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The Resilience of Banks' Exposure to the Commercial Real Estate Market in Slovenia*

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Abstract

This paper uses granular data sets on bank lending coupled with firm characteristics to provide the first in-depth study of commercial real estate (CRE) risks in the Slovenian banking system and assesses the potential of macroprudential policies to mitigate these risks. We find that lending using CRE as collateral and lending for CRE purposes to firms with lower debt-servicing capacity appears to be associated with higher non-performing obligations. However, banks seem to recognize high risk associated with these loans and account for this risk in their higher pricing. We also find that, due to monetary tightening, debt servicing for loans using CRE as collateral became more difficult for small and medium-sized firms already by the end of 2023. In a simulation of rising risks in the CRE market, we find that losses on CRE lending - with riskier loan-to-value (LTV) and debt service coverage ratio (DSCR) - would have only a small impact on banks' capital adequacy and are unlikely to threaten the solvency of the banking system.

JEL Classification Code: G32, G21, D22, L22

Keywords: Commercial real estate market, non-financial corporations, Macroprudential instruments, credit risk, financial stability

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Povzetek

Delovni zvezek proučuje tveganja za finančno stabilnost, ki izhajajo s trga poslovnih nepremičnin, odpornost bank na ta tveganja ter ocenjuje možnosti makrobonitetne politike za omilitev teh tveganj. Pretekle finančne krize so pokazale, da lahko šoki, ki izvirajo s trga poslovnih nepremičnin, povzročijo izdatne izgube v finančnem sistemu. Hitra rast posojil za poslovne nepremičnine, močno povečanje cen nepremičnin in sproščanje kreditnih standardov pred globalno finančno krizo so v več evropskih državah prispevali k velikim kreditnim izgubam. V zadnjem obdobju so s pandemijo covida-19 in zaostrovanjem denarne politike trgi poslovnih nepremičnin spet prišli v ospredje.

Na podlagi podrobnih podatkov o bančnih posojilih in značilnostih podjetij, ugotavljamo ali se ravnanje bank razlikuje pri posojilih, ki so zavarovana s poslovnimi nepremičninami ali so namenjena za nakup, obnovo ali gradnjo poslovnih nepremičnin, glede na ostala posojila podjetjem. Naši rezultati kažejo, da so ta posojila, sklenjena s podjetji, ki imajo slabšo zmožnost odplačevanja dolga, lahko povezana z večjimi deleži nedonosnih izpostavljenosti. Rezultati kažejo tudi, da so banke to prepoznale in povečana tveganja naslovile z višjimi stroški financiranja. Ugotavljamo tudi, da so z zaostrovanjem denarne politike majhna in srednja podjetja težje odplačevala posojila, zavarovana s poslovnimi nepremičninami kot velika že do konca leta 2023.

V delovnem zvezku proučujemo možnosti makrobonitetne politike za omilitev tveganj, ki izhajajo s trga poslovnih nepremičnin. Pri tem uporabimo kazalnika razmerja med posojilom in vrednostjo nepremičnine (LTV) ter kritja odplačila dolga (DSCR), ki sta del makrobonitetnih instrumentov na trgu stanovanjskih posojil. S simulacijo ugotovimo, da bi se v primeru povečanja tveganj, kapitalska ustreznost bank zaradi izgub pri posojilih za poslovne nepremičnine - z bolj tveganimi kazalniki LTV in DSCR - zmanjšala le nekoliko, kar ne bi ogrozilo solventnosti bančnega sistema.

Analiza pokaže, da je spremljanje tveganj, ki izhajajo s trga poslovnih nepremičnin ključno za razumevanje stabilnosti finančnega sistema. Ugotovitve so prav tako pomembne za razvoj makrobonitetne politike, ki zahteva na tem področju veliko premisleka, tudi zaradi kompleksnosti in raznolikosti trga poslovnih nepremičnin.

1 Introduction

Developments on the commercial real estate (CRE) markets can have important implications for financial stability. Past financial crises have shown that adverse shocks in the CRE sector can lead to substantial losses for the financial system. In several European countries, a rapid build-up of CRE lending, sharp increases in CRE prices and an easing of lending standards ahead of the global financial crisis contributed to large credit losses in the aftermath of the crisis (ESRB (2015), Whitley and Windram (2003), Benford and Burrows (2013), IMF (2016)). In recent years, CRE markets have once again raised attention, driven by the COVID-19 pandemic and the tightening of monetary policy. However, data on CRE is scarce and incomplete, making it challenging to fully understand the associated risks. Understanding these risks is nevertheless crucial for understanding the implications CRE markets can have on financial stability.

This paper combines two granular data sets to provide the first in-depth study of CRE risks in the Slovenian banking sector and the potential role of macroprudential policies in mitigating these risks. First, we examine bank exposure to the CRE market, loan pricing and non-performing exposure related to CRE lending. Second, we assess the possible impact of introducing macroprudential measures and examine how losses on CRE lending with riskier loan-to-value (LTV) and debt service coverage ratio (DSCR) could affect bank resilience in the face of rising CRE market risks. Our findings show that lending using CRE as collateral and CRE purpose lending with lower debt servicing capacity appear to be associated with higher non-performing exposure. However, banks appear to recognize the high risk in these loans and account for these risks in their higher pricing. Our findings also indicate that, even if risks in the CRE market rise, potential losses would likely have only limited impact on banks' capital adequacy, suggesting that the solvency of the Slovenian banking system would remain broadly unaffected.

Fluctuations in the CRE markets have shown to have a historical link with financial crises. Banks play a crucial role in CRE financing by providing loans to firms for the purchase, renovation or construction of CRE, often using the property as collateral. A downturn on the CRE market can lead to deterioration of the quality of bank asset and credit defaults. When CRE firms' interest rates and financing costs rise while CRE firms' profits narrow, impairing their ability to service debt, this puts additional pressure on credit defaults. If declining collateral values come along with borrower defaults, banks may incur increased losses. When banks have substantial exposures to CRE, such losses can threaten their solvency. A large level of non-performing exposure can have an adverse impact on bank lending activity and consequently on the banking system and the whole economy.

By combining two highly granular data sets for the first time, we are able to study these dynamics in Slovenia in detail over a period when the market was subject to a number

of severe negative shocks. To measure the exposure of the Slovenian banking system to CRE, we use a detailed micro data set on bank lending between 2010 and 2023, along with data on banks' capital adequacy. We then match this data with a large data set on firm characteristics, based on their annual financial statements. Our matched data set enables us also to measure the loan-to-value (LTV) and the debt service coverage ratio (DSCR), which we use to analyse the potential macroprudential policies for the CRE market. In Slovenia, the financial crisis in 2008-2009 was marked with a highly leveraged construction and real estate sector, construction firms going bankrupt, and construction projects stalled, while banks incurred large losses in the aftermath. In recent years, with the debt servicing burden increasing along with rising interest rates, extremely high construction costs, persistent labour shortages and structural trends such as lower demand for office space following the COVID-19 pandemic, it has become crucial to understand how resilient the banking system is to adverse developments on the market. This is especially relevant for Slovenia, since banks represent a key financing source for the CRE sector, with the non-banking sector having only a minor role.

We begin our analysis by providing the first examination of CRE exposures in the Slovenian banking system. Descriptive results suggest that lending with the use of CRE as collateral forms a significant share of banks' lending to firms (40% in 2023), while its use is widespread through economic sectors and is not only for CRE purposes, i.e. the purchase or renovation and construction of real estate. This shows how important it is to assess risks for financial stability arising from CRE, yet data gaps often make it hard to examine these risks. By raising the efforts on closing real estate data gaps [1], Banka Slovenije. has provided new indicators, including data on the purpose of the loan granted, that we use further on in this paper. This enables us also to distinguish between CRE loans for own use of the real estate and for real estate that generates income, a defining feature of a CRE loan. Previous data gaps made in-depth examination of this portfolio in Slovenia not possible. Combining the two granular data sets enables us to carefully examine bank exposures to the CRE sector, while looking at loan and borrower characteristics and focusing on the LTV and DSCR and in doing so contribute to the scare literature on this subject of research.

We then examine whether banks are actively pricing in risks in their CRE portfolios. In various sets of probit regressions, we study determinants of interest rate loan spread on bank loans to understand if banks charge higher interest rates on CRE lending compared to other types of lending. We find that lending using CRE as collateral and CRE purpose lending with higher DSCR appear to be associated with higher costs of financing.

[1] In 2016 and 2019, the European Systemic Risk Board (ESRB) issued recommendations on closing real estate data gaps to address the lack of real estate-related data and the importance of the development of statistics on real estate-related data. In recent years, the Statistical Office of the Republic of Slovenia (SORS) and Banka Slovenije have put effort into closing data gaps for the CRE market in Slovenia by collecting and providing new indicators, some already available and more to be introduced in the future.

Furthermore, CRE purpose loans with the highest LTV ratios also appear to be higher priced compared to other loans. This suggest that banks find CRE purpose loans with the highest LTV and DSCR highly risky and are accounting for these risks in their higher pricing. Similarly, Barbosa and Riberio (2007) find a positive association between loan spreads and collateral pledging in loans to firms. Our findings also show that asset tangibility seem to be associated with lower loan spread, indicating that having more tangible assets, such as buildings, land and plant, reduces borrowing costs at banks. It has to be noted, however, that there are also other factors that can influence bank loan pricing, such as macroeconomic conditions, bank size and capital adequacy.

Next, we examine the determinants of non-performing exposures for CRE lending and find that non-performing exposures appear to be associated with CRE-collateralized loans and CRE purpose loans with the highest DSCR. As noted above, banks seem to identify high risk in these loans and appear to be accounting for these risks in their higher pricing. To understand how recent monetary policy tightening may have increased financial stability risks, we next compare CRE lending in the period of low interest rates in 2021 and of high interest rates in 2023. As most CRE lending in Slovenia is variable rate, debt servicing costs increased considerably. We find evidence that, due to monetary tightening, debt servicing loans using CRE as collateral became more difficult for small and medium-sized firms already by the end of 2023. Furthermore, after monetary tightening, non-performing obligations in CRE purpose loans seem to have become associated with the highest LTV ratios, which we did not find for the period before monetary tightening. Our results contribute to the literature on the drivers of default in CRE lending. Similarly, Mokas and Nijskens (2019) point out that CRE loans with higher LTV ratios have higher default probability, while Lian and Ma (2020) further find that lenders mostly restrict lending based on firms' earnings and less on their collateral.

Finally, in various sets of microsimulations, we examine the potential for macroprudential policies to mitigate the risks arising from the CRE market. First, we simulate the introduction of macroprudential restrictions for the CRE market and find that a cap on LTV and DSCR could lower credit growth to firms considerably. Second, we simulate a rise in non-performing CRE exposures to examine its possible effects on bank solvency. Our findings indicate that if risk on the CRE market rises and banks incur losses in CRE lending, banks' capital adequacy should fall only slightly, which is unlikely to threaten the solvency of the banking system. This suggests that the banking system could continue providing firms with sufficient financing also in crisis periods. For example, in a similar simulation, Jiang et al. (2023) find for the US that distress on the CRE market could make over 300 mainly smaller regional banks at risk of solvency runs. Substantial losses from CRE lending can therefore constrain banks' capital and liquidity, affecting their ability to lend and grow. For the EU, Daly et al. (2024) point out that CRE lending accounts for only 6% of

euro area bank assets and is unlikely to threaten the solvency of the banking system. Our paper provides key insights to add to the scarce literature on macroprudential instruments for the CRE market. The use of these instruments is more common for residential real estate (RRE) markets, as CRE markets are more complex and data availability is poorer, while banks already use other capital-based macroprudential instruments for containing risks arising from the CRE market. Our results indicate, similarly to the literature on RRE, that macroprudential tools are associated with lower credit growth and can be important in cooling a rapidly growing market (Cerutti et al. (2015), Kelly et al. (2015, 2017). For the CRE market, Ćirjaković and Sokolovska (2024) shows that tightening of macroprudential instruments can reduce both available credit and prices on the market. Our findings are important for the development of the macroprudential policy framework and show that the introduction of macroprudential instruments for the CRE market could reduce credit growth to firms considerably. Policymakers need therefore to put a lot of care and consideration into the calibration of indicators when implementing these measures, also due to the complexity and versatile nature of the CRE market.

To our knowledge, this paper is the first comprehensive assessment of banks' exposure to the CRE market in Slovenia and the potential for macroprudential policies to mitigate the associated risks. Our findings show the importance for policymakers to monitor the developments on the CRE market and banks' exposure to the market. Based on the literature review, we developed three main hypotheses: 1) CRE loans are associated with higher risks compared to other loans, 2) non-performing loan obligations are associated with higher LTV and DSCR loans, and 3) the risks inherent in the CRE market may not significantly threaten the solvency of the Slovenian banking system. The results confirm our main hypothesis, which we present further on in this paper. We also show that high LTV and DSCR can point to the most vulnerable part of the CRE portfolio, for which banks already seem to account in their higher pricing, indicating that the LTV and DSCR could well be used as macroprudential measures for the CRE market. The results also suggest that if non-performing CRE exposures increased, banks' capital adequacy would fall only slightly due to losses on CRE lending, which is unlikely to threaten the solvency of the banking system. Our findings have important implications for financial regulation and risk supervision, as they give a comprehensive assessment of the resilience of the banking system to the exposure to CRE in Slovenia.

The rest of this paper is organized as follows: in Section 2, we review the related literature. In Section 3, we present our data sets and then illustrate the exposure of the banks to CRE. Section 4 provides the methodology used. Section 5 presents the results of the analysis and Section 6 concludes.

2 Literature review

In the past, CRE has played an important role in financial crises. Cyclical movements in CRE prices show strong linkages with credit cycles, due to the predominant reliance on debt financing (IMF, 2016). CRE loans constitute a large proportion for many EU banks, while insurance companies, pension funds, hedge funds and private equity firms can also have large investments in these markets. Such loans tend to be more cyclical and volatile than other types of bank lending, such as RRE lending, and can create relatively higher default rates and credit losses for the banking sector in times of financial crisis. Moreover, fluctuations in CRE prices can also have negative implications for the real economy and therefore indirectly impact banks' balance sheets (ECB, 2008).

This paper aims to contribute to several strands of the literature. The relationship between credit markets and business cycles has been widely studied (Bernanke and Gertler (1989), Bernanke et al. (1999)). For example, Kiyotaki and Moore (1997) observe that when asset prices increase, collateral values increase, which increases firms' borrowing capacity. Then firms' borrowing increases and in turn boosts economic activity, which further increases asset prices. Horan et al. (2023) point out that, given the widespread use of real estate as collateral by firms, it is important that financial stability authorities understand and monitor the dynamics in CRE markets. Another strand of the literature related to this paper is that on credit risk and corporate default. The empirical literature on corporate default is vast, but the literature on the drivers of default in bank loans granted to the CRE sector is scarce. Studies have shown that unsustainable developments in the market can result in severe losses for the financial system. For the UK, for example, Whitley and Windram (2003) find CRE sector links to the NFC sector through its role as collateral and show a link between CRE prices and corporate defaults. Benford and Burrows (2013) show that the CRE sector had a significant role in the financial crisis: rapid build-up of CRE debt supported a boom in prices and a consequent bust led to a sharp rise in non-performing loans and credit losses for the banks.

As noted by the IMF (2016), in a cyclical upswing, CRE prices increase and higher asset valuations increase lending capacity. Collateral values rise and default rates fall, which supports new credit, pushing up prices further in a self-reinforcing cycle. During the downswing, as corporates default and vacancy rates rise, collateral values fall, which puts additional downward pressure on prices, reinforcing the downward spiral. Davis and Zhu (2009) find that a decline in prices increases the proportion of non-performing loans, leads to a deterioration in banks' balance sheets and weakens banks' capital. For the largest Dutch banks, Mokas and Nijskens (2019) examine CRE loans and find that interest rates strongly positively correlated with default risk and confirm variable rate loans as riskier. Barbosa and Ribeiro (2007) examine the determinants of spreads in syndicated loans to

euro area corporates and find that spreads increase with loan size and maturity. Ćirjaković and Sokolovska (2024) examine the impact of climate risks on firm financing costs in Slovenia and find that firm leverage has a positive and asset tangibility a negative effect on loan spread, while spreads increase with the maturity of the loan.

Our findings are also related to a number of papers that have explored the effects of the COVID-19 pandemic on the CRE sector. Bergeaud et al. (2021) find that increases in remote work are associated with higher vacancy rates, decreases in construction and lower prices of offices. For Ireland, Kennedy et al. (2021) show that since the onset of COVID-19, there was a downward adjustment in valuations on the CRE market, with the retail sector particularly affected. Horan et al. (2023) examine banks' treatment of real estate collateral during the COVID-19 crisis and find that lending based on real estate collateral received one-third less credit following the outbreak of the COVID-19 pandemic and that firms experiencing downward revaluations of their collateral were significantly less likely to get new loans.

In recent years, borrower-based macroprudential tools, such as loan-to-value (LTV), loan-to-income (LTI) and debt service-to-income (DSTI) ratio, have become widely used for the RRE market and have proved to be effective in containing risks arising from these markets. Igan and Kang (2011) find LTV and DTI limits in Korea associated with a decline in RRE price appreciation and transaction activity. Cerutti et al. (2015) find macroprudential instruments associated with lower credit growth, while tighter limits can curb house price expectations. Kelly et al. (2017) show an important role for macroprudential tools in cooling a rapidly growing RRE market. Dietsch and Welter-Nicol (2014) also show that the relationship between risk and LTV/DSTI ratios is not monotonic, as credit risk culminates in tranches close to the 100% LTV and 35% DSTI thresholds.

However, the use of macroprudential tools for the CRE market is not yet so common. In comparison to the RRE market, the CRE market is more complex, volatile and cyclical; firms are more heterogeneous than households and data availability is still poorer. The literature on the use of macroprudential instruments for the CRE market is scarce. For example, Ćirjaković (2018) simulates the impact of the introduction of LTV, LTI and DSCR ratios for the CRE market in Slovenia, based on Kelly et al. (2017) and finds tightening of macroprudential instruments can reduce both the available credit and prices on the market. For the Dutch banks, Mokas and Nijskens (2019) show that CRE loans with higher LTV ratios or an LTV above 100% have higher default probability and suggest that loans with a higher share of CRE as collateral are more risky. For US firms, Lian and Ma (2020) further find that lenders mostly restrict lending based on firms' earnings and less on their collateral, with banks imposing limits on the ratio between, for example, firms' debt and EBITDA.

This paper is closely related to Jiang et al. (2023), who find that after declines in CRE values in the US, higher interest rates and a rise in hybrid work, about 14% of all loans have current property values lower than the outstanding loan balances. Furthermore, CRE distress could induce over 300 mainly smaller regional banks to be at risk of solvency runs. Substantial losses from CRE lending can therefore constrain banks' capital and liquidity, affecting their ability to lend and grow. For the EU, Daly et al. (2024) show, that banks are exposed to CRE markets through loans with CRE purpose and with using CRE as collateral, but exposures are typically contained in size. Furthermore, this loan portfolio accounts for only 6% of total euro area bank assets and is unlikely to threaten the solvency of the banking system.

We conclude the literature review with a definition of commercial real estate. The ESRB[2] defines CRE 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". There are four main sub-sectors of CRE: office, industrial, retail and residential. Furthermore, the ECB (2008) defines CRE firms as firms which are predominantly engaged in the ownership of, trading in, and development of income-producing real estate.[3] The defining characteristic of a CRE loan is therefore that it finances real estate that generates income.

3 Data

3.1 The commercial real estate market in Slovenia

In this subsection, we first present the CRE market in Slovenia. When examining the resilience of banks' exposure to CRE, we first need to understand the risks for financial stability arising from the CRE market. The CRE market in Slovenia is small, with frequent fluctuations in prices and number of transactions. Figure A1 in the Appendix shows the growth in prices and number of sales of CRE from 2008 to 2023. In Slovenia, the growth in prices was historically high in 2022 but has since slowed and sales remain low. CRE prices were up around 15% on average in 2022, while the growth slowed to 4.8% in 2023. In the final quarter of 2023, nominal prices were up by a third on 2015. The number of sales has been falling since mid-2022; they were down 21.8% year-on-year by the end of 2023.

In Slovenia, the supply of new CRE is small, and the majority of CRE investors are

[2] Recommendation on closing real estate data gaps, ESRB/2016/14, as amended by Recommendation ESRB/2019/3.ESRB (2019)

[3] Property used for residential purposes, such as multi-household dwellings, is labelled as commercial property when it is owned or developed for commercial purposes.

building for their own needs and not for onward sale or letting. Offices are mainly located in Ljubljana and other major urban and administrative centres, while retail and services premises are more evenly distributed throughout the country (SMARS, 2024). After the financial crisis in 2008-2009, many construction firms went bankrupt and construction projects were stalled, as firm indebtedness rose substantially and was by far the highest in the construction and real estate sectors. More recently, new construction is being hampered by high construction and financing costs as well as labour shortages, which make construction of buildings more difficult, which also fuels CRE prices. After a decade of low interest rates, in 2022 and 2023, the burden of debt servicing increased along with rising interest rates. In addition, structural trends, such as lower demand for office space due to increased work from home following the COVID-19 pandemic brings further challenges for the CRE market in Slovenia.

3.2 Data set

This section explains how the data set was constructed, presents the main variables and reports descriptive statistics. The data set used in this paper consists of detailed information on the CRE exposures of banks in Slovenia and information on the borrowers of bank loans, related to CRE, that is the non-financial corporations. First, we utilise monetary financial institutions' loan-level reporting to Banka Slovenije that covers all bank lending in Slovenia. Second, we use annual firm-level data from the Business Register of Slovenia and the Annual Reports of Corporate Entities that are collected by AJPES.[4] Data from the monetary financial institutions reporting to Banka Slovenije was matched with data provided by AJPES at the firm level and allows us to examine the resilience of banks' exposure to CRE. The data set comprised between 60,712 and 78,572 loan-level annual observations during 2016-2023 when examining the stock of loans and between 17,658 and 52,070 loan-level annual observations during 2017-2023 when examining newly-approved loans.

Data on the characteristics of loans is provided at the loan level and includes detailed monthly information, for example on the volume of the loan, the volume of the CRE used as collateral and the type of collateral (residential real estate, commercial real estate, and offices and commercial facilities), maturity schedules of exposures, and the interest rate. The data set also provides information on the AnaCredit purpose of the loan, such as CRE purpose (purchase or renovation and construction of the commercial and residential real estate), investments, debt financing, imports and exports, and other (the information is available from 2022 onwards). For the years prior to 2022, data flagged as "for commercial real estate" was used. Based on the information on the amount of the loan and the value of the CRE that was used as collateral, we calculate the LTV ratio, dividing the value of

[4]Agency of the Republic of Slovenia for Public Legal Records and Related Services.

the loan to the value of the collateral. The calculation of the LTV ratio may be biased somewhat, as it does not capture the fact that the same real estate used as collateral in a specific loan can be used as collateral in another loan and can therefore be overestimated. Furthermore, the LTV ratio can also be underestimated due to the fact that banks use also other forms of collateral, not only commercial real estate. Overall, the LTV ratio, calculated with only CRE as collateral, may differ from the LTV ratio calculated with all collateral. The LTV ratio was put into classes (quartiles of the LTV ratio of each loan) and introduced as a dummy variable.

To examine firms' costs of financing, we calculate the interest rate spread for new loans. For variable rate loans, the loan spread is reported, while for fixed rate loans, we calculate loan spread as the difference between the contractual interest rate of the loan and the average value of the 6-month EURIBOR in the month of loan approval. Loan maturity is defined at origination and corresponds to the due date of the last loan instalment. Maturity was put into classes (less than 1 year, 1-5 years, over 5 years) and introduced into the regressions as a dummy variable. The interest rate was defined at the origination for each loan (fixed or variable rate). From the reporting by monetary financial institutions to Banka Slovenije, we use monthly data on newly approved bank loans from 2016 to 2023 and data on the stock of bank loans to firms as of the end of each year in the period from 2010 to 2023. In the simulation on the impact on banks, we use COREP data on the banks' regulatory capital and risk weighted assets in 2023.

Our data set enables us to examine whether bank behaviour differs between CRE lending and other types of lending. In doing so, we focus on loans using CRE as collateral and loans with CRE purpose, i.e. purchase or renovation and construction of residential and commercial real estate. According to its definition (ECB, ESRB), commercial real estate refers to any income-producing real estate with the defining characteristic that it finances real estate that generates income. Nevertheless, lending using real estate as collateral forms an important share of bank lending and we therefore include it in our analysis.

Our data set allows us to include detailed information on the characteristics of the borrowers, which enables us to compare firms with loans using CRE as collateral or taking loans for CRE purposes and other firms. The balance sheet and income statement data of firms in Slovenia is provided by AJPES. The AJPES database pertains to all private business entities, their subsidiaries and other organization segments which perform profitable or non-profitable activities. The database also includes information on firm demographics, such as size of firm, industry affiliation and year of establishment.

In the data set, firms are classified into four size groups (micro, small, medium-sized and large) in accordance with the Companies Act. The classification is based on satisfying any

two of the criteria on number of employees, annual turnover and value of assets.[5] The NACE Rev. 2 sectors we examine are Manufacturing (C), Construction (F), Trade (G), Transportation and storage (H), Accommodation and food service (I), and Real Estate (L), with other sectors[6] classified as Other and referred to in the regressions as the base category.

Furthermore, from the AJPES data, we use data on firm age, exporter status, tangibility and debt service coverage ratio (DSCR). Exporters are defined in terms of the share of sales to the EU and non-EU countries in total sales (in %). Firms are classified as exporters if the share is more than 10% (used as a dummy variable). We also include asset tangibility, defined as the ratio of tangible fixed assets to total assets (in %). Based on the information on firm debt, interests paid and EBITDA, we calculate the DSCR for each firm as debt servicing relative to the borrower's income.[7] The DSCR was put into classes (quartiles of the DSCR of each loan) and introduced as a dummy variable.

In this paper, as interest rates increased in 2023 due to the tightening of monetary policy, we also look at "weak" firms. We define "weak" firms as those whose loan repayments increased substantially alongside falling profits in the period from 2021 to 2023 in comparison to other firms (EBITDA decreasing by more than 50% and interests paid increasing by more than 50% from 2021 to 2023). This is similar to Ryan et al. (2023), who identify significant vulnerabilities in loans to CRE arising from rising financing costs and falling firm profits. Table A1 in the Appendix provides further details on variable definitions and sources.

3.3 Summary statistics

This paper explores the risks to financial stability related to the CRE market and the resilience of banks' exposures to CRE in Slovenia. We present some facts and correlations that we found in the data and that motivated our analysis, presented further on in this paper. Figure 3.1 shows bank exposure to CRE in Slovenia for CRE-collateralized loans and loans to the construction and real estate sector.[8] The results show that at the end of 2023, around 40% of bank exposures to NFCs was relying on CRE as collateral. Bank lending with the use of real estate as collateral therefore forms a significant share of banks' NFC borrowing.[9] As Horan et al. (2023) point out, given the widespread use of real estate

[5] as defined in AJPES database.

[6] NACE Rev. 2 categories A, B, D, E, J, M, N, O, P, Q, R and S.

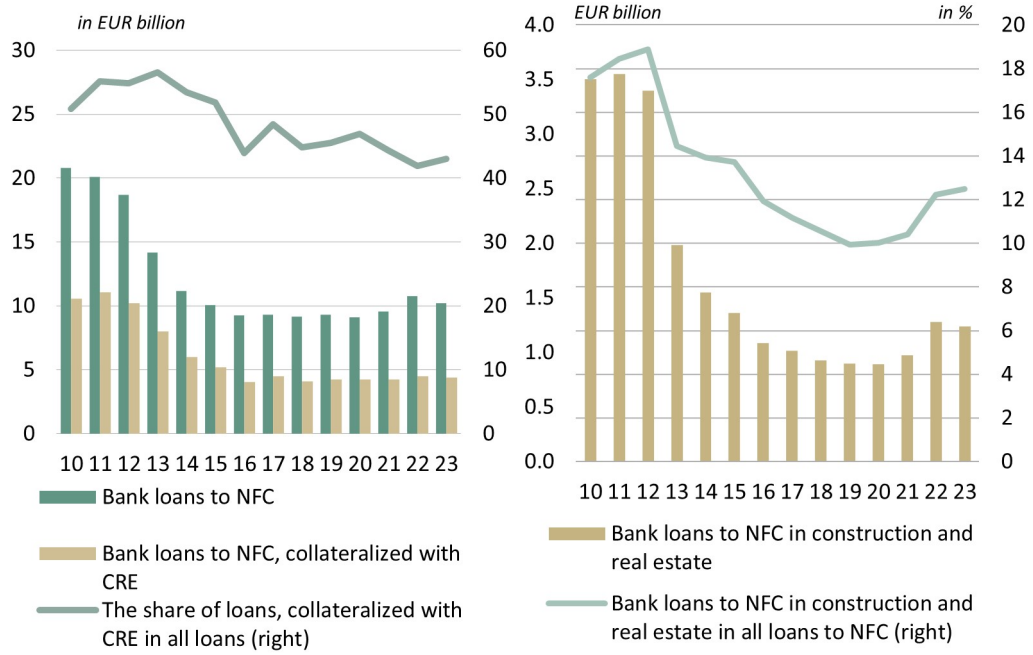
[7] This is an alternative version of the ratio, which can be defined also as EBITDA relative to debt service. However, here we followed a similar indicator to the debt service to income (DSTI) ratio, that is used as a macroprudential measure for households.

[8] CRE firms can be broadly defined also as firms from the construction and real estate sectors, but such a definition can also include firms that are not necessarily CRE-related. For this reason, we do not use this definition later on in the paper, but we show it here as exposure to the construction and the real estate sector nevertheless gives useful information on the developments in the CRE market.

[9] The share of CRE-collateralized lending seems to be among the highest in the EU, maybe also reflecting a precautionary motive due to the large credit losses banks incurred in the aftermath of the financial crisis in 2008-2009, when the indebtedness of firms in the construction and real estate sectors was extremely large.

as collateral by firms, it is important to monitor the dynamics in CRE markets. Figure 3.1 also shows that all bank lending to firms, including bank lending collateralized with CRE decreased in the period 2010-2023, from around EUR 20 billion to around EUR 10 billion. Bank lending to the construction and real estate sectors saw an even larger drop, from around EUR 3.5 billion to around EUR 1.2 billion.

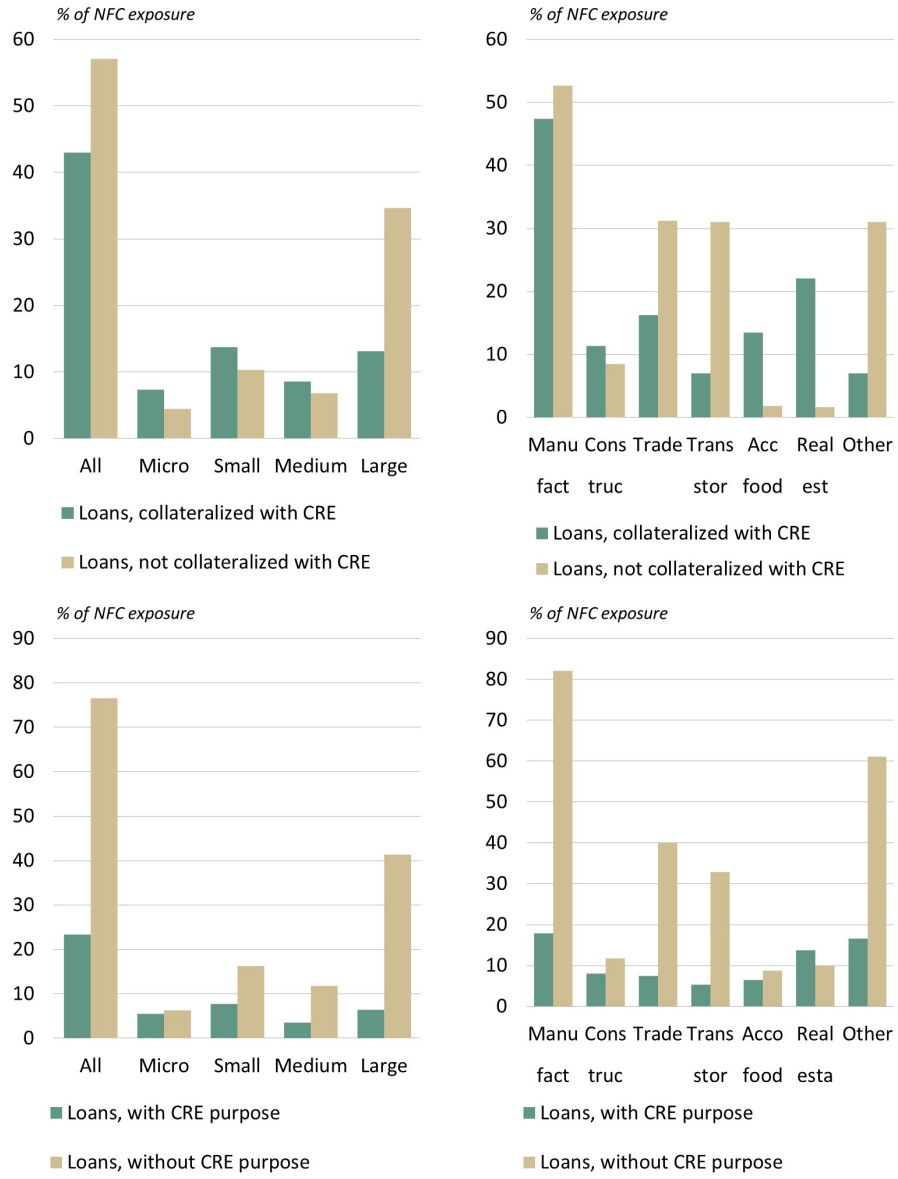
Figure 3.1: Bank exposure to the commercial real estate sector



The results show that at the end of 2023, around 13% of bank exposures to NFCs was to the construction and real estate sectors, though this may also include loans that are not for the purchase or renovation or construction of CRE. After the financial crisis in 2008-2009, when this share stood at almost 18%, many construction firms went bankrupt and construction projects stalled. During the financial crisis, firm indebtedness rose substantially and was by far the highest in the construction and real estate sectors (debt-to-equity ratios stood at 434.6% and 259.6% respectively in 2008). Since then, firm indebtedness, also in the construction and real estate sectors, has substantially decreased. In the last few years, construction activity has faced extraordinarily high construction costs and labour shortages, which have fuelled CRE prices.

Figure 3.2 shows the share of loans using CRE as collateral by firm size and firm sector. CRE is used as collateral by borrowers from the construction and real estate sectors, though two-thirds of loans that are collateralized by CRE are to firms that are not from these two sectors, mostly to firms active in manufacturing, trade, and accommodation and food services sectors. Furthermore, Figure 3.2 breaks down the share of NFC loans that are flagged with a CRE purpose, such as the purchase and renovation of real estate and construction of real estate, by firm size and firm sector. It shows that loans with

Figure 3.2: Bank NFC exposure for commercial real estate by categories, December 2023



Note: A loan is considered to have CRE purpose if it is flagged as a CRE purchase or renovation, an RRE purchase or renovation, or a construction of CRE or RRE. A loan is considered to be CRE-collateralised if the collateral is flagged as CRE, RRE, or offices and commercial premises. It has to be noted that RRE purchased by NFCs is considered to be a CRE purchase.

CRE purpose make up an important share of loans to firms from the construction and real estate sectors, though they are not oriented only to these firms, but also to firms in other sectors. It should be noted that 57% of NFC loans are not collateralized by CRE, with the share particularly high at large firms (35%), which can be in fact more risky for the banks than any lending using CRE as collateral.

Figure 3.2 also shows bank exposure to CRE by the purpose of the loan. It shows that banks grant loans collateralized by CRE for various purposes and not only for CRE purposes. In 2023, 12% of CRE-collateralized loans were obtained for debt financing

and 28% for working capital. Similar to Horan et al. (2023), these figures show that fluctuation in CRE prices can have important implications not only for lending to firms in the construction and real estate sectors, but also to wider economic activity, as CRE represents an important part of collateral. Therefore, as also noted in Ryan et al. (2022), this suggests capacity for substantial spillovers from CRE markets to other parts of the real economy. It should be noted that loans for the purchase of CRE were granted mostly for own use and were not income-producing (64%) and less for renting and sale (36%). Furthermore, in the construction of real estate, half of the loans were granted for construction of CRE for own use, 18% for renting or sale of CRE, while a third were granted for construction of RRE for sale. Loans using CRE as collateral are not considered as typical CRE loans, but developments on the CRE market can have an important impact on these loans, while loans for CRE purpose can be granted also to firms from various sectors.

Figure 3.3 shows CRE loans by loan collateral and CRE purpose. As noted above, the results shows that in December 2023, 23% of NFC loans had a CRE purpose and hence were exposed to CRE markets through the credit risk channel, while 43% used CRE collateral and were therefore exposed through the collateral channel. As the data set allows us to look at the overlaps between loans by industry sector, CRE purpose and CRE collateral type, the results contribute to the understanding of Slovenian banks' CRE exposures. The overlap between these groups is significant, with 17.8% of loans exposed to CRE markets due to both their purpose and their collateral. Furthermore, 25% of loans use CRE as collateral for non-CRE purpose loans, again suggesting that fluctuations in CRE prices could have implications for wider NFC credit. Looking at lending to firms in the construction and real estate sectors that have taken out these loans, 96.2% and 62.7% of loans to the real estate and the construction sectors respectively were either CRE purposed or CRE-collateralized loans or both.

Due to the tightening of monetary policy in 2022-2023, several firms could be considered as more vulnerable to increasing interest rates than others. To estimate the share of bank exposure to these vulnerable firms, we look at "weak" firms, which we define as firms whose loan repayments increased substantially along with falling profits in the period from 2021 to 2023, compared to other firms. Figure 3.3 shows the share of bank lending to "weak" firms in all bank lending. At the end of 2023, "weak" firms accounted for 14.5% of all loans to firms and 18.8% of loans collateralized with CRE.

Since the focus of our analysis is on examining bank lending related to CRE, we also look at the results of the probit regressions for the two categories of CRE lending, CRE-collateralized and CRE purpose lending, to see whether the estimated coefficients effects are statistically significant. Next, we examine the associations observed for the two categories of CRE lending and look at whether the marginal effects also have economic

Figure 3.3: Bank NFC exposure for commercial real estate by categories, December 2023

Note: A loan is considered to have CRE purpose if it is flagged as a CRE purchase or renovation, an RRE purchase or renovation, or a construction of CRE or RRE. A loan is considered to be CRE-collateralised if the collateral is flagged as CRE, RRE, or offices and commercial premises. It has to be noted that RRE purchased by NFCs is considered to be a CRE purchase.

significance. Table 3.1 shows the average marginal effects of probit estimates of CRE loans. The results on CRE lending confirm the findings of the univariate analysis on CRE lending by firm size and firm sector.

The results in Table 3.1 (column 1) show that CRE-collateralized lending appears to be associated more with micro, small and medium-sized firms than with large firms. CRE-collateralized lending also appears to be associated more with the real estate and the accommodation and food services sectors and less with the construction sector, compared to sectors in the base category. Furthermore, the results in columns 2-4 show that CRE

Table 3.1: Average marginal effects of Probit estimates of CRE loans (predicted outcome: CRE loans), December 2023

	CRE	CRE purpose loans		
	collateralized loans	All	Purchase and renovation	Construction
	(1)	(2)	(3)	(4)
Borrower variables				
Firm age dummies				
Age 0 to 4	-0.0204***	0.0019	0.0054**	-0.0012
Age 5 to 9	-0.0318***	-0.0033	0.0043***	-0.0060*
Age 10 to 14	-0.0139***	0.0191***	0.0058***	0.0126
Firm size dummies				
Micro firms	0.0556***	0.0204***	0.0517***	-0.0127
Small firms	0.0739***	0.0367***	0.0514***	0.0053
Medium-sized firms	0.0525***	0.0332***	0.0312***	0.0151
Industry dummies				
Manufacturing	-0.0097***	-0.0155***	-0.0135***	-0.0017
Construction	-0.0256***	-0.0242***	-0.0098***	-0.0120*
Wholes. & retail trade	-0.0288***	-0.0377***	-0.0127***	-0.0240***
Transport & storage	-0.0375***	0.0132***	-0.0171***	0.0211
Accomm. & food serv.	0.0193***	0.0032	0.0003	0.0005
Real estate activities	0.0721***	0.0713***	0.0216***	0.0414***
Exporter	0.0089***	0.0025	-0.0001	0.0006
Tangibility	0.0006***	0.0008***	0.0003***	0.0004***
Debt service coverage ratio (DSCR)				
Quartile 2	0.0078***	0.0054**	0.0023	0.0033
Quartile 3	-0.0144***	-0.0125***	-0.0008	-0.0102*
Quartile 4	0.0197***	0.0009	0.0049***	-0.0045
Loan variables				
Loan-to-value ratio (LTV)				
Quartile 4	0.2084***	0.1223***	0.0706***	0.0576***
Loan maturity dummies				
Less than 1 year	-0.1352***	-0.2153***	-0.0154***	-0.1398***
From 1 to 5 years	-0.0086***	-0.0104***	-0.0012	0.0022
Observations	72,887	72,887	72,887	72,887

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

Notes: The total sample of loans consists of the stock of all loans to NFCs in Dec. 2023. In column 1 loans are entered as a dummy equal to 1 if the loan was collateralized with CRE and equal to 0 if the loan was not collateralized with CRE. In column 2, loans are entered as a dummy if a the loan had Cequal to 1 RE purpose equal to 0 if the loan did not have CRE purpose. In column 3, loans are entered as a dummy equal to 1 if the loan was for the purpose of the purpose of the purchase and renovation of CRE and equal to 0 if it had any other purpose. In column 4, loans for construction are entered as a dummy equal to 1 if the loan was for construction and equal to 0 if it had any other purpose.For the borrower variables, the omitted base category is 15 years or more or firm age, large firms for firm size, non-exporters for exporter status, NACE categories A, B, D, E, J, M, N, O, P, Q, R , and S for industry dummies and quartile 1 for the DSCR. For the loan var., the omitted base category is quartile 1 for the LTV, while LTV quartiles 2 and 3 were omitted because of collinearity and over 5 years for loan maturity. For the the loans with no collateral, LTV was set to zero in order to include these loans in the sample. In the regression, we applied robust standard errors.

purpose lending appears to be associated more with the real estate sector, compared to sectors in the base category. CRE-collateralized lending also appears to be associated less with firms of up to 14 years, while CRE purpose lending appears to be associated more with firms from 10 to 14 years of establishment. The results in column 3 of Table 3.1 also show that both CRE-collateralized and CRE purpose lending seem to be associated with firms with a higher ratio of tangible fixed assets to total assets, loans with the highest LTV ratios (LTV quartile 4) and DSCR (however as well as the lowest DSCR), and loans with maturity of over five years.

4 Methodology

In this section, we describe the estimation approach used in examining the resilience of banks' exposure to commercial real estate. We examine bank lending in a multivariate context by estimating the probability of lending for CRE versus other types of lending using a binary probit model. The estimated equation is as follows:

$$Y_{it} = \beta_0 + \sum_k \beta_k X_{ki,t-1} + \epsilon_i \tag{1}$$

where Y_i takes the value of 1 if firm i had CRE loans in a particular year t and 0 otherwise. β_0 is the constant; β_k is the parameter estimated by the model for variable k; X is the vector of explanatory variables; and ϵ_i is the random error term. Separate regressions are estimated for loans using CRE as collateral and loans with CRE purpose, i.e. the purchase or renovation and construction of real estate.

We next examine non-performing exposures in CRE lending in a multivariate context by estimating the probability of a loan becoming non-performing versus a performing loan using a binary probit model, as described above. The estimated equation Y_i takes the value of 1 if firm i had non-performing exposures in CRE loans in a particular year t and 0 otherwise. In the first set of regressions, separate regressions are estimated for all loans, CRE-collateralized loans and CRE purpose loans. Furthermore, to check if the influence of the various explanatory variables is significantly different between different categories of bank lending, a pooled regression for the three categories combined is estimated in which the explanatory variables are interacted with dummy variables identifying CRE-collateralized and CRE purpose loans. With a pooled regression, we analyse data that has both cross-sectional and time-series dimensions. By including a comparison between CRE-collateralized and CRE purpose lending, we aim to evaluate the credit risk of various categories of CRE lending. In the second set of regressions, separate regressions are estimated for the years of low interest rates (2021), rising interest rates (2022) and high interest rates (2023). For comparison purposes, another set of regressions are estimated

for all firms. Furthermore, a pooled regression for all three years combined is estimated in which the explanatory variables are interacted with dummy variables identifying the "year of rising interest rates" (2022) and the "year of high interest rates" (2023). By including a comparison between the environments of increased interest rates in 2023 and low interest rates in 2021, we aim to evaluate credit risk in CRE lending.

The explanatory variables in the regression equations are similar to those highlighted in the literature on corporate finance and banking and are shown in the Appendix (Table A1). We test for the existence of non-linear effects across various segments, which would enable us to see whether the effect of CRE lending on loan spread is related to factors such as LTV and DSCR ratios. The LTV and DSCR ratios enter in the equation as quartile dummies to allow for a non-linear relationship with firm non-performing exposure. The loan maturity enters as a three-dummy variable. Therefore, all the variables except for exporter status and tangibility enter as dummy variables. We use error clustering at the bank level to relax the assumption of independence of the errors and therefore use the assumption of independence between clusters, so the errors can be correlated within the cluster. When not feasible, we use robust standard errors. The descriptive statistics for the explanatory variables are shown in the Appendix (Table A2).

We next explore the effect of CRE lending's variables on firms' financing conditions by modelling the effect of firm-specific and loan-specific characteristics on the spread of loans granted to firms. We estimate fixed effects regressions for the loan spread, depending on various firm and loan characteristics, including various categories of CRE. The equation for the effect of CRE lending's variables on the spread of loan j is specified as follows:

$$Spread_{jt} = \beta_0 + \beta_1 * X_{it} + \beta_2 * E_{it} + Z_i + v_t + \epsilon_{it} \tag{2}$$

where X_{it} is a vector for time-varying firm-specific and loan-specific explanatory variables, E_{it} is a commercial real estate lending variable, Z_i is a vector of controls for bank effects, and v_t stands for year dummies. The firm-specific variables include firm age, firm size, firm sector, exporter status, tangibility and the DSCR, while the loan-specific variables include the LTV ratio and loan maturity. The regression also includes dummies for bank and year effects. We estimate the equation for all loans, CRE-collateralized loans and loans with CRE purpose. Furthermore, to check if the influence of the various explanatory variables is significantly different between all loans and the two categories of CRE loans, a pooled regression for all loans combined is estimated in which the explanatory variables are interacted with dummy variables identifying the CRE-collateralized and CRE purpose loans. We use error clustering at the bank level, so the errors are allowed to be correlated within the cluster. When not feasible, we use robust standard errors.

Next, we make two micro simulations at the loan level. First, we estimate the growth in bank lending to NFCs in 2023 compared to 2022 if 1) CRE loans with high LTV ratios were approved at lower values of these indicators, such as 100% and 80%, or CRE loans with high DSCR were approved at lower values of these indicators, such as 10 and 5, and 2) CRE prices fell by 5% and 10%, which means the collateral value fell by 5% and 10%. Second, similarly to Jiang et al. (2023), we simulate a fall in CRE prices to see the impacts on banks' resilience, which we define with capital adequacy (CA), which is calculated as a ratio between regulatory capital ($Kreg$) and total risk exposure amount ($RWEA$):

$$CA = Kreg/RWEA \tag{3}$$

We examine loans in "negative equity", defined as those where the current loan balance is more than the current assessed property value, resulting in an estimated LTV exceeding 100%. We look at the capacity of these borrowers to meet their debt obligations, that is the DCSR. Next, we simulate an increase in default rates of CRE firms and its effects on banks equity capital to see how many banks would incur losses in such a situation. We assume a bank is in a "negative equity" position if its value of assets including losses due to defaults on CRE loans is below the face value of its non-equity liabilities, including regulatory capital.

5 Results

5.1 Pricing of bank lending related to commercial real estate

In this section, we examine whether banks price CRE lending differently than other types of lending to understand if CRE lending is associated with higher costs of financing compared to other lending. We examine, first, whether CRE loans in general have higher interest rates compared to other types of loans and, second, whether interest rates on CRE loans are more sensitive to certain borrower and loan characteristics. For this purpose, in our next set of regressions, we use loan-level data on newly approved loans to NFCs from 2016 to 2023.

First, we use the information on the interest rate spread as a dependent variable and the two CRE lending categories (CRE-collateralized and CRE purpose loans) as an explanatory variable. Second, we use the information on the interest rate spread as a dependent variable and loan characteristics, the LTV ratio and loan maturity, coupled with firm-level data on borrower characteristics, firm age, size and sector, exporter status, tangibility, and the DSCR as explanatory variables, with bank- and time-specific dummies and error clustering at the bank level. Further, to check whether the influence of the various explanatory

variables is significantly different between all loans and the two categories of CRE loans, a pooled regression for all loans combined is estimated in which the explanatory variables are interacted with dummy variables identifying the CRE-collateralized and CRE purpose loans. We use pooled regression to analyse data in both cross-sectional and time-series dimensions. The main results of this set of regressions confirm the findings in the literature on this topic.

The results shown in Table 5.1 (in column 1) show that banks seem to be charging higher loan spread for CRE-collateralized loans, while they seem to be charging lower loan spread for CRE purpose loans. The results further show that in CRE-collateralized loans (in column 2), the costs of financing appear to be higher for micro, small and medium-sized firms compared to large firms, while for CRE purpose loans (in column 3), loan spread appears to be higher only with micro firms. Furthermore, in CRE-collateralized loans, the costs of financing appear to be lower for firms in the wholesale and retail trade and real estate sectors compared to other firms, while for CRE purpose loans, the costs of financing appear to be lower for firms in manufacturing and higher for firms in the construction sector.

The results (in columns 1-3) also show that asset tangibility appears to be associated with lower loan spread, indicating that having more tangible assets, such as buildings, land and plant, reduces borrowing costs at banks. The results confirm the findings of Ćirjaković and Sokolovska (2024), who find a negative relationship between loan spread and asset tangibility for bank lending to firms in Slovenia. Furthermore, we find that in CRE-collateralized loans, those with higher DSCR appear to be associated with higher loan spread, while those with the highest LTV ratio appear to be associated with lower loan spread. In CRE purpose loans, those loans with the highest DSCR and LTV ratios appear to be associated with a higher cost of financing.

We next compare loan spread for all loans, CRE-collateralized loans and CRE purpose loans. The results of the pooled regression for all loans, CRE-collateralized and CRE purpose loans with interaction dummies indicate that the relationship with the loan spread on CRE purpose loans compared with the loan spread on all loans and CRE-collateralized loans is significantly different for micro, small and medium-sized firms, wholesale and retail trade, the real estate sector, and loans with the highest DSCR and LTV ratios. For all other covariates, their association with loan spread was not significantly different between the two CRE categories (columns 4-6 in Table 5.1). The results in Table 5.1 (in column 6) show that banks seem to be pricing CRE purpose loans more favourably, but we also find that banks seem to apply higher loan spread for CRE purpose loans with the highest DSCR and LTV ratios. Therefore banks seem to associate higher risk in those CRE purpose loans that have the highest DSCR and LTV ratios. As seen in the literature review, loans with highest LTV and DSCR ratios are indeed associated

Table 5.1: Effects of CRE lending on loan spreads for CRE lending categories, 2016-2023

				CRE-collater. and CRE purpose loans pooled: slope and intercept dummies		
	All loans	CRE collater. loans	CRE purpose loans		CRE collat. loans intera-ction dum.	CRE purp. loans intera-ction dum.
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower variables						
Firm age dummies						
Age 0 to 4	0.355**	0.187*	0.173	0.396**	-0.571***	0.0702
Age 5 to 9	0.229*	0.180	0.138**	0.251*	-0.323**	0.0344
Age 10 to 14	0.226	0.280	-0.0506	0.247	-0.189	-0.203
Firm size dummies						
Micro firms	2.251***	1.758***	0.848***	2.311***	-1.471***	-0.899***
Small firms	1.550***	1.144***	0.363	1.560***	-1.182***	-0.749***
Medium-siz. firms	0.996***	0.706***	0.188	0.995***	-0.865***	-0.546***
Industry dummies						
Manufacturing	-0.264	-0.123	-0.198***	-0.306	0.138	0.0751
Construction	0.251***	0.115	0.167**	0.242**	-0.0363	-0.0186
Wh. & ret. trade	-0.607***	-0.244*	-0.0349	-0.654***	0.608***	0.341*
Transp. & storage	-0.0880	0.0583	-0.0572	-0.112	0.106	0.0202
Acc. & food serv.	0.104	0.0986	0.0132	0.155*	0.0436	-0.166
Real estate act.	-0.861***	-0.582***	-0.189	-1.034***	0.499*	0.596**
Exporter	0.0849	-0.0268	-0.0266	0.0943	0.00297	-0.124
Tangibility	-0.00239***	-0.00420***	-0.00140**	-0.00216**	-0.000564	0.00112
Debt service cov.ratio (DSCR)						
Quartile 2	0.00712	0.224**	0.00668	0.00765	-0.265*	0.120
Quartile 3	-0.0696	0.359***	0.170	-0.0874	-0.0176	0.300**
Quartile 4	0.171	0.365**	0.288***	0.161	-0.0654	0.204*
Loan variables						
Loan-to-value ratio (LTV)						
Quartile 4	-0.592***	-0.305**	-0.0622	-0.434***	-	0.664***
Loan maturity dummies						
Less than 1 year	-0.0685	1.477	0.541	-0.0546	0.792	0.543
From 1 to 5 years	0.262	0.223	0.293***	0.233	-0.0789	0.0664
CRE-collateralized	5.81e-08***				1.047***	
CRE-purpose	-0.899***					-0.615***
Constant	3.056***	1.635***	1.934***	3.055***		
Observations	282,305	49,211	7,939	282,452		
R-squared	0.609	0.509	0.294	0.612		
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
Bank dummies	Yes	Yes	Yes	Yes	Yes	Yes

**** p<0.01, ** p<0.05, * p<0.1)*

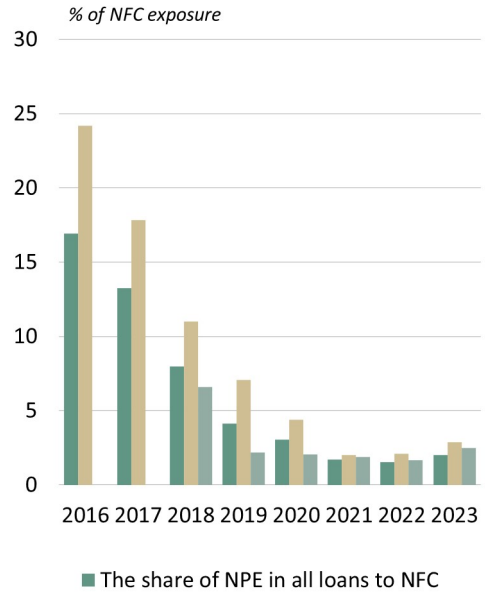
Notes: The total sample of loans consists of of all newly approved loans to NFCs in the period 2016-2023. The interest rate spread is a dependent var. and borrower and loan characteristics are explanatory var. In column 1, all loans are included, in column 2, only CRE-collater. loans are included, and in column 3 only CRE purpose loans are included. In columns 5-7, we present a pooled regression for all loans, CRE-coll. loans and CRE purpose loans with interaction dummies. For the borrower var., the omitted base categ. is 15 years or more for firm age, large firms for firm size, non-exporters for exporter status, NACE categ. A, B, D, E, J, M, N, O, P, Q, R and S for industry dummies and quartile 1 for the DSCR. For the loan var., the omitted base category is quartile 1 for the LTV ratio, while LTV quartiles 2 and 3 were omitted because of collinearity and over 5 years for loan maturity. For the loans with no collateral, the LTV was set to zero in order to include these loans in the sample

with higher risks, as for example Dietsch and Welter-Nicol (2014) show for the RRE market that the relationship between risk and LTV and DSTI ratios is not monotonic as credit risk culminates close to the 100% LTV and the 35% DSTI thresholds. The results also confirm the findings of Barbosa and Ribeiro (2007) that show a positive association between spreads and collateral pledging in loans to firms. It should be noted that there are other factors that also influence bank loan pricing, such as macroeconomic conditions, bank size and capital adequacy and not only borrower or loan-specific factors, but these are not included in this study.

5.2 Non-performing exposures related to commercial real estate

In this section, we first look at the evolution of non-performing exposures to all NFCs, followed by non-performing exposures to NFCs related to CRE. Figure 5.1 shows that in the period 2016-2022, non-performing exposure to NFCs in all lending decreased from around 17% to 1.5%, while in 2023 it again increased slightly to 2%. Figure 5.1 also shows that the share of non-performing exposure was higher in CRE-collateralized loans than in all loans, suggesting higher risks are associated with loans related to CRE.

Figure 5.1: Non-performing exposure in NFC loans by loan categories



Furthermore, the figure also shows that for CRE purpose loans, non-performing exposures in NFCs has been higher than in all loans only in the recent period, while in 2018-2019 the share of non-performing exposures in NFCs was lower compared to all loans. It should be noted that the rise in interest rates in 2022 and 2023 greatly increased debt financing costs and especially so in Slovenia, as CRE lending is mostly variable rate. This was also noted by Banka Slovenije (2023), who show that in June 2023 fully 94% of loans to NFCs

for CRE carried a variable interest rate. Therefore, as the burden of debt service financing is higher in variable rate lending, tighter financing conditions can affect Slovenian firms more than firms in countries where the share of variable rate loans is smaller.

5.2.1 Non-performing exposures by CRE lending categories

In the next set of regressions, we show the results of our econometric analysis linking non-performing exposures with loan and borrower characteristics for all lending, CRE-collateralized and CRE purpose lending in the period 2016-2023. In doing so, we use loan-level data on the stock of loans to NFCs from 2016 to 2023. Table 3 shows the average marginal effects of probit estimates of NPE loans for all loans and the two categories of CRE lending (columns 1-3), followed by pooled regressions for all loans, with intercept dummies CRE-collateralized and CRE purpose loans (columns 4-6) to examine the differences between NPE loans and the two categories of CRE loans.

The results in Table 3 show that non-performing loan obligations seem to be closely related to borrower and loan characteristics in both CRE-collateralized and CRE purpose loans. The results show that non-performing loan obligations appear to be associated with CRE-collateralized loans, while less so with CRE purpose loans. Columns 2 and 3 show that in both CRE-collateralized and CRE purpose loans, non-performing loan obligations appear to be associated less with micro, small and medium-sized firms compared to large firms. Furthermore, they seem more likely in the accommodation and food services sector for all lending categories, as this sector was hit most by the COVID-19 pandemic. However, CRE purpose loans in this sector (column 7) seem to have been more strongly associated with non-performing loan obligations compared to other lending.

The results further show that non-performing loan obligations seem to be associated less with DSCR in the 2nd and 3rd quartiles in CRE-collateralized loans, while more with the highest DSCR (4th quartile) in CRE purpose loans. Therefore the results show that borrower financial conditions have an important influence on firms' ability to repay loans. As noted in the literature review, Lian and Ma (2020) find that lenders mostly restrict lending based on firms' earnings and less on their collateral. Furthermore, the results show that in CRE purpose loans, non-performing loan obligations seem to be associated less with the highest LTV ratios, while no such relationship was found for all loans or CRE-collateralized loans, probably also due to the fact that many CRE purpose loans are not using CRE as collateral.

In Table 5.2 (columns 4-6) we next compare non-performing obligations determinants for CRE purpose loans with all loans and CRE-collateralized loans. The results of the pooled regression for CRE purpose loans and the other two categories of loans with interaction dummies indicate that the relationship with non-performing obligations in

Table 5.2: Average marginal effects of Probit estimates of NPE loans in CRE lending (predicted outcome: NPE loans for CRE-collateralized and CRE purpose loans), 2016-2023

				CRE-collater. and CRE purpose loans pooled: slope and intercept dummies		
	All loans	CRE collater. loans	CRE purpose loans		CRE collat. loans interaction dum.	CRE purp. loans interaction dum.
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower variables						
Firm age dummies						
Age 0 to 4	-0.0053	-0.0493***	-0.0217***	-0.000614	-0.0298***	-0.0109***
Age 5 to 9	0.0041*	-0.0083	-0.0010	0.00628***	-0.0109***	-0.00156
Age 10 to 14	0.0067***	0.0042	-0.0068***	0.00856***	-0.00154	-0.0160***
Firm size dummies						
Micro firms	-0.0250**	-0.0557***	-0.0135***	-0.0226***	-0.0169***	0.0133***
Small firms	-0.0541***	-0.0969***	-0.0406***	-0.0508***	-0.0174***	0.00791**
Medium-siz. firms	-0.0382*	-0.0734***	-0.0380***	-0.0350***	-0.0146***	-0.00616
Industry dummies						
Manufacturing	0.0010	0.0007	-0.0020	0.000713	-0.000587	-0.00299
Construction	0.0065	0.0071	-0.0017	0.00713***	-0.00107	-0.00956**
Wh. & ret. trade	-0.0022	-0.0061*	-0.0063**	-0.000942	-0.00393**	-0.00572*
Trans. & storage	0.0149***	0.0113	-0.0011	0.0161***	-0.00676**	-0.0162***
Acc. & food serv.	0.0185***	0.0287***	0.0231***	0.0166***	0.000977	0.0108***
Real estate act.	0.0101**	-0.0073	-0.0018	0.0162***	-0.0204**	-0.00779
Exporter	-0.0120***	-0.0160***	0.0005	-0.0124***	-0.00105	0.0134***
Tangibility	-0.0001*	-0.0001	-0.0000	-0.000125***	5.01e-05*	7.49e-05*
Debt-service cov. ratio (DSCR)						
Quartile 2	-0.0370***	-0.0719***	-0.0319***	-0.0334***	-0.0187***	0.00119
Quartile 3	-0.0311***	-0.0460***	-0.0150***	-0.0309***	-0.00561***	0.0150***
Quartile 4	-0.0004	-0.0001	0.0055***	-0.000367	-0.00256	0.00857***
Loan variables						
Loan-to-value ratio (LTV)						
Quartile 2			0.0035**	-0.0133***	0.0547***	
Quartile 3						-0.0335***
Quartile 4	-0.0084	-0.0109	-0.0053***	-0.00208		-0.0335***
Loan maturity dummies						
Less than 1 year	-0.0131	0.0651***	0.0541***	-0.0133***	0.0547***	0.0809***
From 1 to 5 years	0.0078***	0.0220***	0.0035**	0.00506***	0.00904***	-0.00507**
CRE-collateralized	0.0341**			0.0499***		
CRE-purpose	-0.0144***			-0.00717		
Constant						
Observations	517,664	76,799	42,534	517,664		

**** p<0.01, ** p<0.05, * p<0.1)*

Notes: The total sample of loans consists of the stock of all loans to NFCs in the period 2016-2023. The NPE loan is a dependent var. and borrower and loan characteristics are explanatory var. In column 1, all loans are included, in column 2, only CRE-collateralized loans are included, and in column 3, only CRE purpose loans are included. In columns 5-7, we present a pooled regression for all loans, CRE-coll. loans and CRE purpose loans with interaction dummies. For the borrower var., the omitted base categ. is 15 years or more for firm age, large firms for firm size, non-exporters for exporter status, NACE categ. A, B, D, E, J, M, N, O, P, Q, R and S for industry dummies and quartile 1 for the DSCR. For the loan var., the omitted base categ. is quartile 1 for the LTV ratio, while certain LTV quartiles 2 and 3 were omitted due to collinearity and over 5 years for loan maturity. For the loans with no collateral, the LTV was set to zero in order to include these loans in the sample. In the regression, we applied robust standard errors.

CRE purpose loans compared with all loans and CRE-collateralized loans was significantly different for firms of up to 4 years and from 10 up to 14 years of establishment, micro and small firms, construction, wholesale and retail trade, the transport and storage sector and the accommodation and food services sector, exporters and firm asset tangibility, loans with higher DSCR, highest LTV ratios and loan maturities of up to five years (see column 6). For other covariates, their association with non-performing obligations was not significantly different between the two categories (columns 4-6 in Table 4). The results therefore show that in CRE purpose loans, non-performing obligations appear to be associated slightly more with micro and small firms compared to large firms, with the accommodation and food services sector, and with exporters. In CRE purpose loans, contrary to the other two categories of loans, non-performing obligations seem associated more with higher DSCR and less with the highest LTV ratios.

As noted in the section on the pricing of bank lending related to CRE, the results show that banks appear to associate CRE-collateralized lending with higher costs of financing (Table 2), and correctly so, as these loans seem to be associated more with non-performing loan obligations (Table 3). Furthermore, the CRE purpose lending seems to be associated with lower costs of financing (Table 2), as non-performing loan obligations seem to be less associated with CRE purpose loans (Table 3). However, in CRE purpose loans, banks seem to take notice that non-performing obligations appear to be associated with higher DSCR, since these loans are also more likely to have higher loan spreads and therefore higher costs of financing. As noted in the literature review, Mokas and Nijskens (2019) examine CRE loans at the largest Dutch banks and find interest rates strongly positively correlated with default risk, while Barbosa and Ribeiro (2007) find a positive correlation between the presence of collateral and borrower default risk in loans to firms.

5.2.2 Non-performing exposures using CRE as collateral after monetary tightening

In this section, we next look at non-performing exposures in two periods that were subject to different shocks. We look at the monetary tightening years 2022-2023 and at the year prior to the monetary tightening, 2021, which was also not a very typical year since it was most likely still affected by the aftermath of the COVID-19 pandemic. We present our econometric analysis linking non-performing exposures with loan and borrower characteristics in the period from 2021 to 2023. The results of the probit regression on the average marginal effects of probit estimates of NPE loans are shown in Table 3, where we present first the results for CRE-collateralized loans. In columns 1-3, we show the results for average marginal effects of probit estimates for 2021, the period of lower interest rates, 2022, and the period of higher interest rates, 2023, while the results in columns 4-6 show the pooled regression for the year of high interest rates, 2023, and the other two years

with interaction dummies.

The results of the probit regression on the average marginal effects of the probit estimates of NPE loans for CRE-collateralized loans are shown in Table 5.3. Column 1 shows that in 2021, the period of lower interest rates, non-performing loan obligations appear to be associated less with small and medium-sized firms compared to large firms, while no relationship was found for micro firms. On the other hand, in the period of higher interest rates in 2023 (column 3), non-performing loan obligations appear to be associated less only with small firms compared to large firms, however the difference became smaller, therefore their position weakened, while no relationship was found for micro and medium-sized firms, showing that the position of medium-sized firms weakened as well. This shows that the position of small and medium-sized firms had deteriorated compared to large firms from 2021 to 2023.

The results in columns 1 and 3 in Table 3 show that in both 2021 and 2023, non-performing loan obligations appear to be associated more with the transport and storage and accommodation and food services sectors, while less with the real estate sector, compared to the base category. The regression results in columns 1-3 also show that in all three years, non-performing loan obligations seem to be associated less with lower DSCR (2nd and 3rd quartiles). This again suggests that borrower financial conditions have an important influence of firms' ability to repay loans. The relationship between non-performing loan obligations and loan maturity is non-linear and shows that non-performing loan obligations seem to be associated more with loans from one to five years of maturity compared with other maturities in the observed period 2021-2023.

In Table 5.3, we next compare the non-performing obligations determinants in 2023, the year of high interest rates, with 2021, the year of low interest rates, and with 2022. The results of the pooled regression for 2023 and the other two years with interaction dummies indicate that the relationship with non-performing obligations observed in 2023 compared with the other two years was significantly different for firm age groups of up to 14 years and small and medium-sized firms. For all other covariates, their association with non-performing obligations was not significantly different between the two periods (columns 4-6). Table 5.3 shows that the relationship between firm age and firm size and the likelihood of non-performing loan obligations changed in 2023 compared to 2021. In 2021, no relationship was found between firm age and the likelihood of non-performing loan obligations, while this changed in 2023, as non-performing loan obligations in CRE-collateralized loans appeared to be associated more with firms of 5-14 years and less with firms of up to 5 years, compared to older firms.

Furthermore, in 2021, small and medium-sized firms seem to be less associated with non-performing loan obligations, while in 2023, small and medium-sized firms appear to

Table 5.3: Average marginal effects of probit estimates of NPE loans for CRE-collateralized loans (predicted outcome: NPE loans for CRE-collateralized loans)

				2021-2023 pooled slope and intercept dummies		
	2021	2022	2023		2022 interaction dummies	2023 interaction dummies
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower variables						
Firm age dummies						
Age 0 to 4	-0.0045	-0.0217**	-0.0495***	-0.0054	-0.0144	-0.0395***
Age 5 to 9	-0.0028	0.0042	0.0121**	-0.0012	0.0048	0.0116*
Age 10 to 14	-0.0069	-0.0028	0.0107**	-0.0057	0.0037	0.0163**
Firm size dummies						
Micro firms	-0.0044	-0.0101	0.0121	-0.0030	-0.0077	0.0154
Small firms	-0.0301***	-0.0360***	-0.0185**	-0.0324***	-0.0061	0.0164*
Medium-siz. firms	-0.0141**	-0.0206***	0.0061	-0.0165**	-0.0060	0.0229**
Industry dummies						
Manufacturing	-0.0017	-0.0084	0.0055	0.0005	-0.0080	0.0045
Construction	0.0017	-0.0096	-0.0012	0.0018	-0.0122	-0.0028
Wh. & ret. trade	-0.0032	-0.0033	-0.0158**	-0.0019	0.0018	-0.0104
Trans.& stor.	0.0229***	0.0035	0.0181*	0.0248***	-0.0201	-0.0084
Acc. & food serv.	0.0337***	0.0377***	0.0325***	0.0371***	0.0018	-0.0066
Real estate act.	-0.0318***	-0.0231**	-0.0232**	-0.0282**	0.0050	0.0080
Exporter	0.0099**	0.0054	0.0044	0.0121**	-0.0064	-0.0078
Tangibility	0.0001	-0.0000	-0.0001	0.0001	-0.0001	-0.0001
Debt-service cov. ratio (DSCR)						
Quartile 2	-0.0469***	-0.0331***	-0.0419***	-0.0510***	0.0163*	0.0131
Quartile 3	-0.0211***	-0.0134***	-0.0253***	-0.0220***	0.0083	-0.0006
Quartile 4	0.0061	-0.0015	0.0074	0.0058	-0.0071	0.0010
Loan variables						
Loan-to-value ratio (LTV)						
Quartile 4				-0.0003	-0.0032	0.0218
Loan maturity dummies						
Less than 1 year	0.0340	0.0286	0.0406			
From 1 to 5 years	0.0119***	0.0185***	0.0211***	0.0115***	0.0053	0.0070
D2022					0.0200	
D2023						-0.0259
Observations	9,108	8,694	8,046	26,976		

**** p<0.01, ** p<0.05, * p<0.1)*

Notes: The total sample of loans consists of the stock of CRE-collateral.loans to NFCs in the period 2016-2023. The NPE loan is a dependent var. and borrower and loan characteristics are explanatory var. In column 1, only loans in 2021, in column 2, only loans in 2022, and in column 3, only loans 2023 are included. In columns 5-7, we present a pooled regression for CRE-collateral. loans in 2021, 2022 and 2023 with interaction dummies. For the borrower variables, the omitted base category is 15 years or more for firm age, large firms for firm size, non-exporters for exporter status, NACE cat. A, B, D, E, J, M, N, O, P, Q, R and S for industry dummies and quartile 1 for the DSCR. For the loanvar., the omitted base categ. is quartile 1 for the LTV ratio, while LTV quartiles 2 and 3 were omitted due to collinearity and over 5 years for loan maturity. For the loans with no collateral, the LTV was set to zero in order to include these loans in the sample.

be more likely to have non-performing loan obligations. The results therefore show that, due to monetary tightening, debt servicing of loans using CRE as collateral became more difficult for small and medium-sized firms compared to large firms already by the end of 2023. With the increase of interest rates in 2022 and 2023, small and medium-sized firms appear to have become less resilient, and the burden of higher interest rates seems to have taken its toll on these firms already by the end of the second year of higher interest rates.

5.2.3 Non-performing CRE purpose exposures after monetary tightening

The results of the probit regression on the average marginal effects of probit estimates of NPE loans for CRE purpose loans are shown in Table 5.4. In CRE purpose loans, non-performing loan obligations seem to be closely related to borrower and loan characteristics. Column 3 shows that in 2023, the period of higher interest rates, non-performing loan obligations appear to be associated less with firms of up to 4 years of establishment and more with micro firms, while no relationship between firm size or firm age and non-performing loan obligation was found in the period of lower interest rates in 2021. The regression results in columns 1-3 also show that non-performing loan obligations seem to be associated less with lower DSCR (2nd and 3rd quartiles) and more with the highest DSCR (4th quartile). The results show the relationship between non-performing loan obligations and DSCR is non-linear and that borrower financial conditions have an important influence of firms' ability to repay loans. Dietsch and Welter-Nicol (2014) also note for the RRE market that the relationship between risk and LTV/DSTI ratios is not monotonic, as credit risk is highest close to the 100% LTV and 35% DSTI thresholds. Furthermore, the results show that in 2023, the year of high interest rates, non-performing loan obligations seem to be associated with the highest LTV ratios, while we did not find this to be the case for the period before monetary tightening. This shows that, in times of higher debt servicing burden, high LTV ratios also appear to be important in pointing out the vulnerable part of the CRE portfolio, for which banks already seem to account in their higher pricing of these loans (Table 5.1, column 6). Similarly, Mokas and Nijskens (2019) point out that CRE loans with higher LTV ratios have higher default probability.

In CRE purpose loans, the results of the pooled regression for 2023, the year of higher interest rates, and the other two years with interaction dummies (columns 4-6 in Table 5.4) indicate that the relationship with non-performing obligations observed in 2023, compared with the other two years, was significantly different for firms of up to four years of age and asset tangibility. For all other covariates, their association with non-performing obligations was not significantly different between the two periods. The results therefore show that in 2023, non-performing loan obligations appear to be associated less with asset tangibility, indicating that having more tangible assets, such as buildings, land and plant, reduces non-performing loan obligations at banks.

Table 5.4: Average marginal effects of Probit estimates of NPE loans for CRE purpose loans (predicted outcome: NPE loans for CRE purpose loans)

				2021-2023 pooled slope and intercept dummies		
	2021	2022	2023		2022 interaction dummies	2023 interaction dummies
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower variables						
Firm age dummies						
Age 0 to 4	-0.0010	-0.0078	-0.0495***		-0.0077	-0.0393***
Age 5 to 9	-0.0022	0.0070	0.0087	-0.0024	0.0103	0.0095
Age 10 to 14	-0.0025	-0.0010	0.0015	-0.0027	0.0016	0.0039
Firm size dummies						
Micro firms	0.0106	0.0038	0.0216**	0.0115	-0.0072	0.0062
Small firms	-0.0111	-0.0127*	0.0005	-0.0120	-0.0024	0.0124
Medium-siz. firms	0.0008	-0.0058	-0.0005	0.0008	-0.0073	-0.0013
Industry dummies						
Manufacturing	-0.0019	0.0000	0.0102	-0.0020	0.0021	0.0103
Construction	-0.0023	-0.0136	-0.0006	-0.0025	-0.0128	0.0020
Wh. & ret. trade	-0.0065	-0.0105	-0.0137	-0.0070	-0.0048	-0.0041
Trans. & stor.	0.0041	-0.0100	-0.0055	0.0045	-0.0158	-0.0089
Acc. & food serv.	0.0254***	0.0267***	0.0248***	0.0275***	0.0025	-0.0073
Real estate act.	-0.0169	-0.0077	-0.0137	-0.0183	0.0096	0.0071
Exporter	0.0110**	0.0019	0.0043	0.0119**	-0.0098	-0.0083
Tangibility	0.0002***	0.0001	-0.0001	0.0002***	-0.0001	-0.0003***
Debt-service cov. ratio (DSCR)						
Quartile 2	-0.0168***	-0.0163***	-0.0203***	-0.0182***	-0.0001	0.0016
Quartile 3	0.0002	-0.0024	-0.0124*	0.0002	-0.0029	-0.0103
Quartile 4	0.0106**	0.0004	0.0094	0.0115**	-0.0110	-0.0038
Loan variables						
Loan-to-value ratio (LTV)						
Quartile 2	-0.2340***	0.0011	0.0172***			
Quartile 3						
Quartile 4	0.0040	0.0023	0.0164***	0.0043	-0.0018	0.0090
Loan maturity dummies						
Less than 1 year	-0.2340***	-0.2297***		-0.2777***	0.0254*	
From 1 to 5 years	0.0045	0.0011	0.0172***	0.0049	-0.0037	0.0091
D2022					0.0207	
D2023						0.0102
Observations	6,599	5,939	5,152			

**** p<0.01, ** p<0.05, * p<0.1)*

Notes: The total sample of loans consists of the stock of CRE purpose loans to NFCs in the period 2016-2023. The NPE loan is a dependent var. and borrower and loan characteristics are explanatory var. In column 1, only loans in 2021, in column 2, only loans in 2022, and in column 3, only loans 2023 are included. In columns 5-7, we present a pooled regression for CRE purpose loans in 2021, 2022 and 2023 with interaction dummies. For the borrower variables, the omitted base category is 15 years or more for firm age, large firms for firm size, non-exporters for exporter status, NACE cat. A, B, D, E, J, M, N, O, P, Q, R and S for industry dummies and quartile 1 for the DSCR. For the loan var., the omitted base categ. is quartile 1 for the LTV ratio, while certain LTV quartiles 2 and 3 were omitted due to collinearity and over 5 years for loan maturity. For the loans with no collateral, the LTV was set to zero in order to include these loans in the sample.

We conclude this section by showing the results of the probit regression on the average marginal effects of probit estimates of NPE loans for all loans in the Appendix (Table A3). The results for all loans show that in 2023, non-performing loan obligations appear to be associated more with micro, small and medium-sized firms, while in 2021, they are associated less with small and medium-sized firms. Therefore our findings again show that, due to monetary tightening, debt servicing became more difficult for small and medium-sized firms (in both CRE-collateralized loans and all loans), while also for micro firms (in all loans) already by the end of 2023.

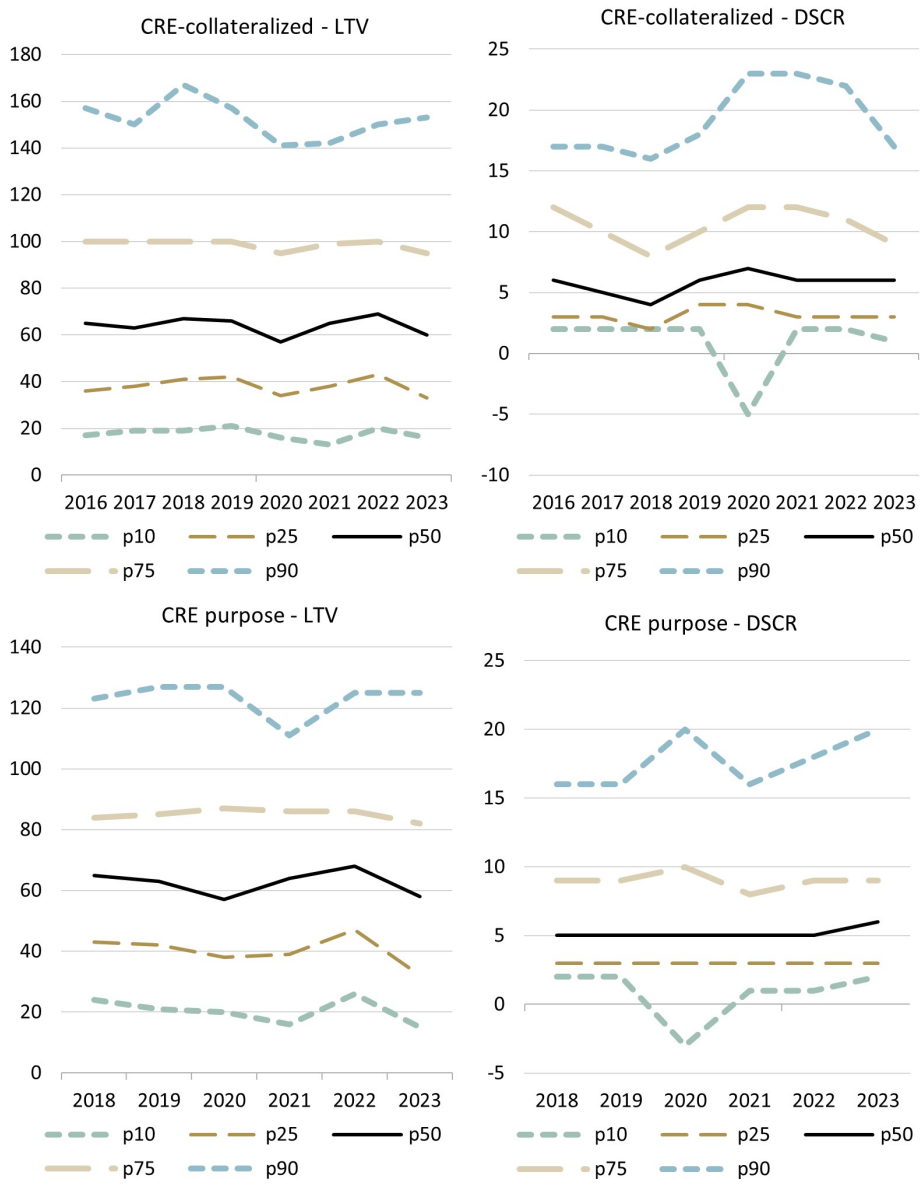
6 Macroprudential instruments for the commercial real estate market

6.1 Loan-to-value (LTV) ratio and debt service coverage ratio (DSCR) for the CRE market

As noted in the literature review, macroprudential instruments such as loan-to-value and debt service-to-income ratios are more widely used for the RRE sector, while the use of these instruments to tackle CRE risks remains limited. The CRE sector is more complex, making macroprudential instruments for this market more difficult to define and calibrate. In the CRE market, borrowers, the NFCs, are more heterogeneous than households on the RRE market, loans can rely on various types of collateral, each collateral being more frequently used for several loans, while in general, income is more steady for firms than for households. Nevertheless, following the LTV and the DSCR ratios for the CRE sector makes an important part of banks' monitoring of lending standards.

Figure 6.1 shows the evolution of the LTV ratio and DSCR for newly approved loans with CRE as collateral in the period from 2016 to 2023. The results show that the median value of CRE-collateralized loans was around 60%, while 25% of loans had an LTV ratio above 90%. Furthermore, 10% of these loans had an LTV ratio above 149%, making this part of CRE lending associated with extreme risk. However, banks also use other types of collateral when granting a loan, which can make the actual overall LTV ratio lower. Furthermore, 60% of bank lending to NFCs was approved without CRE as collateral, which makes these bank exposures even more vulnerable since if such a loan defaults, banks have no possibility for repayments as in the case of collateralized bank lending. We can see in Figure 6.1 that in 2023, for CRE-collateralized loans, the median value of borrowers' DSCR was 6%, while a quarter of these loans had the DSCR above 9%. Figure 6.1 also shows the evolution of the LTV and the DSCR ratios for CRE purpose loans, which shows a somewhat lower share of loans with higher LTV ratios compared to CRE-collateralized loans. It should be noted that the share of CRE purpose loans that

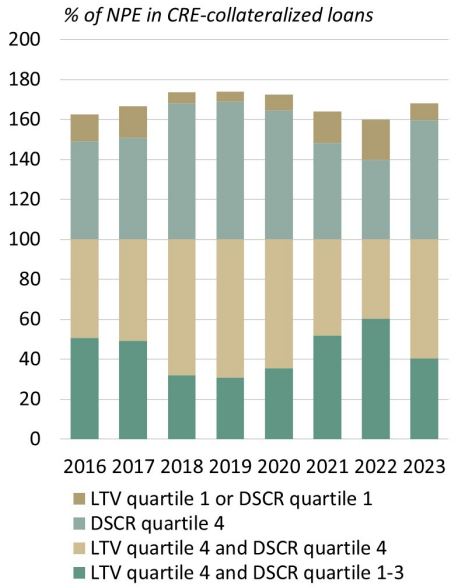
Figure 6.1: Loan-to-value (LTV) ratio (left) and debt service coverage ratio (DSCR) (right) for newly approved CRE-collateralized and CRE purpose loans



also pledged CRE as collateral in all loans stood at around 18% in 2023 (ranging from 16% to 22% from 2018 to 2023).

We next examine the LTV and DSCR ratios in non-performing loan obligations, where we focus on the two main channels of default: the net-worth channel and the cash-flow channel. To capture the two channels of default with our data, we proxy the net-worth channel with the LTV ratio, while we proxy the cash-flow channel with the DSCR. Figure 4 shows the share of NPE in CRE-collateralized loans with high LTV ratio, high DSCR, high both LTV and DSCR ratios, and low LTV and DSCR ratios. The results show that high LTV and DSCR ratios are clearly associated with higher risk of default. For example, in 2023, around 60% of the NPE had the highest LTV and highest DSCR ratios, while

Figure 6.2: Distribution of NPE with the loan-to-value (LTV) and debt service coverage ratios (DSCR) in CRE-collateralized loans



Note: Quartile 4 of the LTV and DSCR ratios refers to the highest LTV and DSCR ratios, while quartile 1 refers to the lowest LTV and DSCR ratios (in the distribution).

only 8.5% of NPEs had the lowest LTV and lowest DSCR ratios. In the appendix, in Table A3 we present the share of non-performing loans by LTV and DSCR quartiles, which shows that both highest LTV and highest DSCR are associated with a higher share of non-performing loan obligations. Our results show support for the existence of two main default channels, as noted by Mokas and Nijskens (2019), who proxied the two channels by the LTV ratio and with the level of current interest rates.

6.2 Simulation of the introduction of macroprudential instruments for the CRE market on bank lending

In the next set of calculations, we move away from the regressions presented earlier in this section and focus on two simple microsimulations to test the resilience of the exposure of banks in Slovenia to the CRE sector and study the potential for macroprudential policies to mitigate the risks inherent in the CRE market. First, we simulate the introduction of a macroprudential instrument, a cap on LTV ratio and a cap on DSCR, starting in January 2023, and calculate the simulated growth in NFC bank loans at the loan level in 2023 compared to 2022. We assume a situation where CRE loans with high LTV and DSCR ratios - above 100% and 80% or above 10 and 8 - were approved only at lower values of these ratios. For the cap on the LTV ratio, with an LTV limit of up to 100% or of up to 80%, we assume the volume of the loan is lower according to the cap on the LTV ratio while the value of the collateral stays the same. For the cap on the DSCR ratio, with a DSCR limit of up to 10 or of up to 8, we assume the volume of the loan is lower according

to the cap on the DSCR ratio. We then calculate the simulated growth in NFC loans at the loan level in 2023 compared to 2022.

Second, we simulate a fall in CRE prices due to a downturn on the CRE market and estimate a simulated growth in loans to the NFCs in such a situation. As noted, it is important for banks and financial stability authorities to monitor trends and developments on the CRE market. CRE lending tends to be more cyclical and volatile than RRE lending, while a decline in CRE prices can lead to defaults, which can in turn weaken banks' capital, as emphasized by several authors (ECB (2008), Whitley and Windram (2003), Davis and Zhu (2009), Benford and Burrows (2013)). Moreover, as noted by the ECB (2008), fluctuations in CRE prices can also have negative implications for the real economy and can indirectly impact banks' balance sheets. To examine the potential effect of a fall in CRE prices on bank lending, we therefore simulate a fall in CRE prices in 2023 compared to 2022, by 5% and 10%, and calculate a simulated growth in NFC bank loans at the loan level in 2023 compared to 2022. We assume the LTV ratio stays the same, so the value of the collateral decreases according to the fall in CRE prices - by 5% and 10% -, which makes the volume of the loan that the banks granted firms decrease by the same amount. We then calculate the simulated growth in NFC bank loans at the loan level in 2023 compared to 2022.

Table 6.1: Simulation of the effect of the introduction of macroprudential restrictions, a cap on LTV and DSCR ratio, and a fall in commercial real estate prices on bank lending

	Credit growth 2022/2023		
Bank lending by CRE categories	All loans	CRE-collater. loans	Loans with CRE purpose
Original data with original LTV and DSCR ratio	-5.3	-2.9	-6.4
LTV set to			
100%	-11.6	-18.1	-17.6
80%	-12.9	-21.2	-19.4
DSCR set to			
10	-6.1	-4.0	-7.6
5	-10.2	-8.6	-11.4
CRE prices fall for			
5%	-9.2	-12.3	-9.9
10%	-13.2	-21.8	-16.9

The results in Table 6.1 show that, according to the original data in the sample, loans to all firms fall by 5.3% in 2023 compared to 2022. If the LTV cap had been set to 100%, CRE-collateralized loans would fall by 18.1%, while loans with CRE purpose would fall by 17.6%. If even stricter macroprudential restrictions were set with the LTV cap at 80%, the fall in credit growth would be even larger. Under the second assumption, where the

cap on DSCR was set to 10 or 5, CRE-collateralized loans would fall by 4%, while loans with CRE purpose would fall by 7.6%. If even stricter macroprudential restrictions were set with the DSCR cap at 5, the fall in credit growth would be even larger. Under the third assumption, where CRE prices fall by 5-10% and the LTV ratio stay the same, the fall in credit growth would also be much larger than in the actual data.

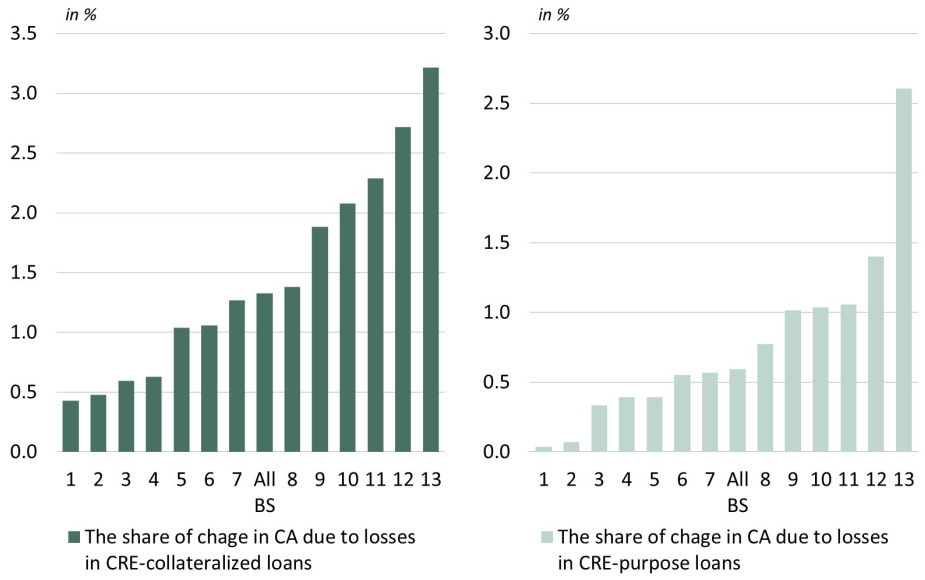
The results confirm findings from the literature that a tightening of macroprudential instruments or a fall in CRE prices can lower credit growth to firms considerably. For example, Cerutti et al. (2015) find macroprudential instruments for the RRE market generally associated with lower credit growth, while Kelly et al. (2015, 2017) find that macroprudential tools play an important role in cooling a rapidly growing RRE market. For example, Ćirjaković (2018) simulates the impact of the introduction of LTV, LTI and DSCR ratio caps for the CRE market in Slovenia, based on Kelly et al. (2015, 2017), and finds that tightening of macroprudential instruments can reduce both the available credit and prices on the market. Furthermore, Ćirjaković (2018) also find that a tightening of macroprudential instruments can reduce credit availability, while when applying for a loan, firms seem to be constrained mostly by their income. As noted, the relationship between credit markets and business cycles has been widely studied in the literature (Bernanke and Gertler (1989), Bernanke et al. (1999)), while Kiyotaki and Moore (1997) observe that when asset prices increase, collateral values increase, which increases firms' borrowing capacity. Therefore, with a fall in CRE prices, the value of commercial real estate pledged as collateral would fall, which would in turn reduce borrowing capacity. It should also be noted, as the IMF (2016) point out, that during a downswing, as corporate defaults rise and collateral values fall, there is additional downward pressure on prices, which in turns reinforces the downward spiral.

6.3 Simulation of an increase in risks on the CRE market and the effect of losses in CRE lending on bank resilience

Next, we explore how an increase in non-performing exposures and losses on CRE lending with riskier LTV and DSCR ratios due to increased risks in the CRE market, for example a fall in CRE prices, would affect bank resilience in Slovenia, similarly to Jiang et al. (2023). We observe bank resilience with capital adequacy, calculated as the ratio between regulatory capital and total risk exposure amount. We assume losses would occur on riskier CRE lending, i.e. lending with higher LTV or DSCR ratios. We define riskier LTV loans as loans where the current value of the loan exceeds the current assessed value of the real estate, resulting in an LTV ratio exceeding 100%. We also look at the capacity of these borrowers to meet their debt obligations, the DCSR, and assume that those firms with loans with DSCR in the 4th quartile of the distribution would not be able to meet their obligations, so these loans are considered as riskier DSCR loans. Loans meeting either

of the two conditions are assumed to be additional non-performing loans to the existing ones. We assume that this (additional) non-performing exposure for each bank had not had impairments on these loans prior to becoming non-performing. Next, we assume that banks are able to get 70% of the value of the loan through the collateral, so 30% of the value of the loan is assumed as a loss for the bank. This loss is then subtracted from the regulatory capital of each bank. To estimate the fall in the resilience of each bank, we calculate capital adequacy for each bank at the end of 2023 and compare it to simulated capital adequacy. We calculate simulated capital adequacy for CRE-collateralized and CRE purpose lending and compare it to capital adequacy prior to simulation (Figure 6.3). In the Appendix, Figure A1 shows the results of the simulation for all bank lending.

Figure 6.3: Simulation of the fall in capital adequacy due to losses from CRE-collateralized and CRE purpose lending, December 2023



Note: The individual bars show results for individual (anonymized) banks. The bar flagged "all BS" shows results for the Slovene banking system as a whole.

Figure 6.3 shows a simulation of the fall in capital adequacy due to losses in CRE lending with riskier LTV and DSCR ratios. The individual bars show results for individual banks, while the bar flagged "all BS" shows results for the Slovenian banking system as a whole. On the left, Figure 4 shows that, due to losses on CRE-collateralized loans, capital adequacy in the Slovenian banking system would decrease by 1.3 p.p., while ranging between 0.4 and 3.2 p.p. for individual banks. On the right, Figure 4 also shows that, due to losses on CRE purpose loans, capital adequacy in the Slovenian banking system would decrease by 0.6 p.p., while ranging between 0.04 and 2.6 p.p. for individual banks. The results show that no bank would be in the position of a solvency run in such a simulation. In a simulation of an increase in non-performing exposures and losses on CRE lending, we therefore find that banks' capital adequacy may fall only slightly, which would not significantly threaten banks' solvency. In a similar microsimulation for the US, Jiang et al.

(2023) find that after declines in the value of CRE, higher interest rates and a rise in hybrid work, CRE distress could induce over 300 mainly smaller regional banks to be at risk of solvency runs. On the other hand, for the EU, Daly et al. (2024) point out that CRE lending accounts for only 6% of euro area bank assets and is unlikely to threaten the solvency of the banking system.

7 Conclusions

Past financial crises have shown that adverse developments in the CRE markets can lead to substantial losses for the financial system. This stresses the need for policymakers to monitor both developments on the market and the banking system exposures to CRE, with a further aim of implementing measures to mitigate associated risks. In Slovenia, the financial crisis of 2008-2009 led to the bankruptcy of many construction firms, while banks suffered substantial losses in the aftermath of the crisis. Over the past decade, however, bank lending related to CRE and firm indebtedness have declined considerably, and banks' capital and liquidity positions remain robust. It is nevertheless crucial for policymakers to continue monitoring financial stability risks arising from the CRE market.

This paper examines the resilience of the banking system's exposure to the CRE market in Slovenia during a period marked by significant shocks: the COVID-19 pandemic and the tightening of monetary policy. We utilize loan-level data on bank lending to firms, coupled with borrower characteristics, to explore whether bank behaviour differs between lending using CRE as collateral and lending for CRE purpose, i.e. the purchase and renovation or construction of real estate, compared to other lending to firms. Our results show that lending using CRE as collateral forms an important share of banks' lending and is widespread through economic sectors, while it is not only for CRE purposes. Developments on the CRE market can therefore have an important impact on overall economic activity.

Out results indicate that banks price loans using CRE as collateral and CRE purpose loans with higher DSCR less favourably than other loans, and correctly so, since these loans appear to be associated with non-performing loan obligations. This suggests that banks identify high risk related to these loans, as they are higher priced. Moreover, the tightening of monetary policy had made debt servicing more challenging, particularly for small and medium-sized firms with CRE-collateralized loans, already by the end of 2023. Our results also show that if banks incurred losses on CRE lending with riskier LTV and DSCR ratios due to increased risks on the CRE market, banks' capital adequacy should fall only slightly, which is unlikely to threaten the solvency of the banking system. This suggests banks could continue providing firms with sufficient financing also in CRE-related crisis periods.

Our findings point to the importance for policymakers of monitoring developments on the CRE market. The results suggest that high LTV and DSCR ratios can point to the vulnerable part of the CRE portfolio, for which banks already seem to account in their higher loan pricing, indicating these ratios could well be used as macroprudential measures for the CRE market. These findings are important for the development of the macroprudential policy framework, while they also show that the introduction of macroprudential instruments could reduce credit growth to firms considerably. Policymakers therefore need to put a lot of care and consideration into the calibration of the indicators when implementing these measures, also due to the complexity and versatile nature of the CRE market.

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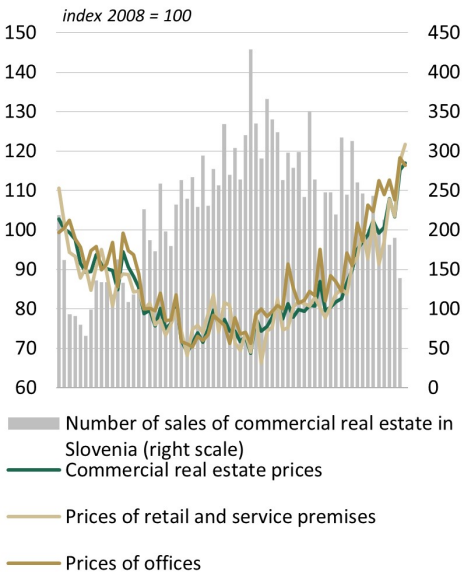
Appendix

Figure 1: Commercial real estate prices and number of sales in Slovenia



Source: SORS

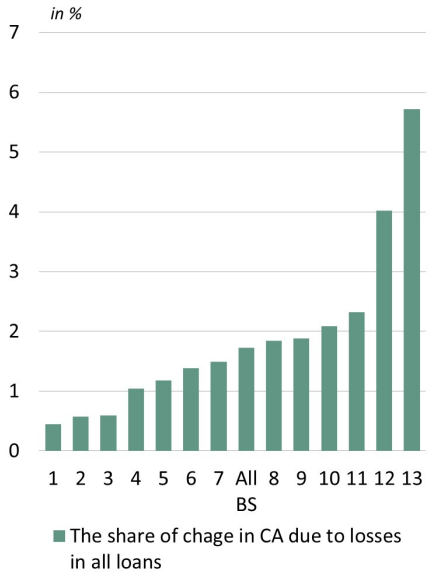
Table 1: Definition of explanatory variables entered in the regression equations

Borrower characteristics	
Firm age	Number of years in operation since establishment. Classified into four groups: 0-4 years, 5-9 years, 10-14 years, 15 years or more. Entered in the equation as three dummy var., with the 15 years or more categ as the omitted base categ.
Firm size	Classified into four groups (micro, small, medium-sized and large) on the basis of satisfying any two of the three criteria on number of employees, annual turnover and value of assets (see section on Data). Entered in the equation as three dummy variables, with large firms as the omitted base category.
Industry affiliation	Entered in the equation as six dummy var., NACE class.: Manufacturing (C), Construction (F), Wholesale and retail trade (G), Transport and storage (H), Accomm. and food service act. (I), nd Real estate act.(L). All other activities (A, B, D, E, J, M, N, O, P, Q, R and S) are grouped together into Other and constitute the omitted base category.
Exporter status	Firms are classified as exporters depending on the share of sales to other EU countries and non-EU countries in total sales. Firms are classified as exporters if the share is more than 10%. Exporter status is used as a dummy variable with 1 = exporters and 0 = non-exporters.
Asset tangibility	Measured as the ratio of tangible fixed assets to total assets, in %.
Debt service coverage ratio (DSCR)	Based on the information on firm debt, interest paied and EBITDA, we calculate the DSCR for each firm as debt servicing relative to the borrowers' income. The DSCR was put into classes (quartiles of the DSCR of each loan) and introduced as a dummy variable.
Loan characteristics	
Loan maturity	Loan maturity is defined at origination and corresponds to the due date of the last loan installment. Classified into three groups (less than 1 year, 1-5 years, over 5 years). Entered in the equation as two dummy variables, with over 5 years the omitted base category.
Interest rate spread	The interest rate is defined at origination for each loan (fixed or variable rate). Interest rate spread is calculated for new loans only. For variable rate loans, the loan spread is reported, while for fixed rate loans we calculate loan spread as the difference between the contractual interest rate of the loan and the average value of the 6-month EURIBOR in the month of the loan approval.
Loan-to-value LTV) ratio	Calculated as the volume of the loan divided by the amount of the collateral, in percent. It was put into classes (quartiles of the LTV ratio of each loan) and introduced as a dummy variable. The first quartile is set as the omitted base category.
Non-performing loan obligations (NPE)	Loan obligations are classified as non-performing if they satisfy either or both of the following criteria: (a) loan obligations which are more than 90 days past due; (b) the debtor is assessed as unlikely to pay its loan obligations in full without realization of collateral, regardless of the existence of any past-due amount or of the number of days past due. Entered in the equation as a dummy variable equal to 1 if the firm had non-performing loan obligations or equal to 0 if the firm did not have such obligations.

Table 2: Descriptive statistics for the stock of loans to NFCs by borrower and loan characteristics, December 2023

	All loans		Loans, using CRE as collateral		Loans with CRE puprose	
	Mean	Standard deviation	Mean	Standard deviation	Mean	Standard deviation
Borrower characteristics						
Firm age dummies						
Age 0 to 4	0.0877	0.2829	0.0651	0.2468	0.0840	0.2774
Age 5 to 9	0.1697	0.3754	0.1396	0.3466	0.1611	0.3677
Age 10 to 14	0.1682	0.3740	0.1812	0.3852	0.2177	0.4127
Firm size dummies						
Micro firms	0.3889	0.4875	0.3204	0.4667	0.3460	0.4757
Small firms	0.3549	0.4785	0.4653	0.4988	0.4349	0.4958
Medium-sized firms	0.0850	0.2789	0.1242	0.3298	0.1049	0.3064
Industry dummies						
Manufacturing	0.2023	0.4017	0.2889	0.4533	0.2380	0.4259
Construction	0.1268	0.3328	0.0874	0.2824	0.0874	0.2825
Wholes. & retail trade	0.2338	0.4233	0.1665	0.3725	0.1266	0.3326
Transport & stor.	0.0842	0.2778	0.0516	0.2213	0.1145	0.3184
Accomm. & food serv.	0.0406	0.1973	0.0927	0.2900	0.0820	0.2744
Real estate act.	0.0020	0.0449	0.0038	0.0616	0.0042	0.0645
Exporter	0.2980	0.4574	0.2807	0.4494	0.2808	0.4495
Tangibility	34.3625	25.2338	46.5077	27.2021	48.0032	27.0187
Debt service coverage ratio (DSCR)	-4660	1263600	29.59	1855	-65891	4742829
Loan variables						
Loan-to-value ratio (LTV)	216	43673.30	1958	131438	2053	149123.70
Loan maturity dummies						
Less than 1 year	0.1147	0.3187	0.0022	0.0468	0.0022	0.0466
From 1 to 5 years	0.2611	0.4393	0.1733	0.3785	0.2155	0.4112

Figure 2: Simulation of the fall in capital adequacy due to losses from CRE lending for all loans, December 2023



Note: The individual bars show results for individual (anonymized) banks. The bar flagged "all BS" shows results for the Slovene banking system as a whole.

Table 3: Average marginal effects of Probit estimates of NPE loans for all loans (predicted outcome: NPE loans for all loans)

				2021-2023 pooled slope and intercept dummies		
	2021	2022	2023		2022 interaction dummies	2023 interaction dummies
	(1)	(2)	(3)	(4)	(5)	(6)
Borrower variables						
Firm age dummies						
Age 0 to 4	0.0067***	0.0030	-0.0030	0.0072***	-0.0037	-0.0097***
Age 5 to 9	0.0060***	0.0118***	0.0081***	0.0064***	0.0073***	0.0003
Age 10 to 14	0.0052***	0.0065***	0.0065***	0.0055***	0.0020	-0.0001
Firm size dummies						
Micro firms	0.0009	0.0030	0.0413***	0.0010	0.0025	0.0333***
Small firms	-0.0188***	-0.0133***	0.0140***	-0.0200***	0.0045	0.0317***
Medium-siz. firms	-0.0206***	-0.0147***	0.0165***	-0.0220***	0.0050	0.0357***
Industry dummies						
Manufacturing	-0.0010	0.0013	0.0065***	-0.0011	0.0026	0.0065**
Construction	-0.0004	0.0050***	0.0086***	-0.0004	0.0062**	0.0076***
Wh. & ret. trade	-0.0052***	-0.0039**	0.0015	-0.0055***	0.0010	0.0068***
Trans. & stor.	0.0203***	0.0100***	0.0154***	0.0217***	-0.0101***	-0.0089***
Acc. & food serv.	0.0204***	0.0205***	0.0247***	0.0218***	0.0021	-0.0012
Real estate act.	-0.0139***	-0.0069	0.0028	-0.0149***	0.0068	0.0172**
Exporter	0.0028**	-0.0011	0.0045***	0.0030**	-0.0043**	0.0007
Tangibility	-0.0000	-0.0000	-0.0002***	-0.0000	-0.0000	-0.0001***
Debt-service cov. ratio (DSCR)						
Quartile 2	-0.0228***	-0.0147***	-0.0244***	-0.0243***	0.0072***	0.0041
Quartile 3	-0.0138***	-0.0059***	-0.0245***	-0.0147***	0.0079***	-0.0056**
Quartile 4	0.0026*	-0.0013	0.0006	0.0028*	-0.0044**	-0.0023
Loan variables						
Loan-to-value ratio (LTV)						
Quartile 4	0.0027**	0.0066***	0.0019	0.0029**	0.0047**	-0.0013
Loan maturity dummies						
Less than 1 year	-0.0121***	-0.0043**	-0.0225***	-0.0129***	0.0079**	-0.0058*
From 1 to 5 years	0.0038***	0.0046***	-0.0031**	0.0041***	0.0012	-0.0066***
D2022					-0.0089**	
D2023						-0.0179***
Observations						

**** p<0.01, ** p<0.05, * p<0.1)*

Table 4: Share of NPE in all loans by LTV ratio and DSCR for CRE-collateralized loans, by firm size and firm sector in December 2021 and December 2023

	Loan-to-value ratio (LTV)				Debt service cov ratio (DSCR)			
in the % of all loans	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
All firms								
2021	1.5	2.1	1.6	2.4	3.6	0.5	2.0	2.7
2022	4.1	1.8	1.3	2.2	1.9	0.8	1.4	6.0
2023	3.3	2.9	2.5	2.9	3.4	0.1	1.3	3.2
December, 2021								
Firm size								
Micro firms	4.3	3.7	1.3	9.8	12.1	0.4	1.6	3.5
Small firms	1.4	1.2	2.3	4.2	2.2	0.3	1.7	2.8
Medium-sized firms	1.5	1.9	2.1	1.4	0.0	0.0	2.5	3.7
Large firms	0.0	2.4	0.1	0.6	0.0	0.0	0.0	3.1
Firm sector								
Manufacturing	1.8	0.5	1.0	0.7	0.2	0.1	0.7	1.4
Construction	5.7	0.7	0.4	1.9	0.1	1.5	0.4	2.0
Wholes. & Trade	0.4	1.0	2.2	3.7	1.1	0.4	0.0	4.0
Transport & storage	3.0	0.0	5.2	2.5	13.5	0.0	4.1	2.1
Accomm. & food serv.	2.3	8.1	7.8	14.7	9.9	0.2	2.8	14.9
Real estate	0.2	1.0	0.1	0.1	9.6	0.0	0.0	0.1
Others	0.7	2.3	2.1	3.7	4.6	0.0	2.4	2.7
December, 2023								
Firm size								
Micro firms	5.6	3.3	1.4	1.0	2.8	1.7	1.8	3.2
Small firms	0.7	2.7	1.2	3.7	2.1	0.5	2.4	3.4
Medium-sized firms	10.9	2.0	0.4	3.1	2.3	2.5	1.7	6.3
Large firms	0.0	3.1	6.7	2.7	0.0	0.0	0.0	12.9
Firm sector								
Manufacturing	3.2	3.8	4.7	3.8	1.3	1.1	0.3	14.3
Construction	0.5	8.9	0.3	0.2	1.0	0.0	8.6	0.8
Trade	0.8	0.4	2.0	4.2	1.1	0.0	0.3	3.0
Transport and storage	1.7	2.6	0.4	8.4	10.6	1.8	0.3	5.2
Accomm. and food serv.	8.2	5.1	2.6	6.9	10.5	0.8	3.0	13.8
Real estate	0.3	0.7	0.0	0.0	2.1	0.0	0.0	0.1
Others	0.3	0.7	0.0	0.0	0.7	0.8	2.3	3.1