8	Intercept	104.8513589	***
8	OIS_1Y_Change	-0.0289219	*
8	Shadow_Rate	0.3719838	*
8	log_Size	-2.4474451	**
8	Equity_ratio	0.0715317	*
8	GDP	-0.1615717	**
8	Inflation	-0.2713294	*

Source: Author's computations (through RStudio with the Orbis Database)

NPL Ratio and its Response to Monetary Policy

Table 6: Coefficients and their Significance - NPL Model

Horizon	Variable	Coefficient	Significance
1	Intercept	13.9221	***
1	OIS_1Y_Change	-0.1338	**
1	Shadow_Rate	0.7127	***
1	log_Size	-0.1663	**
1	Equity_ratio	0.2124	***
1	GDP	0.0792	**
1	Inflation	-0.6323	***
2	Intercept	15.1269	***
2	OIS_1Y_Change	-0.1387	***
2	Shadow_Rate	0.8107	***
2	log_Size	-0.1933	**
2	Equity_ratio	0.1943	***
2	GDP	0.0872	**
2	Inflation	-0.6545	***
3	Intercept	13.1104	***
3	OIS_1Y_Change	-0.0767	**

Table 6: Coefficients and their Significance - NPL Model

Horizon	Variable	Coefficient	Significance
3	Shadow_Rate	0.6673	***
3	log_Size	-0.1446	**
3	Equity_ratio	0.2162	***
3	GDP	0.1129	**
3	Inflation	-0.6064	***
4	Intercept	13.4061	***
4	OIS_1Y_Change	-0.0463	**
4	Shadow_Rate	0.7500	***
4	log_Size	-0.1579	**
4	Equity_ratio	0.2146	***
4	GDP	0.0432	*
4	Inflation	-0.4825	***
5	Intercept	12.3864	***
5	OIS_1Y_Change	-0.1001	**
5	Shadow_Rate	0.3961	***
5	log_Size	-0.1957	**
5	Equity_ratio	0.1769	**
5	GDP	0.0501	**
5	Inflation	-0.3815	**
6	Intercept	12.5999	***
6	OIS_1Y_Change	-0.0392	**
6	Shadow_Rate	0.4135	***
6	log_Size	-0.1987	**
6	Equity_ratio	0.2125	**
6	GDP	0.0558	*
6	Inflation	-0.5386	***
7	Intercept	13.2288	***
7	OIS_1Y_Change	-0.0427	**
7	Shadow_Rate	0.7097	**
7	log_Size	-0.1699	**
7	Equity_ratio	0.3001	**
7	GDP	-0.0418	**
7	Inflation	-0.6647	**
8	Intercept	14.5242	***
8	OIS_1Y_Change	-0.0295	**
8	Shadow_Rate	0.9308	**
8	log_Size	-0.1782	**
8	Equity_ratio	0.3268	***
8	GDP	-0.0450	*
8	Inflation	-0.7865	***

Source: Author's computations (through RStudio with the Orbis Database)

Model Coefficients Before and After the Inclusion of Taylor's Residuals

Table 7: Original vs New coefficients of the OIS_1Y_Change variable

Horizon	Coefficient_original	Coefficient_new
1	-0.05692839	-0.05454812
2	-0.12145225	-0.12032331
3	-0.09845776	-0.09715011
4	-0.02835231	-0.02626986
5	-0.05706471	-0.05470186
6	-0.01303616	-0.01213184
7	0.13042206	0.12775554
8	-0.02892187	-0.04263114

Source: Author's computations (through RStudio with the Orbis Database)

Table 8: Original vs New coefficients of the Shadow_Rate variable

Horizon	Coefficient_original	Coefficient_new
1	0.5181502	0.5882456
2	0.5667218	0.6026734
3	1.0152033	1.0577508
4	0.9967851	1.0644080
5	0.6326599	0.7019453
6	0.4112231	0.4366584
7	0.6723383	0.7193514
8	0.3719838	0.4753885

Source: Author's computations (through RStudio with the Orbis Database)

Table 9: Original vs New coefficients of the log_Size variable

Horizon	Coefficient_original	Coefficient_new
1	-2.406573	-2.425943
2	-2.459721	-2.469348
3	-2.548120	-2.560051
4	-2.511537	-2.530586
5	-2.404676	-2.424120
6	-2.398233	-2.405604
7	-2.435001	-2.450784
8	-2.447445	-2.458548

Source: Author's computations (through RStudio with the Orbis Database)

Table 10: Original vs New coefficients of the Equity_ratio variable

Horizon	Coefficient_original	Coefficient_new
1	0.07753235	0.07476122
2	0.03193336	0.03050899
3	0.03194054	0.03011077
4	0.04754331	0.04434842
5	0.08069638	0.07718151
6	0.13002907	0.12844360
7	0.15287098	0.14864311
8	0.07153171	0.06736764

Source: Author's computations (through RStudio with the Orbis Database)

Table 11: Original vs New coefficients of the GDP variable

Horizon	Coefficient_original	Coefficient_new
1	-0.07391346	0.01045780
2	-0.04548343	-0.00664067
3	-0.04623774	-0.00007800
4	-0.08734484	-0.01497534
5	-0.11248387	-0.04002792
6	-0.13407742	-0.1073853
7	-0.15589360	-0.1028478
8	-0.16157169	-0.09253684

Source: Author's computations (through RStudio with the Orbis Database)

Table 12: Original vs New coefficients of the Inflation variable

Horizon	Coefficient_original	Coefficient_new
1	-0.3956297	-0.3058944
2	-0.4254151	-0.3866706
3	-0.8003718	-0.7549092
4	-0.6106721	-0.5399825
5	-0.2502277	-0.1792942
6	-0.3010749	-0.2751489
7	-0.4961608	-0.4446666
8	-0.2713294	-0.1780041

Source: Author's computations (through RStudio with the Orbis Database)

Executive Summary

This master thesis investigates the relationship between monetary policy (MP) and the risk-taking behavior of banks. Specifically, it explores how monetary policy decisions, particularly during periods of unconventional monetary policies (UMP), influence the lending and risk profiles of banks. This study is set against the backdrop of the Global Financial Crisis (GFC) of 2007-2008, which underscored the role of excessive risk-taking by banks in financial instability.

The primary objective of this research is to assess how MP changes affect bank behaviors and the extent to which bank-specific characteristics (such as size and equity ratios) influence these outcomes. The study employs a strong econometric framework combining High-Frequency Identification (HFI) and Local Projections (LP) models to analyze the impacts of MP shocks.

The empirical analysis uses high-frequency financial data from the Euro Area Monetary Policy Database (EA-MPD) to capture immediate market reactions to European Central Bank (ECB) announcements. This approach minimizes the influence of concurrent economic events, ensuring precise measurement of policy impacts. The study also incorporates bank-specific data, including Loan to Asset (LTA) and Non-Performing Loans (NPL) ratios. The HFI method isolates exogenous monetary policy shocks by examining immediate changes in market indicators such as Overnight Indexed Swap (OIS) rates. These shocks are then used in LP models to estimate the dynamic responses of banks' risk-taking measures over time.

Key findings include that reductions in the OIS rate and the implementation of UMP significantly increase the LTA ratio, indicating that lower borrowing costs encourage banks to extend more credit. Banks with higher equity ratios are more likely to increase lending, leveraging their strong capital positions. Conversely, larger banks with diversified operations tend to allocate a smaller proportion of their assets to loans. Initial impacts of lower interest rates and UMP lead to an increase in the NPL ratio, reflecting riskier lending practices. Over time, however, banks adjust their risk management strategies, stabilizing the NPL ratio and mitigating long-term risks. The findings are validated through robustness tests, including Taylor's residuals, confirming that the observed effects are not driven by endogeneity concerns. This ensures the accuracy of the causal impact of monetary policy on bank behavior.

This research provides evidence supporting the risk-taking channel of monetary policy, demonstrating how lower interest rates and unconventional policies influence banks' lending and risk profiles. The study highlights the importance of considering bank-specific characteristics when analyzing policy impacts and underscores the need for further research to explore heterogeneous responses among different types of banks.

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