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Essays on Central Banking with Microdata

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Abstract

This dissertation brings together three self-contained essays that examine central banking themes related to monetary policy and financial stability. The common thread linking these essays is the use of microdata to address these questions. In addition to the three essays, the dissertation includes an introductory chapter.

The first essay examines the transmission of negative nominal interest rates in Finland. Using three complementary empirical approaches, it finds that cuts in the European Central Bank's policy rate continue to pass through to mortgage rates even when the policy rate is negative, though the pass-through is weaker than in positive territory. Taken together, the results in this essay show that the effectiveness of monetary policy during the negative policy rate period was likely diminished but did not disappear.

The second essay studies whether central bank collateral policy influences credit pricing. Exploiting two unexpected expansions of the Bank of Finland's collateral framework during the COVID-19 pandemic, it finds no significant effect of collateral eligibility on corporate loan interest rates. This contrasts with findings from other jurisdictions and suggests that institutional and economic context may shape the impact of collateral policies.

The third essay maps the ownership structure of Finland's commercial real estate market using network analysis and comprehensive register data. It shows that government entities are the most important ultimate owners of commercial real estate firms and that government ownership is associated with lower spreads on the loans of these firms, consistent with perceived lower credit risk. These findings underscore the relevance of ownership structures for financial stability assessments and credit risk modeling.

Acknowledgements

This dissertation marks the culmination of a journey spanning more than a decade.

My postgraduate education began at Goethe University Frankfurt in 2014, where I had my first proper experience with academia. Around the time I was completing my Master's thesis in 2016, I joined the Bank of Finland, which has since served as both my professional and academic home. In 2022, I decided to resume a formal academic path and enrolled in the Doctoral School at the University of Helsinki. Since then, I have worked toward this dissertation, which distills a decade of experience in macroeconomic analysis, central banking, economic research, data science, and microdata.

I thank Jin Cao and Shusen Qi for serving as pre-examiners of this dissertation, and I am especially grateful to the former for also agreeing to act as my opponent. I am grateful to my dissertation supervisor, Antti Ripatti, for ensuring a smooth dissertation process, as well as to my excellent co-authors—Simon Kwan, Mauricio Ulate, and Aleksi Paavola—for their efficient collaboration and for teaching me a great deal about economic research.

I have had the pleasure of working with many talented researchers and analysts at the Bank of Finland and within the wider central banking community, who have helped shape both my research ideas and my general understanding of economics. This includes Zuzana Fungáčová, Iftekhar Hasan, Maija Järvenpää, Karlo Kauko, Kimmo Koskinen, Hanna Putkuri, and Eero Tölö, to name just a few. Esa Jokivuolle, as Head of the Research Department, has provided invaluable support in navigating academic waters. I also extend my gratitude to my supervisors, Helinä Laakkonen and Katja Taipalus, for enabling me to conduct policy-oriented research.

As the title suggests, this dissertation would never have been completed without comprehensive and high-quality data. I want to thank my colleagues in the Statistics Unit at the Bank of Finland, as well as the Research Services of Statistics Finland, for many discussions and iterations regarding the use, interpretation, and access to various datasets. Special thanks go to the library staff at the Bank of Finland, who have diligently provided the necessary references for my work.

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Helsinki, February 2026
Ville Voutilainen

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List of original publications

This thesis is based on the following publications:

I Kwan, Ulate, and Voutilainen (2025): *The transmission of negative nominal interest rates in Finland*. Journal of the European Economic Association, 23(5), 1809-1837.

II Paavola and Voutilainen (2024): *Central bank collateral policy and credit pricing: evidence from Finland*. Bank of Finland Research Discussion Paper No. 7/2024.

III Voutilainen (2025): *Estate owners' ensemble—mapping commercial real estate concentration using Finnish firm ownership network*. Bank of Finland Research Discussion Paper No. 12/2025.

The publications are referred to in the text by their roman numerals.

Co-authored article contributions

The transmission of negative nominal interest rates in Finland
Kwan and Voutilainen conceived the study based on Kwan's original research idea. They designed the initial empirical framework, and Voutilainen conducted the data work, including extraction, preparation, and descriptive analysis. Ulate joined the project later and contributed to the theoretical understanding, as well as designed new experiments. Voutilainen carried out all experiments and most of the calculations, while Ulate provided a dedicated piece of code for monetary policy shock extraction. All authors contributed to interpreting the results and provided critical feedback that helped shape the research. Ulate and Kwan wrote the manuscript with input from all authors. All authors contributed to the final manuscript. Ulate oversaw the journal submission process.

Central bank collateral policy and credit pricing: evidence from Finland
Paavola conceived the study and designed the initial research framework. Voutilainen joined the project, refined the empirical design, and carried out the data-related tasks, including extraction and preparation. Both authors contributed to the analysis, calculations and experiments, as well as to the interpretation of the results and the writing of the manuscript.

Estate owners' ensemble—mapping commercial real estate concentration using Finnish firm ownership network
Single-authored.

1 Introduction

1.1 Motivation and background

Central banks constitute an integral component of the global financial system.[1] While the full range of central bank responsibilities is extensive and subject to jurisdictional variation (Singleton, 2010, p. 5–9), in modern economies their ultimate mandate is typically to ensure the stability of the economy against two principal risks: high inflation and financial crises (Monnet, 2023). The former is addressed through monetary policy, and the latter through activities related to financial stability.

Monetary policy refers to the management of monetary and financial conditions within the economy. Modern monetary policy has its intellectual roots in a macroeconomic program referred to as *Second Generation New Keynesian Modeling* (De Vroey, 2016) or the *New Neoclassical Synthesis* (Goodfriend & King, 1997). Within this framework, it is accepted that monetary policy constitutes an effective instrument—particularly for maintaining price stability—and that it is appropriate for central banks to keep inflation within certain bounds (Woodford, 2009, p. 273). The primary mechanism through which central banks pursue this objective is the adjustment of short-term interest rates.

Financial stability is defined as *"a condition in which the financial system is capable of withstanding shocks and the unravelling of financial imbalances"* (European Central Bank, 2025). From the central bank's viewpoint, it encompasses two distinct perspectives. On the one hand, the *microprudential* perspective seeks to ensure the soundness of individual financial institutions, such as banks. On the other hand, the *macroprudential* perspective, which rose to prominence in the aftermath of the Global Financial Crisis of 2008, aims to safeguard the financial system as a whole by reducing both the likelihood of systemic crises and their economic consequences (Freixas, Laeven, & Peydró, 2015, p. 257). This involves

[1] Any opinions and conclusions expressed herein are those of the author alone and should not be interpreted as representing any organization. During the preparation of this work, I used Microsoft Copilot to reword and rephrase text. After using this tool/service, I reviewed and edited the content as needed and take full responsibility for the content of the publication.

macroprudential surveillance of the financial system and the implementation of macroprudential policies designed to prevent specific segments of financial markets from overheating. The rationale for macroprudentialism arises from the recognition that not all aspects of *systemic risk*[2] can be mitigated through microprudential regulation and supervision. This is particularly true for risks that stem from general equilibrium effects and externalities imposed on other financial market participants, even when each acts optimally from its own perspective (Freixas et al., 2015, p. 199–200, 254–255).

To design appropriate monetary or macroprudential policy, extensive analysis and research are undertaken to generate information on which policy decisions can be based. This dissertation has arisen from such a need. It comprises three independent essays. The first essay examines the pass-through of monetary policy into mortgage rates during the period of negative interest rates. The second essay investigates the impact of central banks' collateral frameworks on the pricing of corporate loans used as collateral in monetary policy operations. The third essay focuses on macroprudential analysis by studying ownership structures in the commercial real estate market and discussing their implications for credit pricing.

Beyond its origins in central banking analysis, a common thread linking the essays in this dissertation is the use of high-quality *microdata*, defined as *"unit-level data obtained from sample surveys, censuses, and administrative systems"* (World Bank, 2025). Macroeconomic research has traditionally been conducted using statistics or aggregated time series—collectively referred to here as *macrodata*—partly due to the scarce availability of detailed data and due to the way economics as a discipline has evolved. The rapid expansion in data availability and infrastructural capacity has opened new possibilities. In essence, there has been a clear push to employ more granular data in macroeconomics, both to complement traditional modeling techniques and to open new methodological avenues. Selected examples of such work include: transmission of monetary policy, Beraja, Fuster, Hurst, and Vavra (2018) and Jiménez, Ongena, Peydró, and Saurina (2014); effects of macroeconomic shocks to bank lending, Buch, Eickmeier, and Prieto (2014); business cycle theory, Gabaix (2011); inflation measurement and dynamics, Cavallo (2013) and Cavallo and Rigobon (2016); estimation of fiscal multipliers, Nakamura and Steinsson (2014); explanations of the Great Recession, Mian and Sufi (2010) and Mian and Sufi (2011); analysis of stability and creditworthiness of the banking sector, Tölö, Jokivuolle, and Virén (2017) and Tölö, Jokivuolle, and Virén (2021). In this dissertation, I extend this list by demonstrating how microdata from a single

[2] Defined as the *"risk of threats to financial stability that impair the functioning of a large part of the financial system with significant adverse effects on the broader economy"* (Freixas et al., 2015, p. 13).

country can be harnessed to advance understanding of central banking questions, which are inherently macroeconomic in nature.

On a general level, the benefits of microdata relative to macrodata include the following: (i) they allow for the inspection of distributions rather than sums or averages, which can reveal important compositional details that may influence aggregates; (ii) evidence on individual behavior or constraints can help clarify mechanisms that propagate macroeconomic shocks; (iii) they facilitate the estimation of heterogeneous treatment effects rather than average treatment effects, paving the way for more targeted policy evaluations. Utilizing microdata can be a double-edged sword, however, as a range of new challenges arise compared to working with macrodata. These include frictions in data access, the burden of data curation, and hardware- and human capital-related challenges (see, e.g., Cole, Dhaliwal, Sautmann, and Vilhuber, 2022). For this reason, the adoption of microdata cannot be treated as "business as usual" by economists or institutions proficient in handling macrodata. A more structured approach is required—one that leverages multiple skill sets and involves the development of new capabilities.

As mentioned above, too *high* an inflation rate has traditionally been considered a principal risk for price stability. Yet too *low* an inflation rate (or excessively low inflation expectations) can also be harmful, as it can limit the efficacy of monetary policy. This occurs when the economy reaches the so-called *Zero Lower Bound* (ZLB) of monetary policy—that is, when short-term nominal interest rates approach zero.[3] If the central bank is unable to set the nominal interest rate sufficiently low because of the ZLB, monetary policy becomes disinflationary, and in the worst case the economy may fall into a so-called "deflationary trap", in which declining inflation expectations and disinflationary impulses reinforce one another (Bindseil & Fotia, 2021, p. 34). Nevertheless, several central banks—including those of the euro area, Switzerland, Sweden, Denmark, and Japan—lowered their policy rates into negative territory in 2014 or shortly thereafter (Ulate, 2021), initiating the so-called *Negative Interest Rate Period* (NIRP). One particularly relevant question is whether the pass-through of monetary policy to bank lending rates—an important channel of monetary policy transmission—changed during the NIRP. As documented by Balloch, Koby, and Ulate (2022), while a slight majority of papers in the literature find that cuts in the policy rate in negative territory continue to pass through to various types of loan rates, disagreement remains.

[3] Intuitively, the rationale for the belief that nominal interest rates cannot fall below the ZLB—or, more precisely, below some *Effective Lower Bound*, which is a negative value close to zero—is that, since cash offers a nominal return of zero percent, economic agents should not be willing to pay for the privilege of holding their funds and thereby incur a negative interest rate.

Essay I examines this issue by comparing the pass through of the ECB's monetary policy—represented by the deposit facility rate—to mortgage loan rates between normal times and the NIRP, using three distinct empirical methodologies (event studies, high-frequency identification, and exposure-measure regressions) with Finland as a case study. The essay provides robust evidence that there continues to be pass-through of a cut in the policy rate to mortgage rates even in the territory where the policy rate is negative.

One advantage of focusing on a single loan product in a single euro area country is that it enables access to proprietary microdata on banks operating under uniform reporting requirements. For the empirical methodologies, this means that, relative to using aggregated series, we can increase the number of observations and control for bank-specific fixed effects. In addition, it enables the use of the so-called "exposure-measure" identification strategy, in which relative effects for banks that are more versus less exposed to negative rates are identified (Balloch et al., 2022). Implementing this strategy requires taking a stance on what constitutes being "more exposed" to negative rates. The deposit-to-assets ratio is selected as the exposure variable and it is constructed carefully for individual bank groups in the sample, bearing in mind the difference resulting from that some groups conduct bulk of their activities outside Finland, whereas others operate primarily within Finland. Deriving bank-level indicators with this level of detail would be impossible without granular bank balance sheet data.

As part of the implementation of monetary policy, central banks extend credit to commercial banks. To mitigate credit risk in lending operations, they require banks to post collateral. Consequently, the availability of eligible collateral constrains the amount of credit a central bank can extend to an individual institution. In essence, the collateral framework constitutes an important—yet often overlooked—component of monetary policy.[4] As emphasized by Nyborg (2017), the collateral framework of central banks may exert a tangible influence on both the amount and the price of allocated credit—for example, through haircuts and eligibility criteria—as well as on real economic outcomes, since the framework may bias the production of assets that are eligible as collateral. Accordingly, further research on central banks' collateral frameworks is warranted.

Essay II investigates, using Finland as a case study, whether corporate bank loans that are pledgeable within the central bank's collateral framework exhibit lower liquidity premia and, consequently, lower interest rates. This would occur if

[4] Bindseil (2013, p. 60) even argues that widening the set of eligible collateral constitutes an unconventional monetary policy tool, as it *"supports the ability of banks to continue providing credit and lowers the intermediation spread between short-term and risk free rates and bank lending rates"*.

a larger share of loans granted by banks were eligible as collateral, as banks could more easily obtain secured funding and use other, more liquid assets more efficiently. The relevance of the study is underscored by the fact that collateral frameworks should avoid generating high collateral eligibility premia, which could distort relative asset prices (Bindseil & Fotia, 2021, p. 48).

The empirical methodology of the second essay is a *difference-in-differences* (DiD) design, based on two unanticipated changes to the Bank of Finland's collateral framework following the COVID-19 pandemic. The first change, introduced in April 2020, lowered the minimum nominal amount threshold for pledgeable corporate loans from EUR 500,000 to EUR 25,000. Furthermore, in August 2020, the Bank of Finland announced that it would adopt the so-called *Additional Credit Claims* framework from September 2020 onward, thereby accepting loans with a broader range of *probability of default* (PD) estimates as collateral. Detailed microdata are crucial for the study. First, constructing the treatment group (newly eligible loans) and the control groups (non-eligible loans and already-eligible loans) requires detailed information on individual loan sizes and PD estimates over time. Second, to establish the validity of the parallel trends assumption in the DiD design, it is necessary to control for relevant bank- and debtor-level characteristics. Such data are provided by the Finnish implementation of the *Analytical Credit Dataset* (AnaCredit), a proprietary and confidential euro area corporate loan dataset.

One section of the economy where macroprudential oversight is routinely applied is the *commercial real estate* (CRE) market. It is among the most cyclical components of the economy and therefore often has direct consequences for real economic activity. CRE owners and investors incur losses when prices fall, and construction firms are adversely affected through reduced activity. Beyond such real economy effects, CRE can also pose risks by elevating systemic risk. For example, banks are exposed to the CRE market through their lending activities. Because CRE constitutes a non-trivial share of banks' loan portfolios, sharp declines in CRE asset values may trigger significant losses. Furthermore, banks are exposed through the use of CRE as collateral, which can create a financial accelerator effect by linking CRE market prices to broader credit conditions (European Central Bank, 2022). Obtaining a comprehensive view of the interconnectedness of the CRE market players is therefore essential for macroprudential analysis, yet it has proven difficult due to the sector's opaque nature and persistent data gaps (European Central Bank, 2024; European Systemic Risk Board, 2019).

Essay III expands the macroprudential analytical toolkit by providing new insights into CRE interconnectedness through mapping ownership structures in the CRE market, again using Finland as a case study. It sheds light on which owners ultimately bear the losses in the event of a CRE market downturn and examines the predicted influence of government ownership on bank loans of CRE firms.

The essay applies tools from network analysis and constructs a granular network of firm-to-firm ownerships, complemented with relevant background information on the firms. Furthermore, it merges the ownership network with the previously mentioned corporate bank loan data from the Finnish implementation of AnaCredit. As such, the paper relies on a novel and unique microdataset that (i) enables the careful identification of commercial real estate firms at the firm level, (ii) captures a major share of inter-firm ownership within the economy and allows for a detailed investigation of ownership structures, and (iii) supports loan–firm–owner-level cross-sectional regressions with a rich set of control variables to examine the association between government ownership of CRE firms and the pricing of their bank loans. Such analysis would be impossible without rich register data.

As a summary, this dissertation brings together three essays that address highly policy relevant questions related to the core functions of modern central banks. Across the three essays, the availability of detailed Finnish microdata enables insights that would be difficult, if not impossible, to obtain from aggregated series alone. The dissertation thus highlights the analytical value of high-quality microdata in central bank and macroeconomic research, as well as underscores the importance of continued investment in data infrastructure and access.

1.2 Summary of the essays

1.2.1 Essay I: The transmission of negative nominal interest rates in Finland

Many advanced economies introduced negative nominal policy rates in the last decade. Despite the implementation, there is still much we do not know about the effectiveness of this instrument. Essay I, co-authored with Simon Kwan and Mauricio Ulate, assesses the effectiveness of unconventional monetary policy tools by studying how the pass-through of the European Central Bank's policy rate to mortgage rates in Finland changes once the policy rate turns negative. The essay employs three distinct empirical methodologies: (i) event studies (panel regressions to evaluate the "mortgage beta", i.e., the relationship between the policy rate and changes in mortgage rates), (ii) high-frequency identification (measuring the impact of extracted monetary policy shocks on mortgage rates), and (iii) exposure-measure regressions (identifying the effects on banks that are more exposed to the negative-rate environment relative to the effects on banks that are less exposed, as measured by their deposit-to-assets ratio). Using these methodologies, the essay provides robust evidence that there continues to be pass-through of a cut in the policy rate to mortgage rates even in the territory where the policy rate is negative.

However, the essay also finds that the pass-through in negative territory is smaller than the one in positive territory.

1.2.2 Essay II: Central bank collateral policy and credit pricing: evidence from Finland

Essay II, co-authored with Aleksi Paavola, studies the effect of collateral eligibility of corporate loans on their pricing by banks in Finland. Specifically, the essay investigates whether loans that are pledgeable as collateral for central bank borrowing carry lower liquidity premia and, consequently, lower interest rates. The methodology relies on a difference-in-differences framework using quasi-natural experiments, based on two unanticipated changes in the Bank of Finland's collateral framework following the COVID-19 pandemic in 2020. The analysis employs loan-level corporate credit data from the Finnish implementation of AnaCredit. The main finding is that there is no evidence that collateral pool expansions by the central bank significantly affected interest rates paid by borrowers. This result contrasts with recent studies suggesting significant effects of similar collateral pool expansions on credit supply. The essay hypothesizes that differences in the institutional settings and economic environments across countries may explain these contradictory results. The findings indicate that collateral policies may not have similar effects on credit pricing in all circumstances.

1.2.3 Essay III: Estate owners' ensemble—mapping commercial real estate concentration using Finnish firm ownership network

The commercial real estate market is an important source of financial stability risks, yet its ownership structure remains opaque. This opacity matters for financial stability: when prices collapse, who ultimately bears the losses? And do implicit guarantees, such as government ownership, influence credit markets? Essay III uses comprehensive Finnish register data and tools from network analysis to answer these questions by constructing a firm-level ownership network and identifying the owners of CRE firms. It is documented that government entities are the most important ultimate owners, holding about 10% of the sector's balance sheet. Further, using cross-sectional regressions on a merged dataset of CRE firms, their ownership, and their bank loans, it is demonstrated that government ownership predicts lower interest rate spreads on CRE bank loans, consistent with creditors perceiving such firms as less risky. The results highlight the need to incorporate ownership structures into financial stability assessments and credit risk models. This, in turn, provides new tools to address the daunting data gaps related to CRE.

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2 Essay I: The transmission of negative nominal interest rates in Finland

Abstract
Despite the implementation of negative nominal interest rates by several advanced economies in the last decade, there is still much we do not know about the effectiveness of this instrument. In this paper, we analyze the pass-through of the European Central Bank's changes in the deposit facility rate to mortgage rates in Finland between 2005 and 2020. We use monthly data and three different empirical methodologies: event studies, high-frequency identification, and exposure-measure regressions. We provide robust evidence that there continues to be pass-through of a cut in the policy rate to mortgage rates even when the policy rate is in negative territory, but that this pass-through is smaller than when the policy rate is in positive territory.

JEL: E44, E52, E58, G21.

This essay has been published as: Kwan, S., Ulate, M., & Voutilainen, V. (2025). The transmission of negative nominal interest rates in Finland. Journal of the European Economic Association, 23(5), 1809-1837. Reproduced by permission of Oxford University Press.

3 Essay II: Central bank collateral policy and credit pricing: evidence from Finland

Abstract
We study the effect of collateral eligibility of corporate loans on the pricing of these loans by banks in Finland. Specifically, we investigate whether loans that are pledgeable as collateral for central bank borrowing have lower liquidity premia and thus lower interest rates. For identification, we utilize two unanticipated changes in the collateral framework of the Bank of Finland after the COVID-19 pandemic in 2020 and loan level corporate credit data from the Finnish implementation of Anacredit. Our main result is that we do not find evidence that collateral pool expansions by the central bank significantly affected interest rates paid by borrowers. The result contrasts with recent findings that imply significant effects of similar collateral pool expansions on credit supply. We hypothesize that differences in the institutional setting and economic environment between countries may explain the contradictory results. Our findings show that collateral policies may not have similar effects on credit pricing in all circumstances.

JEL: E43, E52, G21, G28.

This essay has been published as: Paavola, A., & Voutilainen, V. (2024). Central bank collateral policy and credit pricing: evidence from Finland. Bank of Finland Research Discussion Paper No. 7/2024.

4 Essay III: Estate owners' ensemble—mapping commercial real estate concentration using Finnish firm ownership network

Abstract
The commercial real estate (CRE) market is an important source of financial stability risks, yet ownership structures remain opaque. This paper uses comprehensive Finnish register data to construct firm-level ownership network and identify owners of CRE firms. We document that government entities are the most important ultimate owners, holding about 10% of the sector's balance sheet. We show that government ownership predicts lower interest rate spreads on CRE bank loans, consistent with creditors perceiving such firms as less risky. Our results highlight the need to incorporate ownership structures into financial stability assessments and credit risk models.

JEL: R33, G10, C63.

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