

The Impact of Monetary Policy on the German Commercial Real Estate Market

Transmission Analysis and Financial Stability Considerations

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Disclaimer

From October 2023 to March 2024, I completed my mandatory internship at the German Central Bank (Deutsche Bundesbank) in the Financial Stability Department, specifically in group F30 “Finanzstabilitätsrisiken aus Investmentfonds, sonstigen Finanzintermediären und Gewerbeimmobilien” (Financial Stability Risks from Investment Funds, Other Financial Intermediaries, and Commercial Real Estate). Since April 2024, I have been employed as a working student in the same group.

However, it is important to note that this thesis does not constitute an official central bank analysis. The views expressed, research conducted, and conclusions drawn in this work are entirely my own and do not reflect the positions or policies of the German Central Bank, the Eurosystem, or any of their employees.

19.07.2024

Date

A handwritten signature in black ink, appearing to read 'C. Erdogan', written over a horizontal line.

Signature

Abstract

This thesis examines the impact of monetary policy on the German Commercial Real Estate (CRE) market, focusing on transmission analysis and financial stability considerations. Using data from the Analytical Credit Dataset (AnaCredit) spanning April 2019 to April 2024, we investigate the distribution of CRE debt across Germany and analyze the interest rate pass-through mechanism in this sector.

Our findings reveal significant heterogeneity in CRE debt distribution, with a clear concentration in urban and industrial areas, particularly in Germany's seven major cities. The study demonstrates an incomplete pass-through of the European Central Bank's policy rate changes to CRE loan rates, suggesting that banks do not fully transmit these changes to borrowers.

Notably, developer loans show higher sensitivity to policy rate changes compared to other CRE types, aligning with their role as primary risk-bearers in the sector. The analysis also uncovers complex interactions between monetary policy, firm characteristics, default probability, and agreed rates in CRE lending.

These insights contribute to a nuanced understanding of monetary policy transmission in the CRE sector and highlight potential vulnerabilities, particularly in light of recent challenges such as high financing costs and increased insolvencies. The study's findings can inform more targeted policy approaches and risk assessments, aiding in maintaining financial stability in this crucial sector of the German economy.

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List of Abbreviations

AAR Annualized Agreed Rate. 24

AnaCredit Analytical Credit Dataset. 4

CRE Commercial Real Estate. 1

ECB European Central Bank. 1

ESRB European Systemic Risk Board. 3

KNN K-Nearest Neighbors. 25

MICE Multivariate Imputation by Chained Equations. 25

MRO Main Refinancing Operations. 14

PD Probability of Default. 24

PMM Predictive Mean Matching. 25

REITs Real Estate Investment Trusts. 8

RRE Residential Real Estate. 3

1 Introduction

The German Commercial Real Estate (CRE) market has faced significant disruption and volatility since the COVID-19 pandemic began in 2020. The sector has been hit by a wave of economic shocks, leading to a sharp increase in insolvencies. By mid-2024, over 40 CRE firms had either filed for bankruptcy or ceased operations, a stark contrast to the low numbers seen in previous years. This instability has created a landscape full of new challenges and uncertainties. In response to broader economic shifts, the European Central Bank (ECB) made dramatic monetary policy changes, most notably raising interest rates for the first time in 11 years on July 21, 2022 by 50 basis points (ECB, 2022). These factors have pushed the CRE market into a period of intense turbulence, calling for a thorough examination of its current state and future prospects.

Recent headlines underscore the severity of the situation in the German CRE market. Major banks and financial institutions are warning of what could be the “greatest real estate crisis since the financial crisis” (Fortune, 2024). These concerns are not limited to Germany but reflect a global trend in commercial real estate.

The CRE sector’s vulnerability to macroeconomic shocks and policy changes brings to mind the global financial crisis of 2008. That crisis, triggered primarily by a housing market collapse in the United States, showed how instability in the real estate sector can have far-reaching economic consequences (Mishkin, 2011, p. 56). Today’s situation in the German CRE market, while different in its specifics, might pose similar risks to broader economic stability.

Both the German Central Bank and the ECB are keeping a close eye on the CRE market, often highlighting its importance in their financial stability reports (Deutsche Bundesbank, 2023). This increased attention underlines the need for a comprehensive study of the German CRE market. Our research aims to address two main questions that encompass several key issues in the sector. First, we explore how CRE debt is

distributed across Germany, examining different geographic regions and types of companies involved. This analysis helps us understand the current structure of the German CRE landscape, identifying the main players and the scale of their investments. Second, we investigate how monetary policy, particularly changes in interest rates, affects the German CRE market. This includes analyzing the effectiveness of the interest rate pass-through mechanism in this sector. Through these two main research questions, we also consider the broader implications of CRE market dynamics for overall financial stability. By addressing these interconnected issues, we aim to provide a comprehensive understanding of the German CRE market's current state, its sensitivity to policy changes, and its potential impact on the broader financial system.

Based on initial research and market observations, we propose two hypotheses. First, we suggest that CRE debt in Germany is unevenly distributed, varying significantly across regions and company types, with most debt concentrated in urban areas. This uneven distribution may affect how different parts of the market respond to economic shocks. Second, we hypothesize that changes in the ECB's policy rate, along with an additional risk markup for certain types of firms, are quickly reflected in borrowing costs in the CRE sector. Understanding this pass-through effect is crucial for assessing how monetary policy impacts the market, especially during times of volatility.

To address these questions and test our hypotheses, we use a combination of qualitative and quantitative analyses. This mixed approach allows us to build a comprehensive picture of the German CRE market and its relationship with monetary policy. The qualitative component helps explain the context and depth behind our quantitative findings.

The paper is organized as follows: We start with an analysis of the German CRE market, followed by a detailed look at how interest rate changes affect the market. We then discuss our findings, consider the implications for financial stability, and conclude. Our analysis reveals a complex relationship between monetary policy, firm characteristics, default probability, and loan rates in the CRE market. We find that policy rate changes affect loan rates differently across various market segments, highlighting the importance of considering these differences when analyzing how monetary policy impacts the CRE sector.

By addressing these issues, our research aims to provide a deeper understanding of the CRE market's dynamics and its role in the broader economy. This knowledge is vital for policymakers, regulators, and other stakeholders as they navigate the increasingly complex world of real estate and finance, especially during times of market turbulence.

2 German Commercial Real Estate Market Analysis

2.1 Definition and Scope of Commercial Real Estate

Before examining the CRE market, it is crucial to establish a clear definition of what constitutes CRE. This study adopts the definition provided by the European Systemic Risk Board (ESRB) in its 2019 recommendation on closing real estate data gaps, which is also used by the ECB and the German Central Bank in their analyses and reports. According to this definition, CRE is defined as:

Any income-producing real estate, either existing or under development, including rental housing; or real estate used by the owners of the property for conducting their business, purpose or activity, either existing or under construction; that is not classified as Residential Real Estate; and includes social housing (ESRB, 2018, p. 40).

This comprehensive definition encompasses a broad range of property types, extending beyond traditional conceptions of CRE to include rental and social housing. To distinguish CRE from Residential Real Estate (RRE), the ESRB provides guidance on handling mixed-use properties:

If a property has a mixed CRE and RRE use, it should be considered as different properties (based for example on the surface areas dedicated to each use) whenever it is feasible to make such breakdown; otherwise, the property can be classified according to its dominant use (ESRB, 2018, p. 40).

This approach reflects the complex nature of real estate assets that may serve multiple purposes. Adopting this definition ensures our analysis is consistent with official approaches, facilitating comparison with institutional reports and contextualizing our research within European financial stability considerations. The inclusion of “rental housing” and “social housing” within the CRE category is noteworthy, as it broadens the scope of what is traditionally considered commercial real estate. This inclusive approach reflects the complex nature of the real estate market and its various intersections with both commercial and residential sectors.

2.2 Methodology for Market Analysis

This study primarily relies on the Analytical Credit Dataset (AnaCredit), a comprehensive credit and credit risk database established by the ECB (ECB, 2019). AnaCredit provides granular information at the borrower and loan level, focusing on credit extended to legal entities and other legal persons. The dataset spans from September 2018, marking the inception of the first reporting cycle, to April 2024, with specific timeframes utilized for various analyses as required.

AnaCredit’s granularity is particularly valuable for this study, allowing for a nuanced examination of the CRE market. The dataset’s reporting threshold, set at loans where a debtor’s total commitment exceeds 25,000, ensures comprehensive coverage of commercially significant credit exposures. Each exposure is characterized by over 100 data points, encompassing counterparty information, instrument details, collateral specifics, and accounting data. The quarterly reporting frequency facilitates up-to-date analysis of market trends.

Supplementary data sources include a systematic review of news articles, company annual reports, and financial statements. This qualitative analysis involves a methodical examination of industry reports and literature, categorization of companies based on their characteristics and market segments, and identification of emerging trends and patterns in the market structure.

The analytical framework for this study draws heavily from methods used in German

Central Bank studies, as there are no systematic approaches to studying the German CRE market in existing literature. Consequently, the German Central Bank's research serves as the primary reference point for our analytical approach. This framework incorporates both quantitative analysis of the AnaCredit data and qualitative assessment of secondary sources to provide a comprehensive view of the German CRE market dynamics.

Our approach aims to synthesize these diverse data sources and analytical methods to offer a robust and nuanced understanding of the CRE market, its current state, and potential future trajectories. However, it is important to note that this framework, while comprehensive, is constrained by the limitations of available data of the German CRE sector.

2.3 Characteristics, Interconnectedness and Risks in the German CRE Market

CRE plays a central role in the German financial system as collateral for bank loans and as an investment, accounting for about 15% of GDP as of 2019 (? , p. 101). The CRE market is particularly sensitive to economic cycles, with prices reacting strongly to cyclical developments. This sensitivity has often led to adverse developments in CRE markets amplifying financial crises in the past (? , pp. 97-98).

Bank loans are the dominant form of CRE financing in Germany, accounting for about one-third of loans to non-financial corporations (? , p. 103). The CRE market is interconnected with banks, insurers, real estate funds, and the broader economy through multiple channels that can amplify shocks (? , pp. 99-101).

The German CRE market is not isolated from international influences. A significant share of German CRE loans have connections to other countries, and foreign players are heavily involved in the German CRE market as direct investors (? , pp. 107-108). This international interconnectedness means that CRE markets tend to develop along similar paths and are influenced by the same global factors.

CRE prices in Germany move broadly in line with other European countries, with about 60% of price fluctuations explained by European factors (?, pp. 109-110). However, since mid-2022, the CRE market has been experiencing a downturn, with both prices and transaction volumes declining (Deutsche Bundesbank, 2023, p. 30). This is due to high inflation, the abrupt rise in interest rates, weak economic activity, and structural economic changes.

The risks from developments in the CRE markets have grown (Deutsche Bundesbank, 2023, p. 7). Real estate companies have comparatively low interest coverage ratios, making them more vulnerable to rises in interest rates (Deutsche Bundesbank, 2023, p. 62). Around one-third of CRE loans could be subject to significant interest rate adjustments over the next three years, potentially causing credit defaults and losses to rise (Deutsche Bundesbank, 2023, p. 62). Since mid-2022, the German CRE sector has experienced a significant surge in insolvencies. Based on our own research, from mid-2022 until the time of writing, 40 CRE firms have either filed for bankruptcy or ceased operations. These companies vary considerably in size, scope of activities, and overall market impact. However, a common thread among them is that they are predominantly developers. While precise data on bankruptcy rates prior to 2022 is not readily available, the scarcity of information suggests that the number was likely very low. This stark contrast highlights the severity of the current situation in the German CRE market.

To address these risks, capital-based macroprudential instruments have been activated in Germany. There is an ongoing discussion about the potential implementation of borrower-based instruments for the CRE sector (International Monetary Fund, 2023, p. 13). The Bundesbank suggests that improved transparency and data collection in the CRE market, particularly regarding international exposures and interconnections, could enhance the understanding of CRE-related risks and their potential impact on financial stability (?, p. 88).

Overall, the systemic risks from developments in the CRE markets have continued to grow as interest rates have risen (Deutsche Bundesbank, 2023, p. 62), presenting a significant challenge for the German financial system going forward. The diverse company types in the sector, from developers to municipal housing companies, each

face unique challenges in this evolving landscape, contributing to the complexity of the German CRE market.

2.4 Composition of the German CRE Sector

The German CRE sector is a complex ecosystem comprised mainly of four key entity types, each playing a distinct role in the market. It is important to note that the definitions that follow are my own, as there is no coherent definition, or in some cases no definition at all, in the existing literature. These entities are developers, construction companies, multi-service companies, and municipal housing companies. Understanding their unique functions and risk profiles is crucial for analyzing the sector's dynamics and its response to economic changes. A detailed comparison of the four key entity types in the German CRE sector, including their roles, risk profiles, and unique features, can be found in Table A9 in the Appendix.

Developers are the primary risk-takers in the CRE value chain. They initiate and manage real estate projects, operating on both commissioned and speculative bases across various asset classes such as office, retail, industrial, and residential complexes. Their responsibilities include project financing, regulatory compliance, and ensuring overall project viability. This high-risk position makes developers particularly sensitive to market fluctuations and changes in financing conditions.

In contrast, **construction companies** primarily act as service providers, executing plans conceived by developers or property owners. While this model shields them from certain rollover and financing risks, they remain exposed to market fluctuations. Recent data from Statistisches Bundesamt (2024) highlights the challenges facing this sector, reporting a 31.9% year-on-year decrease in building permits issued for apartments in April 2023. This decline is attributed to factors such as escalating construction costs, rising interest rates, and reduced subsidies.

Multi-service companies represent a more diversified entity within the CRE sector. Exemplified by companies like Vonovia SE, these entities engage in property ownership, management, and leasing across various asset types. Often structured as *Ak-*

tiengesellschaften (public limited companies) or Real Estate Investment Trusts (RE-ITs), their diversified business model and their focus on residential real estate provides some insulation against market volatility. However, they remain susceptible to broader macroeconomic trends.

Municipal housing companies play a unique role in Germany's affordable housing sector. Typically owned by municipal or state governments, these entities focus on developing and managing social housing and publicly-owned properties. They operate under a dual mandate: providing affordable housing solutions while ensuring sustainable management of public resources. Their primary goal is to meet social housing needs rather than maximize profits. Their state backing may provide them with additional stability compared to purely private entities.

This diverse composition of the German CRE sector reflects the complex interplay of private enterprise, public policy, and market dynamics. Each entity type contributes uniquely to the sector's overall functioning while facing distinct challenges and opportunities in the current economic landscape.

The categorization into these four distinct entity types is crucial for transmission analysis, as each type bears a different risk profile. The underlying hypothesis is that entities more heavily involved in financing, and thus more exposed to rollover risks, inflation, and interest rate fluctuations, will exhibit higher sensitivity to rising interest rates. For instance, developers may be more vulnerable to these risks compared to state-backed municipal housing companies.

It is important to note that while these distinctions are recognized within the real estate industry, there is a lack of academic studies that systematically analyze the CRE sector using this specific categorization. Therefore, this approach offers a novel perspective on the differential impacts of market conditions across various CRE entity types.

This framework, although not definitive, provides a structured approach to examining the nuanced responses of different CRE market participants to changing economic conditions, particularly interest rate fluctuations. It serves as a foundation for the subsequent analysis, allowing for the exploration of potential variations in risk exposure

and market behavior across these categorized entity types.

2.5 Current Market Conditions

The German CRE market has exhibited diverse trends across property types and geographical areas since 2020. Office properties have continued to perform well, with price indices approaching 180 by 2024 (2010=100), while retail properties have stagnated [Deutsche Bundesbank, 2024, p. 1]. This divergence highlights a significant performance gap between office and retail sectors post-2020. Geographically, the seven major cities (Berlin, Cologne, Düsseldorf, Frankfurt am Main, Hamburg, Munich, and Stuttgart) have consistently outpaced smaller towns and cities in both rent and price growth, further widening the urban-rural divide [Deutsche Bundesbank, 2024, p. 1].

The market faces significant challenges, particularly in the residential and office segments. According to Bulwiengesa's Development Monitor 2024, construction starts by developers dropped by 47% in Q2 2023 compared to the same period in previous years, with the residential sector experiencing a 54% decline. Major metropolitan areas saw a 28% decrease in newly started projects, while smaller cities faced a steeper 61% drop. The second quarter of 2024 marked a record low in construction starts, attributed to high land costs and insufficient demand from investors, making many projects financially unviable. The financing environment remains challenging, with restrictive credit conditions and a preference for smaller loan volumes (Bulwiengesa, 2024, pp. 2-11). Financial indicators show that yields have continued to decline post-2020, falling below 3% in major cities by 2023 (Deutsche Bundesbank, 2024, p. 4). However, the full impact of the July 2022 interest rate change is not yet clearly visible in the data, suggesting a potential lag in effects. Lending experienced a sharp drop in 2020, likely due to the COVID-19 pandemic, but recovered in subsequent years (Deutsche Bundesbank, 2024, p.3).

Despite potential pandemic impacts, transaction volumes continued to show an upward trend post-2020, especially in the seven major cities (Deutsche Bundesbank, 2024, p. 6). Office vacancy rates in these cities remained low through 2023, despite potential

changes in office use patterns (Deutsche Bundesbank, 2024, p. 6). However, this low vacancy rate might partially result from ongoing lease contracts that have not yet expired.

Overall, the German CRE market has demonstrated resilience post-2020, particularly in the office and residential sectors and in major cities, while the retail sector has faced more challenges. The full impact of the July 2022 interest rate change is not clearly visible in most metrics by the end of 2023, indicating a time lag in how monetary policy affects various aspects of the CRE market. This paper will analyze this lag in pass-through effects in Chapter 3 to better understand the impact of monetary policy on the German CRE sector.

2.6 Geographical Distribution

In this section, we examine the geographical distribution of the German CRE market through an analysis of debt and collateral locations. Given the limitations of available data on the actual economic size and distribution of CRE activities, this approach provides the most feasible approximation of market distribution. Our analysis focuses on mapping the locations of debtors and collaterals associated with CRE loans, offering insights into the geographical spread of CRE financing as a proxy for understanding the broader market distribution. It is important to note that we do not examine the value of individual collaterals; instead, we concentrate on their geographical locations.

Figures 2.1 and 2.2 show the distribution of aggregated loan amounts for April 2024, offering a snapshot of the market at that time. Figure 2.1 illustrates the distribution by the registered office of the debtor (company headquarters), while Figure 2.2 shows the distribution by collateral location.

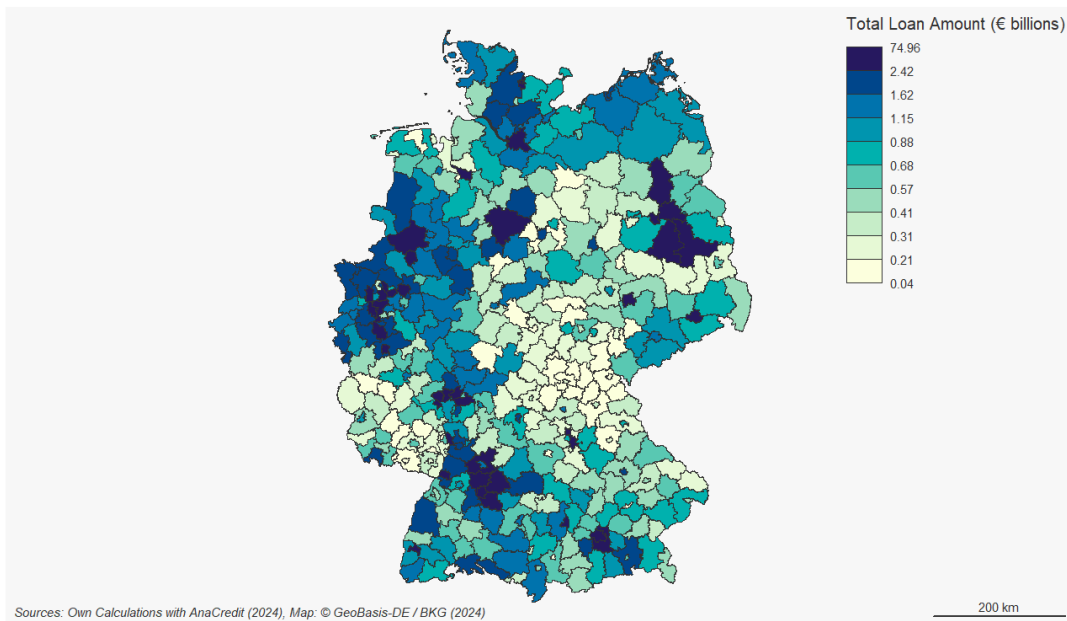


Figure 2.1: Aggregate Loan Amount Distribution by Debtor Location (April 2024)

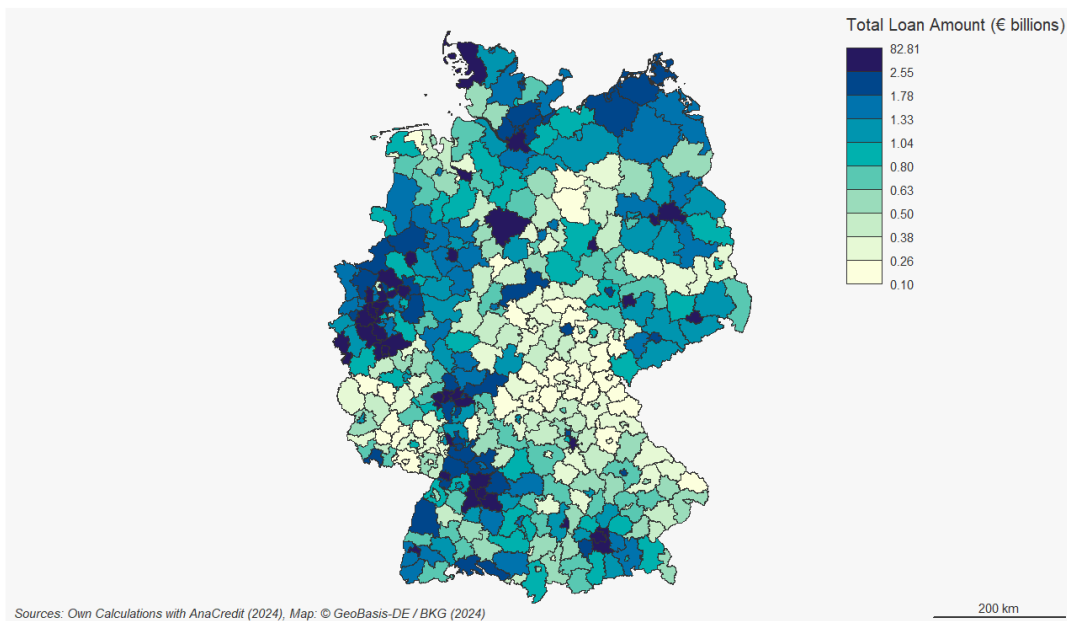


Figure 2.2: Aggregate Loan Amount Distribution by Collateral Location (April 2024)

We assume firms mainly operate in the areas where they are registered. Larger CRE firms often create local subsidiaries for individual projects, typically registered in the project's location. The location of the protection (collateral) can serve as an additional

indicator of CRE activity, as firms often use their properties or other real estate assets as loan collateral. By mapping both debtor and collateral locations, we aim to build a comprehensive picture of CRE loan distribution. This approach allows us to potentially identify areas of CRE project development and reveal patterns in financing sources and project locations. Collateral properties are likely related to the borrowing firms, either as project sites or as existing real estate holdings. However, these assumptions, while reasonable, remain untested in our study. This method has limitations and should be seen as a starting point for understanding market distribution rather than a definitive representation.

Our analysis of German CRE loan distribution reveals a heterogeneous landscape with a strong correlation between debtor and collateral locations. The data shows a significant concentration of CRE-related debt in urban areas, aligning with the higher density of real estate development and construction activities typically found in these regions.

The maps provide visual insights into the potential vulnerability of regional CRE markets to local economic conditions. Areas with high concentrations of CRE loans may be more susceptible to industry-specific economic fluctuations. For instance, the Stuttgart region, with its significant automobile industry presence, illustrates this vulnerability. Any major changes in the automotive sector could have a cascading effect on the local CRE market, potentially impacting property values, project viability, and overall loan performance. This could manifest in reduced demand for new office spaces, leading to fewer development projects; decreased need for industrial facilities, affecting construction projects; lower demand for retail spaces due to reduced consumer spending; and indirect effects on the residential real estate market, particularly in the higher-end segment, as employment and income levels might be affected. This relationship between regional industry concentration and CRE market stability underscores the importance of considering local economic factors when assessing CRE risk.

The figures illustrate the total loan amounts distributed across different regions in Germany, with darker shades indicating higher loan amounts. The maps reveal a clear concentration of CRE loans in urban and industrial areas, especially in the seven major cities. These areas, characterized by significant economic activity and real estate development, exhibit the highest levels of CRE-related debt, reinforcing the correlation

between economic hubs and CRE financing. This visual representation underscores the importance of urban centers in the CRE market and highlights potential areas of economic vulnerability and opportunity within the sector.

While it would be intriguing to further explore the relationship between industry concentrations and CRE distribution by mapping various sectors across different regions, such an endeavor falls beyond the scope of this study and warrants its own dedicated research project. This geographical perspective on the CRE market offers a foundation for understanding regional economic dynamics and their potential impact on real estate development. However, it also underscores the need for more granular data and specialized research methodologies to fully capture the nuances of industry-specific influences on the CRE landscape.

2.7 Limitations

The AnaCredit dataset used in this analysis, while substantial, has several limitations. Notably, there are numerous missing entries, particularly in the NACE codes, which are the European statistical classification of economic activities used to classify industry branches (European Commission, 2010). The reliability of these codes is questionable due to incomplete data and the potential for companies to operate across multiple sectors. For instance, a firm might engage in both development and construction activities. Commercial Real Estate (CRE) activities span multiple NACE sections, including F (Construction), L (Real Estate Activities), and M (Professional, Scientific and Technical Activities). However, the classification can be misleading; for example, a holding company in the CRE sector might be classified under M 70.1 (Activities of head offices), a code that could apply to firms in any industry. Consequently, while our CRE subset provides a reasonable approximation, it cannot definitively delineate the size of individual CRE types.

Assessing the sector's overall risk profile is challenging for several reasons. The probabilities of default provided by banks are often incomplete, limiting their utility as risk indicators. Information about loan protections is often missing or ambiguous. Fur-

thermore, there is a lack of data regarding the specific locations of projects (such as construction sites) financed by these loans. Our analysis is thus confined to the registered locations of companies and the geographical distribution of protections. While we might assume that protections are often linked to project locations, there is insufficient data to confirm this hypothesis.

While our loan data provides insights into debt financing, we lack information on equity capital, which limits our understanding of overall market dynamics. Recent trends, such as increased remote work, likely affect demand for commercial real estate. However, quantifying these effects is challenging due to a lack of reliable data. We can observe general trends, but their precise impact remains unclear. The CRE market is also influenced by complex factors beyond the scope of our analysis. These include technological advancements affecting business operations and space requirements, long-term shifts in supply and demand patterns, and changes in competitive landscapes across various industries. The interplay of these factors is not well-documented in existing literature, making it difficult to draw definitive conclusions about their effects on the CRE market. Given these constraints, our analysis should be viewed as an informed estimate of CRE market dynamics rather than a comprehensive assessment. It provides valuable insights but acknowledges the complexity and evolving nature of the market.

3 Transmission Analysis

This section aims to investigate the interest rate pass-through effect in the German CRE sector. We will examine how changes in the ECB's Main Refinancing Operations (MRO) rate have impacted the CRE sector, focusing on the responsiveness of lenders to different CRE market segments – to broader economic policy shifts.

3.1 Literature Review

Interest rate pass-through in the Euro area has undergone significant changes since the 2008 financial crisis, revealing a complex interplay of factors affecting its effectiveness and uniformity across member countries. These changes accord with fundamental principles of finance theory, which assert that higher risk should be rewarded with greater potential returns (Malkiel and Xu, 1997, p. 9).

The great financial crisis and subsequent sovereign debt issues have reshaped monetary policy transmission, leading to increased heterogeneity and generally less complete pass-through mechanisms. Bank characteristics and market conditions play crucial roles in this process. Canova et al. (2016, p. 5) found that factors such as capital ratios and government bond holdings influenced conventional monetary policy transmission, aligning with Holton and Rodriguez d'Acri's (2018, p. 295) emphasis on individual bank characteristics, particularly those that reflect funding difficulties.

The importance of market conditions is further underscored by Aristei and Gallo (2014, p. 291) observation of lower pass-through during periods of high market rate volatility. This volatility can be linked to the risk-return relationship observed in stock markets by studies such as ?, p. 329 and Park (2009, p. 93).

Research in the banking sector has focused on two primary areas: the risk-return relationship as reflected in stock market performance (Elyasiani and Mansur, 2003; Neuberger, 1991) and the influence of monetary policy on bank lending practices through the risk-taking channel. Recent studies on the latter suggest that lower policy rates tend to increase funding for riskier borrowers (Morais et al., 2019; Afanasyeva and Güntner, 2020; Michail et al., 2021).

These dynamics have implications for interest rate pass-through, particularly since the financial crisis. Several studies, including Blot and Labondance (2022, p. 5978) and Hristov et al. (2014, p. 107) reported a general decrease in pass-through completeness post-crisis. However, Illes and Lombardi (2013, p. 58) offered a contrasting perspective. They compared lending rates to a composite cost-of-borrowing indicator instead of traditional monetary policy rates and argued that the pass-through mechanism re-

mained largely unchanged. This divergence in findings highlights the importance of measurement methodology in assessing pass-through effectiveness and suggests that perceived changes in the mechanism may be partly attributable to how it is evaluated.

The crises have not only affected pass-through completeness but also increased heterogeneity across Euro area countries. Leroy and Lucotte (2015, p. 4) attributed this growing disparity to strained financial markets, challenging economic conditions, and country-specific financial market structures. This heterogeneity is further illustrated by Blagov et al. (2015, p. 30) finding that global risk factors increased lending rates in Spain and Italy, with additional country-specific issues contributing to the variations.

In response to these challenges, central banks have implemented non-standard monetary policy measures. These interventions have shown some effectiveness in improving pass-through mechanisms. Von Borstel et al. (2016, p. 398) reported that these measures effectively impacted pass-through, leading to lower lending rates. Similarly, Camba-Mendez et al. (2016, p. 21) found that measures aimed at reducing money market volatility and improving financing terms via covered bonds had a positive impact on pass-through completeness.

In conclusion, the post-crisis era revealed a more complex and heterogeneous interest rate pass-through mechanism in the Euro area. However, it is crucial to note that the monetary policy landscape has undergone further significant changes since mid-2022, which are likely to impact these pass-through dynamics in ways that have not yet been fully studied or understood.

The recent surge in inflation has prompted a substantial shift in monetary policy, with the ECB embarking on a cycle of interest rate increases beginning in July 2022. This policy shift marks the end of a prolonged low-interest-rate era that had persisted for over a decade. The full effects of this policy shift on interest rate pass-through are yet to be comprehensively analysed, as the pass-through process typically occurs with a time lag.

A key factor influencing the pass-through effect is the distribution of interest rate types within the market – namely fixed, variable, and mixed rates. This distribution plays a

crucial role in determining both the speed and extent of pass-through. Fixed-rate loans, for instance, delay the immediate impact of rate changes, while variable-rate loans respond more quickly. Consequently, markets with a higher proportion of fixed-rate loans like Germany may experience slower but potentially more stable pass-through compared to those dominated by variable-rate loans. Understanding this interplay between interest rate types and pass-through dynamics is essential for accurately gauging the full effects of the ECB's recent policy shift on the CRE sector and the broader economy.

Banks now face the challenge of adjusting their rates in response to higher policy rates and increased risks in certain markets. However, this adjustment is not straightforward. Banks must balance the need to reflect these higher costs and risks with the desire to retain their customer base. This balancing act is further complicated by banks' expectations of future interest rate trends. Banks may exhibit caution in fully transmitting current rate increases to their lending practices if they anticipate a potential reversal in interest rates in the near to medium term. This hesitancy could affect both existing loans with adjustable (variable) interest rates and the pricing of new loans. Such strategic behavior by banks can result in an incomplete or delayed pass-through of policy rate changes to market rates. This strategy could help them maintain their competitive position and customer relationships in the long run, even if it means absorbing some short-term costs.

Moreover, the pass-through dynamics in this new environment are likely to be influenced by the same factors that shaped the post-crisis landscape: bank characteristics, market conditions, government bond yields, and country-specific economic situations. However, the relative importance of these factors may shift in the context of rising interest rates and inflationary pressures.

As research catches up with these recent developments, we can expect new insights into how the pass-through mechanism adapts to a rising interest rate environment following a prolonged period of low rates. This evolving situation underscores the need for continued study and potentially new approaches to understanding interest rate transmission in the diverse Eurozone economies. The coming years will likely provide rich data for researchers to analyse how the pass-through mechanism responds

to this significant shift in monetary policy. However, Michaelis (2024, pp. 21-22) suggests that the current high volatility and uncertainty in the banking sector might temporarily reduce the explanatory power of monetary policy changes for bank lending rate adjustments. This volatility adds complexity to the already intricate pass-through mechanism, potentially obscuring traditional relationships between central bank actions and lending rates. Consequently, policymakers and researchers should approach the analysis of interest rate pass-through with caution and acknowledge the challenge of predicting and interpreting monetary policy effects in this unprecedented environment.

3.2 Methodology

Given the novel sector-specific focus of this research, we employ a step-by-step methodology using regression analysis. This approach allows for a targeted examination of CRE dynamics while gradually increasing complexity through the incorporation of control variables and fixed effects. While simpler than traditional macroeconomic models, this method allows a focused investigation of sector-specific dynamics.

Our methodology draws inspiration from Durrani et al. (2022), who analyzed changes in bank lending rates for different borrower segments using AnaCredit loan-level data. Their study, which employed similar regression analysis with fixed effects, offers valuable insights into the complexity of risk pricing in banking. They revealed non-linear relationships between risk and interest rates across borrower segments, with evidence of cross-subsidization between household and NFC loans (Durrani et al., 2022, p. 18). Their findings also highlighted potential mispricing of risk, particularly for high-risk NFCs, which could have implications for financial stability (Durrani et al., 2022, p. 28). By adapting elements of their approach to a sector-specific context, our study aims to contribute new insights to the understanding of interest rate pass-through mechanisms. This targeted analysis may reveal nuances in lending practices and risk assessment not captured in broader, macroeconomic studies, potentially informing more tailored regulatory approaches in the future.

They employed a fixed effects model to account for unobserved heterogeneity across banks and time periods. Specifically, they state:

In order to assess the relationship between risks and returns, a panel regression model is estimated which accounts for unobserved heterogeneity across banks and periods of time (i.e. bank and time fixed effects). At the same time, we control for various further characteristics pertaining to the bank, the debtor, the portfolio, the loan, and the prevailing macroeconomic environment (Durrani et al., 2022, p. 3).

This approach is particularly relevant for our sector-specific interest rate pass-through analysis as it allows us to control for unobserved heterogeneity that may exist across banks, firm characteristics and regional effects, ensuring that our estimates are not biased by omitted variable bias. By incorporating fixed effects, we can isolate the impact of these factors on interest rate pass-through, providing more accurate and reliable results.

3.3 Data

Our dataset is sourced from the AnaCredit Database and extends from September 2018 to April 2024. The primary analysis covers April 2019 to April 2024, with a subset analysis from January 2022 to April 2024, to focus on a timeframe where policy rate changes occur. Firms were handpicked based on their size within each CRE type, utilizing Bundesbank internal data and our own research. We meticulously investigated each firm, ensuring we captured the entirety of their operations, including numerous subsidiaries where applicable. For developers, we compiled a list of approximately 2,000 companies. Other CRE types have more limited selections due to time constraints. Each selected firm was identified within the AnaCredit Database. We define new loans as entries where the loan inception date matches the reporting month reference date (Durrani et al., 2022, p. 11). While the handpicked nature of our dataset results in a relatively small sample compared to the entire CRE subset, this approach was necessary to reliably examine differences within CRE firm types. For the ECB

policy rate, we use the MRO rate. This choice is appropriate because the MRO rate is the ECB's key policy rate directly influences short-term interest rates in the money market and serves as a crucial benchmark for bank funding costs. It is important to note that this dataset contains strictly confidential, non-public information, including loan amounts for identifiable firms.

3.3.1 Descriptive Statistics

The summary statistics reveal several key insights into our dataset. The mean Annualized Agreed Rate is higher in the imputed PD datasets compared to the existing PD datasets, indicating potential differences in the risk profiles captured by the imputed data. The range of Debtor PD values is broader in the imputed datasets, with negative minimum values due to the imputation process. Additionally, the distribution of CRE types varies significantly between the existing and imputed datasets, with a notable increase in the number of Developer and Municipal entries in the imputed datasets. Furthermore, the subset timeframe (January 2022 to April 2024) shows higher mean Annualized Agreed Rates compared to the entire timeframe (April 2019 to April 2024), reflecting potential changes in market conditions and interest rate environments during this period.

A boxplot and histogram illustrating the distribution of annualized agreed rates across different CRE types, as well as a correlation matrix of the key variables, are included in the Appendix for further visual analysis of the data. Additionally, summary statistics and a detailed comparison of original versus imputed PD values can be found in the Appendix, providing a comprehensive overview of the dataset and the impact of the imputation process.

Figure 3.1 illustrates the smoothed annualized agreed rates for different CRE types from 2021 to 2024. This visualization reveals how interest rates have evolved across various CRE sectors over time, highlighting distinct patterns and differences among the CRE types. The graph serves as the starting point for our investigation, suggesting potential variations in interest rate pass-through and/or spreads across different CRE categories. Notably, the differentials between CRE types appear to decrease towards

the end of the observed period, setting the stage for our detailed analysis of monetary policy transmission in the German CRE market.

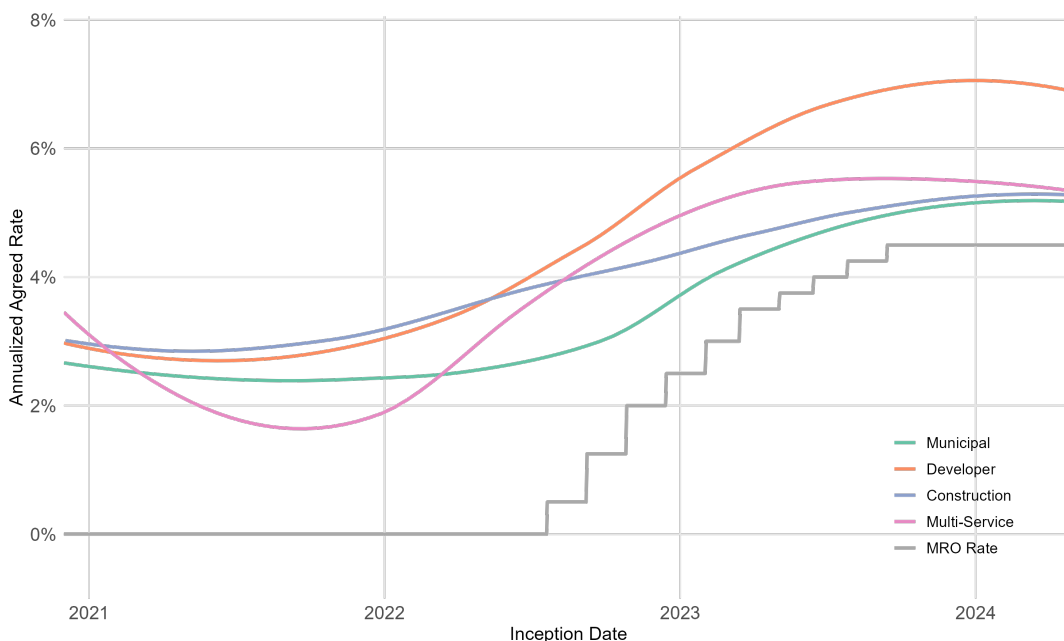


Figure 3.1: Smoothed Annualised Agreed Rates by CRE Type

Developer loans consistently show the highest interest rates throughout the period, with a sharp increase starting in 2022 and peaking in late 2023 at around 7.5%. This trend suggests that developers face the highest borrowing costs among all CRE types, potentially reflecting higher perceived risk or market pressures in this sector.

Construction loans follow a similar pattern to developer loans but with slightly lower rates. They also experience a significant increase from 2022 onwards, reaching about 6.5% by 2024. This trend aligns with the challenges faced by the construction industry in recent years. Real Estate loans show a more moderate increase over time, starting lower than municipal loans in 2021 but surpassing them by 2023. Their rates peak at approximately 5.5% in 2024.

Municipal loans exhibit the most stable pattern among all CRE types. They start with relatively high rates in 2021 but show the least volatility and the smallest overall increase, ending at about 5% in 2024. This stability could reflect the lower perceived risk associated with municipal borrowers. The ECB policy rate, represented by the gray stepped line, shows discrete increases starting in 2022, clearly influencing the

trends seen in other loan types. However, the varying responses of different CRE types to these policy rate changes highlight the heterogeneous nature of interest rate pass-through in the CRE market. These observations support our hypotheses about the heterogeneity of CRE debt and suggest varying degrees of interest rate pass-through across different CRE types. Loans for developers and construction companies seem more sensitive to policy rate changes, while municipal loans show greater resilience.

3.3.2 Variables

Our empirical model incorporates a comprehensive set of variables to analyze interest rate pass-through in the German CRE sector. The dependent variable is the Annualized Agreed Rate (`annlstd_agrd_rt`), which represents the interest rate individually agreed between the creditor and debtor. This rate is converted to an annual basis, quoted as a percentage per annum, and accounts for all interest payments on the loan while excluding other charges that may apply.

The primary independent variables are:

- The Main Refinancing Operations (MRO) Rate, representing the primary monetary policy stance
- CRE Type (TYPE), a categorical variable indicating the type of CRE firm (developer, construction company, multi-service company, or municipal housing company)

Several control variables are incorporated to account for loan-specific characteristics and borrower risk:

- Debtor Probability of Default (`debtor_pd`): A crucial control variable due to its significant role in explaining risk markup variations. Our dataset presents challenges with missing PD values, which we address through multiple approaches detailed in a subsequent section.

- Loan Maturity (*maturity*): The agreed duration of the loan, calculated as the difference between the final maturity date and the inception date.
- Outstanding Loan Amount (*otstndng_nmnl_amnt_debtor_share_cv*): The remaining principal amount of the loan owed by the debtor, excluding accrued interest or other charges. In cases of multiple debtors, this variable specifies the portion attributable to a particular debtor.

To account for unobserved heterogeneity, we incorporate several fixed effects:

- Region (NUTS3): Corresponds to districts or equivalent administrative units, with each NUTS3 region assigned a unique five-digit code.
- Creditor ID (*creditor_cp_id*): Uniquely identifies the creditor in a credit relationship, which could be a bank or any other financial institution.
- Enterprise Size (*debtor_entrprs_sz*): Classifies the size of the debtor enterprise according to the categories defined in the European Commission Recommendation 2003/361/EC, ranging from micro to large enterprises based on factors such as staff headcount, annual turnover, and annual balance sheet total.

All loan-related variables, except for the categorical variable, are measured at the loan level and sourced from the AnaCredit database. These variables are collected to control for loan-specific characteristics, borrower risk, and broader market factors in our analysis. We incorporate fixed effects to account for unobserved heterogeneity across lenders, regions, and firm sizes. The Appendix provides a detailed description of these variables, including their exact definitions and any applied transformations.

3.3.3 Data Cleaning and Filtering

To ensure the quality and reliability of our analysis, we implemented several data cleaning and filtering procedures. Significant data cleaning in terms of observations and firm categorization was conducted. Each firm in our dataset was carefully checked and categorized into a specific CRE type. This meticulous pre-processing ensures that

our dataset is well-structured and accurately represents the various CRE segments we aim to analyze.

For the Annualized Agreed Rate (AAR), we applied a standard filtering approach, removing values greater than 0.2 and less than 0.02. This step eliminates extreme values and potential typographical errors, which are common in large datasets. Our primary analysis covers the timeframe from April 2019 to April 2024. However, we also examine a subset of data from January 2022 to April 2024. This subset analysis allows us to focus more specifically on the period when the policy rate was not consistently zero for an extended time. We include data from January 2022, six months before the first policy rate increase in July 2022. This timeframe allows us to observe potential preemptive actions by lenders who might have adjusted their rates in response to market signals preceding the official policy change.

In addition to AAR filtering, we also addressed the Probability of Default (PD) variable. We removed any PD values above 0.5 to eliminate unrealistic numbers and potential typographical errors. This step ensures that our PD values remain within a reasonable and interpretable range. These data cleaning and filtering steps, combined with our thorough pre-processing, provide a robust foundation for our subsequent analysis of interest rate pass-through in the CRE sector.

3.3.4 Handling Missing PD Data

The PD serves as a crucial control variable in our model, significantly explaining variations in risk markup. However, our dataset presents challenges with missing PD values, which substantially reduce our sample size. Given that loan interest rates are primarily explained by the MRO rate and the risk markup, incorporating PD is essential for a comprehensive interest rate pass-through analysis.

To address this challenge, we employ a multi-faceted approach. We begin by conducting a complete case analysis, using only observations with reported PD values. This approach reduces our sample size by 80%. While it ensures we work with actual reported data, the significant decrease in sample size could potentially reduce the

statistical power of our analysis and limit the generalizability of our results.

To mitigate this issue, we implemented a nuanced approach to impute missing PD values across different CRE types. We experimented with multiple imputation techniques, including Multivariate Imputation by Chained Equations (MICE) with Predictive Mean Matching (PMM) and Bayesian Linear Regression, as well as K-Nearest Neighbors (KNN). For each CRE type, we selected the method that most closely approximated the original PD distribution, based on comparisons of summary statistics and distribution plots (see Table A3). Specifically, we chose KNN for Municipal, MICE-PMM for Developer, and MICE with Bayesian Linear Regression for Construction and Multi-Service CRE types (Rubin, 1976). Importantly, we only imputed values for missing PDs, preserving the original values where they existed.

This imputation approach serves multiple purposes: it allows us to assess the stability of coefficients across other variables, potentially increases statistical power due to a larger sample size, and provides a means to identify potential biases introduced by the imputation process. By comparing regression results from both the original and imputed datasets, we can assess the robustness of our findings and better understand the impact of missing data on our analysis. This comparison allows us to evaluate the consistency of our results across different data treatments.

To address missing PD data, we maintain our original model specification which includes bank fixed effects. These capture the average effect of all time-invariant characteristics of each bank, including their general risk profile. Additionally, we incorporate firm size fixed effects. While these fixed effects cannot fully substitute for the detailed information contained in PD, they may capture some broader patterns related to credit risk. It is important to note that these fixed effects were part of our initial model design and are not primarily intended as a solution for missing PD data. Their inclusion allows us to control for unobserved heterogeneity across banks and firm sizes, which complements our analysis of interest rate pass-through.

By employing these different approaches, we aim to comprehensively address the PD data challenge while maintaining the integrity of our analysis. Each method has its strengths and limitations, which we will discuss when interpreting our results. The

regression tables in the appendix will reflect these different approaches, allowing for a comparison of outcomes. We interpret any differences between the models cautiously and report results from both mean imputed PD and filtered PD analyses transparently, discussing any discrepancies and their potential implications. This approach allows us to compare outcomes from using the imputed dataset and the dataset with only reported PD values, providing a more comprehensive view of the impact of missing PD data on our findings.

3.4 Model Specification

Our methodology employs a step-wise approach to examine the interest rate pass-through in the German CRE sector. We begin with a simple model and progressively add complexity to capture various factors influencing loan interest rates.

The basic relationship between the policy rate and bank lending rates is expressed as:

$$i = \alpha + \beta_0 \cdot m + \varepsilon \quad (1)$$

where i is the annualized agreed rate for the loan, α is the intercept, β_0 is the coefficient of the MRO rate, m is the MRO rate of the ECB, and ε is the error term. This model assumes a direct relationship between policy rates and bank lending rates through the bank lending channel.

We then introduce CRE types as dummy variables, using municipal housing firms as our baseline,

$$i = \alpha + \beta_0 \cdot m + \beta_1 \cdot \text{type} + \varepsilon \quad (2)$$

To account for varying sensitivities of different CRE types to changes in financing costs, we introduce an interaction term:

$$i = \alpha + \beta_0 \cdot m + \beta_1 \cdot \text{type} + \beta_2 \cdot (m \times \text{type}) + \varepsilon \quad (3)$$

This step is crucial for our study, as our main hypothesis posits a direct link between financing costs and changes in credit risk profile, resulting in higher risk markups by creditors. Next, we add control variables:

$$i = \alpha + \beta_0 \cdot m + \beta_1 \cdot \text{type} + \beta_2 \cdot (m \times \text{type}) + \sum_{k=1}^K \beta_{3k} \cdot \text{Control}_k + \varepsilon \quad (4)$$

At present, due to time constraints and the limited number of observations, our control variable is restricted to PD. We recognize this constraint and will address its implications more comprehensively in the limitations section of our study. We include PD as a control variable, employing various methods to handle missing data as discussed earlier. This approach allows us to account for borrower risk while maintaining the integrity of our analysis across different sample sizes.

Finally, we incorporate fixed effects:

$$i = \alpha + \beta_0 \cdot m + \beta_1 \cdot \text{type} + \beta_2 \cdot (m \times \text{type}) + \sum_{k=1}^K \beta_{3k} \cdot \text{Control}_k + \sum_{j=1}^3 \gamma_j \cdot \text{Fixed Effects}_j + \varepsilon \quad (5.1)$$

Our model incorporates three types of fixed effects: bank, firm size, and firm region, to account for important time-invariant characteristics that may influence loan interest rates. These fixed effects control for persistent differences among lending institutions, firm size categories, and geographic variations that might affect loan interest rates. The term $\sum_{k=1}^K \beta_{3k} \cdot \text{Control}_k$ represents the set of K control variables, each with its own coefficient β_{3k} .

Since we currently only use PD as a control variable, we can rewrite equation (5.1) for clarity purposes as:

$$\begin{aligned}
i = & \alpha + \beta_0 \cdot m + \beta_1 \cdot \text{type} + \beta_2 \cdot (m \times \text{type}) + \beta_3 \cdot \text{PD} \\
& + \sum_{j=1}^3 \gamma_j \cdot \text{Fixed Effects}_j + \varepsilon
\end{aligned} \tag{5.2}$$

In this simplified version, β_3 specifically represents the coefficient for the PD control variable. This formulation clearly shows our current focus on PD as the primary control variable in our model, while maintaining the structure to potentially incorporate additional control variables in future analyses.

We opt for firm size fixed effects instead of firm fixed effects to avoid multicollinearity issues with our CRE type dummies while still accounting for firm-specific characteristics. This approach allows us to capture an important aspect of firm heterogeneity without compromising our primary research objective of examining differences across CRE types. The ordinal nature of our firm size variable, ranging from 1 (smallest firms) to 4 (biggest firms), makes this approach particularly appropriate.

The inclusion of firm region fixed effects further controls for geographic variations that might affect loan interest rates, such as regional economic conditions or local real estate market dynamics.

This methodological choice enables us to control for broad differences across firm size categories that may affect loan interest rates. While our size categories are relatively coarse, they can still capture general trends related to firm scale. This approach provides a balance between accounting for size-related effects and maintaining model simplicity. It allows us to estimate the impact of enterprise size on our dependent variable while avoiding potential issues of multicollinearity with our CRE type variables.

Our step-by-step approach to building the model helps us understand how interest rates are set for commercial real estate loans. By starting with a basic model and gradually adding more factors, we can observe how each factor affects loan interest rates and how changes in the central bank's policy rate impact different types of commercial real estate firms. This method provides a clearer picture of how banks determine interest rates for these loans, enhancing the depth and reliability of our analysis.

3.5 Main Results and Discussion

The analysis presents four sets of regression models (Appendix A.2) examining the determinants of annualized agreed rates in the context of monetary policy, CRE type and borrower and loan characteristics. The models cover two time periods: April 2019 - April 2024 and January 2022 - April 2024, using both existing and imputed Debtor Probability of Default (PD).

A key finding across all models is the consistent positive and statistically significant effect of the MRO rate on the AAR. However, the magnitude of this effect, ranging from about 0.3 to 0.6, suggests an incomplete pass-through of policy rate changes to loan interest rates. This finding challenges the conventional expectation that banks would fully transmit changes in the policy rate to their loan rates.

The incomplete pass-through observed in our regression analysis aligns with findings from previous literature, particularly those related to periods of high market volatility. As noted in our literature review, Aristei and Gallo (2014) observed lower pass-through during periods of high market rate volatility. This phenomenon is particularly relevant to our study period, which encompasses significant economic turbulence, including the aftermath of the COVID-19 pandemic and a rapid shift in monetary policy stance. The ECB's transition from a prolonged period of accommodative policy to aggressive tightening, moving away from zero interest rates, represents a substantial shock to the financial system. This abrupt change likely contributed to increased market volatility, which could explain the incomplete pass-through we observe. The CRE sector, being particularly sensitive to economic cycles and financing conditions, may be especially prone to exhibiting this incomplete pass-through during such volatile periods. The incomplete pass-through could be attributed to several factors. Banks may be absorbing some of the policy rate changes to maintain competitive lending practices or support long-standing customer relationships. The presence of long-term fixed-rate loans in banks' portfolios could dilute the immediate impact of policy rate changes. Additionally, banks may be using other funding sources beyond central bank borrowing, which could buffer the impact of MRO rate changes on their lending rates. This interpretation not only supports our empirical findings and aligns with existing litera-

ture, but also contextualizes them within the broader understanding of how monetary policy transmission can be impacted by market conditions, especially during times of significant economic and policy shifts.

Durrani et al. provide further insights into this phenomenon, suggesting that “the risk-return relationship is present but varies significantly across and within borrower segments” (Durrani et al., 2022, p. 29). They found that “banks tend to charge higher rates to riskier borrowers, [but] such changes are non-linear” (Durrani et al., 2022, p. 29). Importantly, their research indicates that “interest rate mark-ups across all borrower segments become less responsive to an increase in borrower’s risks” (Durrani et al., 2022, p. 29). This finding aligns with our observation of incomplete pass-through and suggests that banks may be strategically pricing loans based on factors beyond just policy rates and individual borrower risk. Furthermore, Durrani et al. note that “banks do not appear to always charge the appropriate risk-adjusted interest rate, especially in the case of NFCs that reside in the riskiest quantiles of the distribution” (Durrani et al., 2022, p. 29), which could explain some of the variability we observe in the transmission of policy rates to lending rates across different firm types.

The analysis distinguishes between different types of firms: Developers, Construction firms, and Multi-Service firms and Municipal Housing companies. The results for these firm types vary across the models, with some showing statistical significance in certain specifications but not in others. Despite this inconsistency, these findings still offer insights into how different firms may respond to changes in monetary policy:

Loans for Developers consistently demonstrate higher sensitivity to MRO rate changes, with positive and significant interaction terms across most models. This heightened responsiveness aligns with our hypothesis that Developers are the primary risk-bearers in the CRE value chain. As initiators and managers of real estate projects, operating on both commissioned and speculative bases across various asset classes, Developer projects carry significant financial and operational risks. These projects involve responsibilities including financing, regulatory compliance, and ensuring overall viability, placing them in a high-risk position that naturally makes them more susceptible to market fluctuations, inflation, and changes in financing conditions.

In contrast, loans for Construction firms show mixed results, with some models indicating higher sensitivity to MRO rate changes and others showing no significant difference. Loans for Multi-Service firms generally exhibit less consistent results, with varying sensitivities to MRO rate changes across different models.

This heterogeneity in MRO rate coefficients across firm types suggests that the monetary policy transmission mechanism varies depending on the nature of the projects and firms involved. These differences could be driven by variations in bargaining power, perceived risk, or sector-specific economic conditions. The particularly high sensitivity observed in loans for Developer projects underscores their unique position in the CRE market, where changes in financing costs can have substantial impacts on project viability and overall business strategies.

The PD, whether existing or imputed, generally shows a positive relationship with the agreed rate, indicating that firms with higher default probability face higher borrowing costs. However, this effect is not consistently significant across all model specifications, particularly when fixed effects are included. This observation is noteworthy and somewhat surprising, as it suggests that bank, firm size, and regional fixed effects may collectively capture a substantial portion of the variation typically explained by PD. This could indicate that risk profiles are strongly correlated with bank characteristics, firm size categories, and geographic locations in our sample.

The fact that including PD does not substantially alter the MRO rate coefficients merits further discussion. This finding suggests that the incomplete pass-through we observe is not primarily driven by risk considerations as captured by PD. In other words, the variation in how banks transmit policy rate changes to loan rates seems to be influenced by factors beyond the measured credit risk of the borrower. This could point to other important determinants of loan pricing, such as competitive pressures, relationship banking aspects, regional economic conditions, or strategic considerations that are not fully captured by our PD measure. It also underscores the complexity of the interest rate transmission mechanism in the CRE sector and highlights the need for a bigger sample size and additional control variables to further unravel these relationships.

The models with fixed effects (for creditor, firm size, and firm region) show higher

R^2 values. While this increase in R^2 is expected when adding variables, particularly numerous fixed effects, it suggests these factors contribute to explaining the variation in agreed rates. However, we should interpret this cautiously without drawing strong conclusions about the relative importance of these factors. R^2 values increase as more variables and fixed effects are added to the models, reaching values above 0.8 in some specifications. This indicates that the full models account for a large proportion of the variation in agreed rates, though it is important to note that high R^2 values alone do not necessarily imply better model quality or predictive power. Comparing the models with existing Debtor PD to those with imputed Debtor PD, we observe larger sample sizes and higher R^2 values in the imputed PD models. However, this difference could be due to selection bias, as the datasets with and without PD may have different underlying characteristics. To draw more robust conclusions, we would need to conduct further analysis. These observations highlight the need for a more detailed analysis to fully understand the relationships between our variables and the implications of our model specifications. We must interpret these results cautiously, recognizing that further, more nuanced examination is necessary to draw definitive conclusions.

The models that utilize imputed PD demonstrate strong overall performance, offering several advantages over those using only existing PD data. These imputed PD models benefit from significantly larger sample sizes, allowing for a more comprehensive analysis of the CRE lending market. This expanded dataset likely provides a more representative picture of market dynamics, potentially reducing selection bias present in the complete case analysis. The higher R^2 values observed in these models, particularly for the more recent period suggest improved explanatory power and a better fit to the data. The quality of the PD imputation appears to be reasonably good, with the imputed values serving as a credible proxy for existing PD. This is evidenced by the generally positive and significant coefficients for imputed PD across various model specifications, which aligns with the economic intuition that higher default risk corresponds to higher interest rates. However, it is important to note that the magnitude and significance of these coefficients vary across different specifications, mirroring the variability seen in models using existing PD data.

While there are broad similarities in trends between models using existing and imputed

PD, notable differences emerge upon closer inspection. The imputed PD models often exhibit stronger and more consistent effects, particularly for firm type variables and their interactions with the MRO rate. This suggests that the imputed PD is not merely replicating the results of existing PD models, but potentially capturing additional information or patterns in the data. These differences could be attributed to the larger, more diverse sample or to the imputation process itself uncovering relationships that were not apparent in the more limited dataset of existing PDs.

The models for the recent period (January 2022 - April 2024) show differences compared to the full period models in coefficient magnitudes and significance. This suggests evolving dynamics between monetary policy, macroeconomic conditions, and agreed rates. While R^2 values are higher in these recent models, this doesn't necessarily indicate better fit or predictability.

This recent period is marked by significant macroeconomic shifts, particularly high inflation and a dramatic change in monetary policy. The ECB's transition from accommodative policy to rapid tightening, moving away from zero interest rates and reducing asset purchase programs, signals a new phase potentially altering the transmission mechanism to lending rates. This unique economic scenario combines post-pandemic recovery with surging inflation and subsequent policy responses. It presents different challenges for CRE market participants compared to preceding years, likely influencing lending behaviors and pricing strategies. Additionally, this timeframe excludes the initial COVID-19 shock, instead capturing a period of adaptation to post-pandemic realities. This includes changes in work patterns, commercial real estate demand, and risk assessment in light of structural shifts.

These factors collectively create a distinctly different economic context compared to the earlier years in our full sample period, potentially explaining the observed differences in model results. It is important to interpret these results cautiously, as the differences between the full period and recent period models could be due to a complex interplay of these macroeconomic factors. Further analysis would be needed to disentangle these effects and draw more definitive conclusions about the changing dynamics in CRE lending over time, particularly in relation to the high-inflation environment and the significant shift in monetary policy.

In conclusion, these results illuminate the complex interplay between monetary policy, firm characteristics, default probability, and agreed rates in the CRE lending market. The observed incomplete pass-through of policy rates to loan rates underscores that this relationship is not straightforward, but rather mediated by a complex array of factors including firm-specific attributes, risk assessments, competitive dynamics, and potentially strategic behavior by banks. This multifaceted transmission mechanism has significant implications for monetary policy effectiveness and merits further investigation.

Notably, our findings provide strong support for our hypothesis that developers experience a higher degree of interest rate pass-through in their loans compared to other CRE types, and that these loans exhibit greater sensitivity to changes in policy rates. This sector-specific insight underscores the importance of considering heterogeneity across different segments of the real estate market when analyzing monetary policy transmission.

While the models incorporating imputed PD data offer valuable insights and potentially more representative results due to larger sample sizes, these findings should be interpreted cautiously. The enhanced performance and more consistent effects observed in these models must be balanced against potential biases introduced by the imputation process. To strengthen the validity of these findings and address concerns about potential circularity in the analysis, future research would benefit from additional robustness checks, such as sensitivity analyses employing various imputation methods or comparisons across different data subsets.

Ultimately, these findings emphasize the need for a nuanced understanding of how monetary policy differentially impacts various economic sectors and how diverse factors influence the transmission of policy changes to actual lending rates in the CRE market. Our approach, while acknowledging its limitations, demonstrates the value of sector-specific analyses in uncovering nuanced patterns in monetary policy transmission, laying the groundwork for more sophisticated investigations in the future.

3.6 Limitations

Our study on interest rate pass-through in the Commercial Real Estate (CRE) sector, while offering valuable insights, is subject to several important limitations that must be considered when interpreting the results. The most significant challenge we faced was the substantial amount of missing data, resulting in a relatively small dataset. This limitation necessitates caution when interpreting our findings, even those that are statistically significant. The constraints of our dataset may impact the generalizability of our results and potentially introduce biases in our estimates.

To address the issue of missing data, particularly for Probability of Default (PD) values, we employed an imputation method. While this approach allowed us to expand our dataset and gain initial insights, we recognize that our imputation method is relatively simplistic. This raises methodological concerns, particularly the potential for a “regression in a regression” scenario. If the PD imputation process heavily correlates with annualized agreed rates and existing PDs, there is a risk of circularity in the analysis, potentially leading to inflated coefficients or overstated significance levels in our final models. Ideally, a more robust imputation process incorporating a wide range of firm characteristics and market conditions beyond existing PDs and agreed rates would be employed. However, time constraints in data preparation limited our ability to implement a more sophisticated approach.

Our analysis relies primarily on PD as a control variable, given its crucial role in determining loan interest rates. While this decision was driven by the need to maintain a sufficient sample size, it meant excluding other potentially important control variables such as loan maturity and loan-to-value ratios. The omission of these variables may lead to omitted variable bias and limit the comprehensiveness of our analysis. We acknowledge that our regression model, while informative, lacks the statistical sophistication typically seen in more advanced econometric analyses. This limitation was a conscious trade-off given our primary goal of exploring the applicability of this type of model to a specific sector.

Despite these limitations, our approach has yielded valuable insights, particularly

in supporting our hypothesis that developers experience higher pass-through in their loans and greater sensitivity to changes in policy rates. This study should be viewed as an initial exploration into sector-specific interest rate pass-through mechanisms. Our findings, while preliminary, clearly indicate that this is a fertile area for further research.

Future studies could build upon this foundation by employing more sophisticated statistical techniques and econometric models, expanding the dataset to include a broader range of CRE firms and a longer time period, and incorporating additional control variables to capture a more comprehensive set of factors influencing loan interest rates. Comparative analyses across different economic sectors could help identify sector-specific patterns in monetary policy transmission. Additionally, developing more robust methods for handling missing data and imputing key variables would greatly enhance the reliability of results in this field.

In conclusion, while our study has limitations, it serves as a valuable starting point for understanding sector-specific monetary policy transmission mechanisms. We hope that this research will motivate further investigations into the nuanced effects of interest rate pass-through across different segments of the economy, ultimately contributing to a more refined understanding of monetary policy effectiveness. The clear patterns we observed, particularly regarding developers' sensitivity to policy rate changes, underscore the potential value of sector-specific analyses in uncovering nuanced aspects of monetary policy transmission.

4 Financial Stability Considerations

The concept of financial stability is central to understanding the broader implications of our analysis on the CRE market. As defined by the German Central Bank, a stable financial system “fulfils its central macroeconomic functions smoothly and at all times,” including “the efficient allocation of financial resources and risks as well as the provision of an efficient and secure financial infrastructure” (Deutsche Bundesbank, 2016). This stability is maintained through both microprudential oversight of

individual institutions and macroprudential supervision of the entire financial system.

In the context of the CRE market, the primary macroprudential concern is the potential for contagion effects. The current market conditions, characterized by increased insolvencies among developers, fewer new projects, high inflation leading to increased construction costs, changing demand patterns for office and retail spaces, and rising interest rates, all contribute to this concern. However, it's important to note that the short-term outlook from regulatory bodies remains cautiously optimistic, with statements often indicating that while there are concerns, the market currently seems stable.

The ECB's primary mandate is to maintain price stability, not to support specific sectors like CRE. This raises an important question: Why would the ECB deliberately make life difficult for developers? The answer lies in the ECB's focus on price stability for the entire Eurozone, rather than the well-being of any particular market sector.

Our analysis reveals that the burden of additional financing costs is particularly challenging for the CRE market. However, this should not necessarily be viewed normatively, as one could argue that such pressures are part of natural market corrections. The more intriguing aspect is the apparent mismatch in the market. Despite a housing crisis in urban areas across Europe and globally, developers and construction companies are facing bankruptcy and declining orders. This suggests a disconnect between current market dynamics and actual housing needs, particularly in the realm of affordable housing.

This mismatch raises a broader question about the role of government in addressing market failures. It's worth considering - without necessarily advocating for it - whether more municipal housing, municipal developers, or government-backed projects for developers could help address this issue. Our results indicate that municipal housing company loans are less affected by policy rate rises, which could be a factor in favor of such approaches.

However, it's crucial to emphasize that this is not a normative argument for government intervention, but rather an observation based on market dynamics. The question is: given the high demand for affordable housing and the market's current inability

to meet this demand without intervention, what options are available? Potential solutions could include making development cheaper through subsidies or increasing government-backed investments. Again, these are presented as ideas for consideration, not as definitive recommendations.

From a financial stability perspective, this situation highlights the need for a more comprehensive approach that goes beyond traditional central bank concerns. It involves considering the interplay between monetary policy, fiscal policy, and market dynamics. Our findings suggest that there may be a need for a more nuanced government response to monetary policy changes, especially in sectors critical to social welfare like housing.

Looking ahead, future research should explore the aftermath of these transmission effects. What are the long-term implications for states or economies when monetary policy significantly impacts crucial sectors like housing? How can policy responses be tailored to maintain financial stability while addressing pressing social needs?

In conclusion, while our analysis focused on the transmission of monetary policy to the CRE market, the implications extend far beyond this sector. The challenges in the CRE market, particularly in affordable housing development, highlight the complex interplay between financial stability, monetary policy, and social needs. As we move forward, it will be crucial to consider how various policy tools - both monetary and fiscal - can be used in concert to address these multifaceted challenges, always keeping in mind the broader goal of maintaining overall economic and financial stability.

5 Conclusion

This study aimed to investigate the landscape of CRE debt distribution in Germany and examine the transmission effect of monetary policy, particularly the interest rate pass-through, to the German CRE market. Our analysis has yielded several significant insights that contribute to our understanding of this complex sector.

Regarding the distribution of CRE debt, our findings support the hypothesis of hetero-

geneity across different regions and types of companies. The geographical analysis revealed a clear concentration of CRE loans in urban and industrial areas, especially in the seven major German cities. This pattern underscores the correlation between economic hubs and CRE financing, highlighting potential areas of both opportunity and vulnerability within the sector.

Our investigation into the interest rate pass-through mechanism revealed a nuanced picture. While we observed a consistent positive relationship between the ECB's Main Refinancing Operations (MRO) rate and annualized agreed rates for CRE loans, the transmission was incomplete. This suggests that banks do not fully pass on changes in the policy rate to their CRE loan rates, possibly due to competitive pressures, relationship banking considerations, or strategic pricing decisions. Importantly, our analysis supported the hypothesis that developers experience a higher degree of interest rate pass-through compared to other CRE types. Developer loans consistently demonstrated higher sensitivity to MRO rate changes across most model specifications. This finding aligns with the understanding of developers as primary risk-bearers in the CRE value chain, making them more susceptible to changes in financing conditions.

The study also highlighted the complex interplay between monetary policy, firm characteristics, default probability, and agreed rates in the CRE lending market. The inclusion of firm types, probability of default, and various fixed effects in our models revealed heterogeneity in how different segments of the market respond to policy rate changes. However, our research also faced limitations, primarily due to data constraints and methodological challenges. The substantial amount of missing data, particularly for Probability of Default values, necessitated imputation techniques that, while allowing for expanded analysis, also introduced potential biases.

In conclusion, this study contributes to our understanding of the German CRE market's dynamics and its relationship with monetary policy. The findings underscore the importance of considering heterogeneity across different segments of the real estate market when analyzing monetary policy transmission. As the CRE sector continues to face challenges, with high financing costs being the most critical issue, alongside increased insolvencies and changing demand patterns, these insights can inform more nuanced policy approaches and risk assessments in the future. The sector's struggle

with elevated interest rates highlights the need for adaptive strategies from both market participants and policymakers to ensure the stability and sustainability of the CRE market in Germany.

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A Appendix

A.1 Descriptive Statistics

Table A1: Summary Statistics for ALL Data

	With Existing debtor_pd			With Imputed debtor_pd		
	annlsd_agrd_rt	debtor_pd	cre_type	annlsd_agrd_rt	pd_imputed_type	cre_type
Min.	0.02008	0.000000	Municipal: 433	0.02005	-0.032446	Municipal: 1688
1st Qu.	0.02726	0.001870	Developer: 1908	0.02580	0.001638	Developer: 9027
Median	0.03959	0.008157	Construction: 273	0.03984	0.005900	Construction: 2362
Mean	0.04059	0.025097	Stock: 158	0.04873	0.016139	Stock: 500
3rd Qu.	0.05000	0.029644		0.05320	0.016350	
Max.	0.14984	0.310000		0.19975	0.310000	

Table A2: Summary Statistics for SUBSET Data

	With Existing debtor_pd			With Imputed debtor_pd		
	annlsd_agrd_rt	debtor_pd	cre_type	annlsd_agrd_rt	pd_imputed_type	cre_type
Min.	0.02010	0.000100	Municipal: 381	0.02005	-0.02346	Municipal: 1532
1st Qu.	0.03660	0.001015	Developer: 1057	0.03319	0.00090	Developer: 4960
Median	0.04649	0.003380	Construction: 163	0.04597	0.00350	Construction: 1950
Mean	0.04750	0.021592	Stock: 93	0.05516	0.01326	Stock: 439
3rd Qu.	0.05612	0.020600		0.05891	0.01428	
Max.	0.14984	0.260773		0.19975	0.26077	

Table A3: Comparison of Original vs. Imputed debtor_pd (SUBSET)

cre_type	original_mean	original_median	imputed_mean	imputed_median
Municipal	0.002419803	0.000300	0.002763721	0.000300000
Developer	0.032310311	0.014229	0.019414495	0.005972000
Construction	0.008046252	0.004504	0.007911875	0.007534201
Stock	0.002062774	0.001015	0.002233310	0.001783026

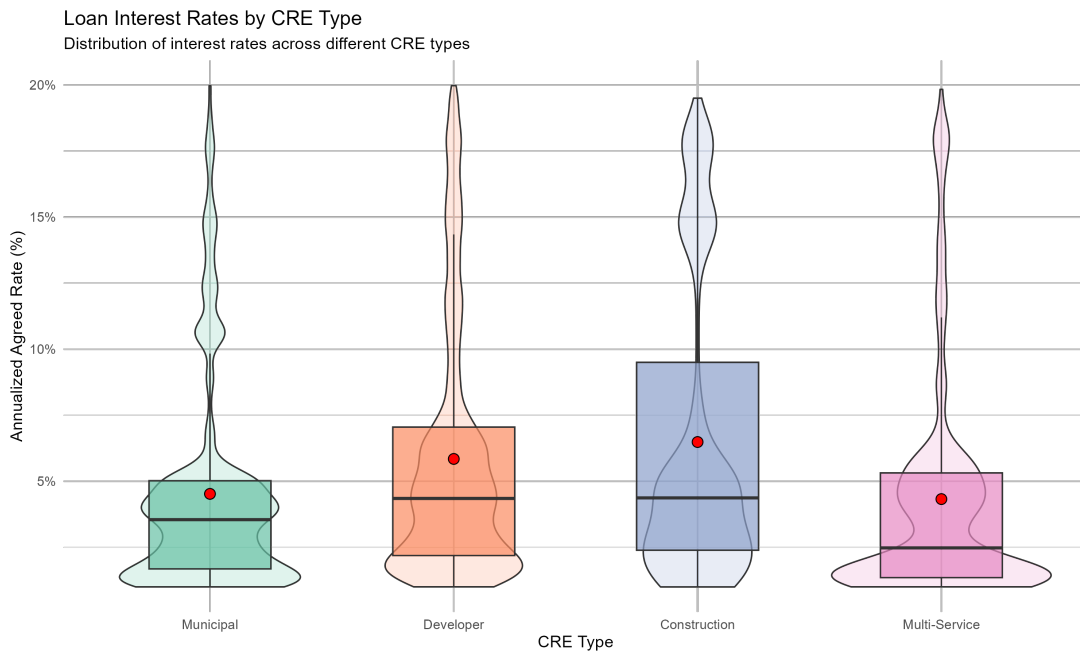


Figure A.1: Boxplot and Violin-Plot of Annualised Agreed Rates Distribution by CRE Type

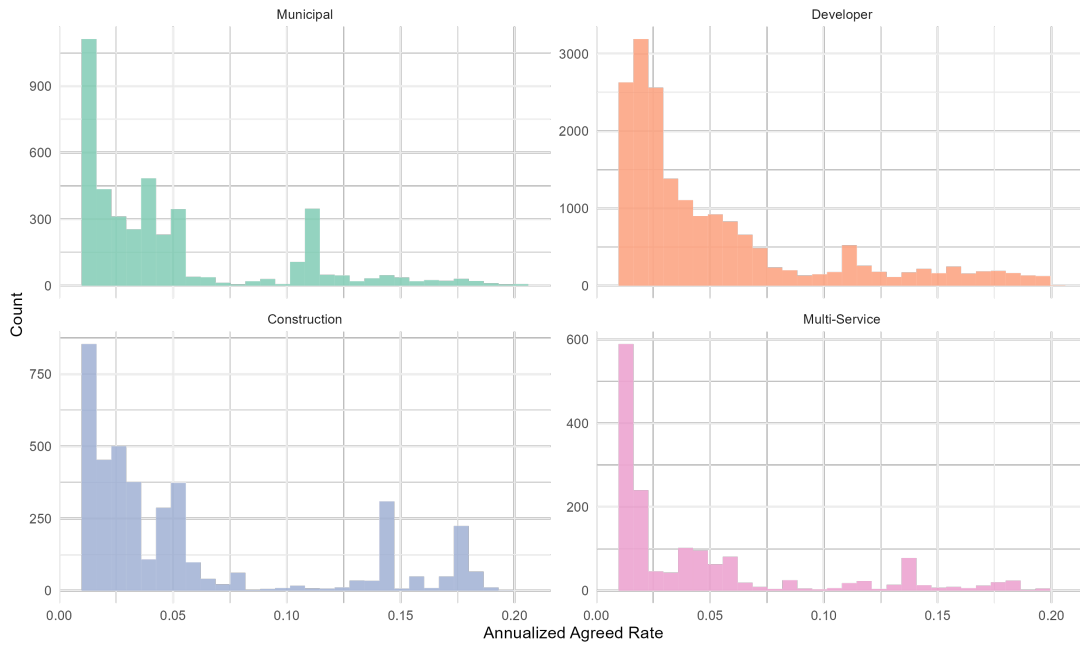


Figure A.2: Histogram Annualised Agreed Rates Distribution by CRE Type

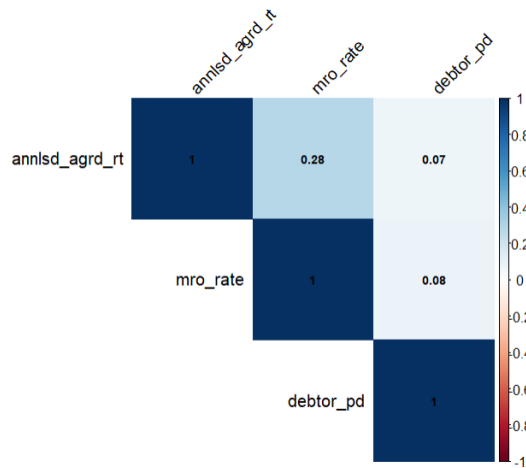


Figure A.3: Correlation Matrix for Variables

A.2 Regression Models

Table A4: Model with existing Debtor PD (April 2019 - April 2024)

	annlsd_agrd_rt										
	(1)	(2)	(3)	(4)	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)	(5.7)
Constant	0.0301*** (0.0014)	0.0210*** (0.0026)	0.0295*** (0.0012)	0.0292*** (0.0012)							
MRO Rate	0.5717*** (0.0601)	0.6316*** (0.0732)	0.3676*** (0.0437)	0.3682*** (0.0450)	0.4761*** (0.0455)	0.3727*** (0.0471)	0.4224*** (0.0701)	0.4744*** (0.0471)	0.4917*** (0.0486)	0.4028*** (0.0667)	0.4657*** (0.0463)
Developer		0.0106*** (0.0036)	0.0012 (0.0018)	-0.0021 (0.0016)	-0.0024 (0.0015)	-0.0055*** (0.0017)	-0.0016 (0.0026)	-0.0045** (0.0019)	-0.0024 (0.0020)	-0.0041 (0.0026)	-0.0043** (0.0020)
Construction		0.0062** (0.0024)	-0.0017 (0.0018)	-0.0022 (0.0018)	-0.0017 (0.0021)	-0.0029 (0.0018)	0.0031 (0.0033)	-0.0021 (0.0023)	0.0012 (0.0032)	0.0016 (0.0036)	0.0001 (0.0033)
Multi-Service		0.0012 (0.0017)	-0.0052*** (0.0018)	-0.0055*** (0.0018)	-0.0019 (0.0023)	-0.0057*** (0.0018)	-0.0016 (0.0030)	-0.0030 (0.0024)	-0.0002 (0.0033)	-0.0022 (0.0030)	-0.0021 (0.0033)
MRO Rate × Developer			0.3272*** (0.0876)	0.3549*** (0.0762)	0.2612*** (0.0724)	0.3940*** (0.0868)	0.4027*** (0.0969)	0.2943*** (0.0824)	0.3445*** (0.0814)	0.4342*** (0.0907)	0.3737*** (0.0770)
MRO Rate × Construction			0.2312** (0.1033)	0.2304** (0.1003)	0.1612 (0.0990)	0.1804** (0.0766)	0.2198** (0.0907)	0.1152 (0.0835)	0.1992** (0.0781)	0.2096** (0.0861)	0.1984*** (0.0738)
MRO Rate × Multi-Service			0.1578** (0.0791)	0.1669** (0.0796)	0.0340 (0.0814)	0.1644* (0.0843)	0.1806** (0.0915)	0.0508 (0.0857)	0.1449 (0.1015)	0.1915** (0.0928)	0.1126 (0.0892)
Debtor PD				0.0940*** (0.0142)	0.0286 (0.0396)	0.0840*** (0.0153)	0.0355 (0.0307)	0.0336 (0.0342)	0.0308 (0.0347)	0.0316 (0.0278)	0.0250 (0.0320)
Observations	2,772	2,772	2,772	2,772	2,772	2,669	2,731	2,669	2,731	2,651	2,651
R ²	0.45549	0.51481	0.53060	0.57045	0.63184	0.61452	0.75223	0.66328	0.79744	0.76712	0.81400
Adjusted R ²	0.45529	0.51411	0.52941	0.56921	0.61948	0.61293	0.73222	0.65166	0.77392	0.74801	0.79211
AIC	-16,549.4	-16,863.2	-16,948.9	-17,192.8	-17,456.2	-16,852.1	-18,036.6	-17,057.0	-18,426.8	-17,690.2	-18,130.0
BIC	-16,537.5	-16,833.5	-16,901.5	-17,139.4	-16,916.9	-16,781.4	-16,824.6	-16,526.9	-16,741.7	-16,501.9	-16,482.9
creditor fixed effects					✓			✓	✓		✓
firm size fixed effects						✓		✓		✓	✓
regional fixed effects							✓		✓	✓	✓

Standard errors (in parentheses) are clustered at the firm level. Fixed effects models include combinations of creditor, firm size and firm region.

Table A5: Model with imputed Debtor PD (April 2019 - April 2024)

	annlsd_agrd_rt										
	(1)	(2)	(3)	(4)	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)	(5.7)
Constant	0.0407*** (0.0053)	0.0284*** (0.0042)	0.0281*** (0.0008)	0.0277*** (0.0008)							
MRO Rate	0.4055*** (0.1095)	0.3574** (0.1396)	0.3684*** (0.0332)	0.3752*** (0.0339)	0.4585*** (0.0643)	0.3915*** (0.0430)	0.4523*** (0.0687)	0.4580*** (0.0654)	0.4254*** (0.0380)	0.4645*** (0.0731)	0.4244*** (0.0389)
Developer		0.0103*** (0.0025)	0.0071** (0.0028)	0.0060** (0.0029)	0.0010 (0.0013)	0.0076** (0.0035)	0.0084*** (0.0032)	-0.0007 (0.0014)	0.0023 (0.0017)	0.0076** (0.0038)	0.0006 (0.0017)
Construction		0.0361** (0.0154)	0.0611** (0.0255)	0.0608** (0.0255)	-0.0029 (0.0026)	0.0616** (0.0272)	0.0379*** (0.0143)	-0.0037 (0.0023)	-0.0034 (0.0031)	0.0377** (0.0152)	-0.0046* (0.0027)
Multi-Service		0.0042*** (0.0016)	0.0023 (0.0019)	0.0023 (0.0020)	0.0003 (0.0014)	0.0018 (0.0020)	0.0028 (0.0043)	-0.0014 (0.0015)	0.0004 (0.0020)	0.0013 (0.0043)	-0.0012 (0.0020)
MRO Rate × Developer			0.2086** (0.0974)	0.2014** (0.0945)	0.1286 (0.0857)	0.1474 (0.0915)	0.1561* (0.0911)	0.1556* (0.0861)	0.2255*** (0.0662)	0.1289 (0.0952)	0.2452*** (0.0653)
MRO Rate × Construction			-0.9286* (0.4865)	-0.9350* (0.4867)	0.1562 (0.1275)	-0.9304* (0.5298)	-0.7755 (0.4734)	0.1796 (0.1150)	0.1656 (0.1131)	-0.7939 (0.5060)	0.2007** (0.0890)
MRO Rate × Multi-Service			0.0754 (0.0706)	0.0712 (0.0716)	0.0136 (0.0748)	0.0978 (0.0790)	0.0526 (0.1081)	0.0211 (0.0809)	0.1113* (0.0657)	0.0605 (0.1075)	0.0894 (0.0641)
Imputed PD				0.0718*** (0.0184)	0.0383*** (0.0134)	0.0573*** (0.0203)	0.0403*** (0.0134)	0.0365*** (0.0121)	0.0394*** (0.0112)	0.0416*** (0.0131)	0.0368*** (0.0110)
Observations	13,577	13,577	13,577	13,577	13,569	12,909	13,499	12,901	13,491	12,860	12,852
R ²	0.04987	0.14506	0.19349	0.19677	0.84520	0.20522	0.49001	0.84935	0.86349	0.49928	0.86815
Adjusted R ²	0.04980	0.14481	0.19308	0.19630	0.83674	0.20455	0.47572	0.84082	0.85184	0.48490	0.85655
AIC	-52,757.9	-54,185.1	-54,970.9	-55,024.3	-75,936.6	-52,903.6	-60,067.1	-72,959.7	-76,419.5	-57,915.9	-73,662.2
BIC	-52,742.8	-54,147.5	-54,910.8	-54,956.6	-70,645.6	-52,814.0	-57,295.8	-67,793.8	-68,444.1	-55,229.6	-65,902.5
creditor fixed effects					✓			✓	✓		✓
firm size fixed effects						✓		✓		✓	✓
regional fixed effects							✓		✓	✓	✓

Standard errors (in parentheses) are clustered at the firm level. Fixed effects models include combinations of creditor, firm size and firm region.

Table A6: Model with existing Debtor PD (January 2022 - April 2024)

	annlsd_agrd_rt										
	(1)	(2)	(3)	(4)	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)	(5.7)
Constant	0.0311*** (0.0015)	0.0200*** (0.0029)	0.0264*** (0.0014)	0.0265*** (0.0014)							
MRO Rate	0.5457*** (0.0584)	0.6184*** (0.0751)	0.4427*** (0.0503)	0.4355*** (0.0521)	0.5498*** (0.0506)	0.4339*** (0.0539)	0.5051*** (0.0882)	0.5429*** (0.0512)	0.5271*** (0.0624)	0.4772*** (0.0841)	0.4988*** (0.0561)
Developer		0.0129*** (0.0039)	0.0049** (0.0021)	0.0012 (0.0020)	-0.0009 (0.0024)	-0.0027 (0.0021)	-0.0011 (0.0037)	-0.0026 (0.0026)	-0.0023 (0.0029)	-0.0039 (0.0036)	-0.0049* (0.0026)
Construction		0.0078** (0.0031)	0.0040 (0.0030)	0.0034 (0.0030)	0.0044 (0.0032)	0.0002 (0.0032)	0.0053 (0.0039)	0.0018 (0.0039)	0.0021 (0.0031)	0.0030 (0.0035)	1.94×10^{-5} (0.0026)
Multi-Service		0.0018 (0.0020)	0.0013 (0.0030)	0.0011 (0.0030)	0.0043 (0.0034)	-0.0009 (0.0030)	0.0068 (0.0042)	0.0029 (0.0036)	0.0048 (0.0040)	0.0048 (0.0041)	0.0017 (0.0040)
MRO Rate × Developer			0.2355*** (0.0900)	0.2801*** (0.0812)	0.2108*** (0.0718)	0.3156*** (0.0966)	0.3288*** (0.1136)	0.2334*** (0.0799)	0.3149*** (0.0922)	0.3678*** (0.1091)	0.3516*** (0.0839)
MRO Rate × Construction			0.0886 (0.1159)	0.0912 (0.1140)	0.0168 (0.1137)	0.0887 (0.1040)	0.1526 (0.1115)	0.0264 (0.1180)	0.1779* (0.0872)	0.1571 (0.1151)	0.1892** (0.0893)
MRO Rate × Multi-Service			0.0010 (0.0802)	0.0070 (0.0812)	-0.1032 (0.0855)	0.0466 (0.0891)	-0.0394 (0.1169)	-0.0890 (0.0929)	-0.0583 (0.1106)	0.0192 (0.1146)	0.0016 (0.1054)
Debtor PD				0.0805*** (0.0245)	-0.0550 (0.0413)	0.0708*** (0.0228)	0.0619 (0.0458)	-0.0311 (0.0300)	0.0195 (0.0359)	0.0517 (0.0397)	0.0146 (0.0316)
Observations	1,694	1,694	1,694	1,694	1,694	1,649	1,693	1,649	1,693	1,648	1,648
R ²	0.30219	0.41011	0.41903	0.44694	0.58021	0.52339	0.71388	0.61663	0.80623	0.73176	0.82401
Adjusted R ²	0.30178	0.40871	0.41662	0.44431	0.56691	0.52019	0.68066	0.60389	0.77727	0.69987	0.79731
AIC	-9,707.1	-9,985.7	-10,005.6	-10,087.0	-10,466.0	-10,091.4	-10,859.8	-10,366.4	-11,431.6	-10,703.6	-11,314.2
BIC	-9,696.3	-9,958.6	-9,962.1	-10,038.1	-10,178.0	-10,026.5	-9,897.9	-10,074.3	-10,230.7	-9,751.9	-10,135.4
creditor fixed effects					✓			✓	✓		✓
firm size fixed effects						✓		✓		✓	✓
regional fixed effects							✓		✓	✓	✓

Standard errors (in parentheses) are clustered at the firm level. Fixed effects models include combinations of creditor, firm size and firm region.

Table A7: Model with imputed Debtor PD (January 2022 - April 2024)

	annlsd_agrd_rt										
	(1)	(2)	(3)	(4)	(5.1)	(5.2)	(5.3)	(5.4)	(5.5)	(5.6)	(5.7)
Constant	0.0501*** (0.0081)	0.0347*** (0.0057)	0.0265*** (0.0008)	0.0257*** (0.0009)							
MRO Rate	0.1660 (0.1589)	0.1542 (0.1727)	0.4088*** (0.0326)	0.4234*** (0.0340)	0.4935*** (0.0625)	0.4563*** (0.0479)	0.4489*** (0.0591)	0.4858*** (0.0622)	0.4362*** (0.0308)	0.4737*** (0.0601)	0.4314*** (0.0299)
Developer		0.0141*** (0.0022)	0.0146*** (0.0031)	0.0134*** (0.0032)	0.0002 (0.0015)	0.0141*** (0.0046)	0.0116*** (0.0040)	-0.0018 (0.0016)	0.0008 (0.0017)	0.0108** (0.0044)	-0.0014 (0.0015)
Construction		0.0341** (0.0143)	0.0794*** (0.0246)	0.0793*** (0.0246)	-0.0015 (0.0048)	0.0799*** (0.0268)	0.0493*** (0.0158)	-0.0032 (0.0041)	-0.0029 (0.0052)	0.0495*** (0.0170)	-0.0052 (0.0041)
Multi-Service		0.0059*** (0.0021)	0.0049** (0.0023)	0.0055** (0.0024)	0.0002 (0.0021)	0.0060** (0.0024)	0.0083* (0.0047)	-0.0003 (0.0020)	0.0021 (0.0024)	0.0068 (0.0049)	0.0002 (0.0023)
MRO Rate × Developer			0.0159 (0.0966)	0.0062 (0.1030)	0.1226 (0.0798)	-0.0459 (0.1143)	0.0874 (0.1039)	0.1574** (0.0797)	0.2209*** (0.0585)	0.0563 (0.1062)	0.2507*** (0.0538)
MRO Rate × Construction			-1.391*** (0.4474)	-1.405*** (0.4481)	0.0951 (0.1637)	-1.381*** (0.5004)	-1.032** (0.4533)	0.1379 (0.1410)	0.1287 (0.1578)	-1.060** (0.4903)	0.1864 (0.1188)
MRO Rate × Multi-Service			0.0109 (0.0734)	-0.0041 (0.0743)	0.0101 (0.0759)	-0.0191 (0.0853)	-0.0721 (0.0984)	-0.0045 (0.0784)	0.0659 (0.0657)	-0.0804 (0.1058)	0.0589 (0.0645)
Imputed PD				0.0935*** (0.0262)	0.0247 (0.0197)	0.0710** (0.0332)	0.1053*** (0.0228)	0.0250 (0.0162)	0.0375*** (0.0126)	0.0927*** (0.0204)	0.0354*** (0.0125)
Observations	8,810	8,810	8,810	8,810	8,806	8,427	8,798	8,423	8,794	8,419	8,415
R ²	0.00538	0.09552	0.15384	0.15781	0.87739	0.16802	0.49368	0.88231	0.89732	0.49646	0.90307
Adjusted R ²	0.00527	0.09510	0.15317	0.15704	0.86876	0.16693	0.47301	0.87377	0.88538	0.47533	0.89149
AIC	-33,159.9	-33,990.8	-34,572.1	-34,611.4	-50,420.2	-33,510.4	-38,357.2	-48,847.0	-51,225.6	-37,044.2	-49,770.9
BIC	-33,145.7	-33,955.4	-34,515.4	-34,547.7	-46,311.9	-33,426.0	-35,906.7	-44,827.8	-44,731.5	-34,651.2	-43,444.0
creditor fixed effects					✓			✓	✓		✓
firm size fixed effects						✓		✓		✓	✓
regional fixed effects							✓		✓	✓	✓

Standard errors (in parentheses) are clustered at the firm level. Fixed effects models include combinations of creditor, firm size and firm region.

A.3 Definitions

Table A8: AnaCredit Variables and Descriptions

AnaCredit Variable	Meaning	Description
annlsd_agrd_rt	Annualised agreed rate	The interest rate agreed between the creditor and debtor, converted to an annual basis
dt_incptn	Date of inception	The date when the contractual relationship originated
debtor_pd	Debtor probability of default	The probability that the debtor will default over a one-year period
entrps_sz	Enterprise size	Classification of enterprises by size (e.g., micro, small, medium, large)
rl_estt_clltrl_lctn	Real estate collateral location	The region or country where the real estate collateral is located
debtor_trrtrl_unt	Debtor territorial unit	The territorial unit where the debtor is registered
otstndng_nmnl_amnt	Outstanding nominal amount (debtor currency)	The outstanding amount in the currency of the debtor
typ_intrst_rt	Type of interest rate	Classification of credit exposures based on the interest rate type (e.g., fixed, variable)
creditor_typ_cp_id	Creditor type counterparty identifier	The type of identifier used for the creditor
intrst_rt_sprd	Interest rate spread	The margin added to the reference rate
pymnt_frqncy	Payment frequency	How often payments are due (e.g., monthly, quarterly)
debtor_entr	Debtor country	The country of residence of the debtor
dt_lgl_fnl_mtrty	Date of legal final maturity	The contractual maturity date of the instrument
prtctn_vl	Protection value	The amount of protection used to secure the instrument

Source: Based on information from the ECB's AnaCredit Reporting Manual.

Table A9: Comparison of Key Entity Types in the German CRE Sector

Entity Type	Developers	Construction Companies	Multi-service Companies	Municipal Housing Companies
Primary Role	Initiate and manage real estate projects	Execute construction plans	Property ownership, management, and leasing	Develop and manage social housing
Risk Profile	High-risk; primary risk-takers	Moderate risk; exposed to market fluctuations	Moderate risk; diversified model	Lower risk; state-backed
Key Activities	Project financing, regulatory compliance, project viability	Construction execution	Property management across various asset types	Affordable housing development and management
Market Sensitivity	Highly sensitive to market fluctuations and financing conditions	Sensitive to construction sector trends	Somewhat insulated due to diversification	Less sensitive due to public mandate
Typical Structure	Private companies	Service providers	Aktiengesellschaften or REITs	Government-owned entities
Asset Focus	Various (office, retail, industrial, residential)	Construction projects	Diverse, often with residential focus	Social and publicly-owned housing
Unique Feature	Operate on commissioned and speculative bases	Recent challenges due to decreased building permits	Diversified business model	Dual mandate of affordability and returns

Statutory Declaration

I hereby formally declare that I have written the submitted Master Thesis entirely by myself without anyone else's assistance. Wherever I have drawn on literature or other sources, either in direct quotes, or in paraphrasing such material, I have given the reference to the original author or authors and to the source where it appeared.

I am aware that the use of quotations, or of close paraphrasing, from books, magazines, newspapers, the internet or other sources, which are not marked as such, will be considered as an attempt at deception, and that the thesis will be graded with a fail.

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Berlin, 19.07.2024

Place, Date



Signature