BANKA SLOVENIJE

EVROSISTEM

MACROPRUDENTIAL INSTRUMENTS AND THE COMMERCIAL REAL ESTATE MARKET

Jelena Ćirjaković

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Abstract

We simulate the impact of the introduction of macroprudential instruments, the loan-to-value (LTV), the loan-to-income (LTI) and the debt-service-ratio (DSR) for firms on the commercial real estate market. We use loan-level data on bank loans to firms for commercial property and firm financial statements data to construct a measure of firm credit availability that is determined by the credit standards ratios at the loan level. Then, we suggest a price model and use the coefficients from the model to measure the impact of various scenarios of the instruments on credit availability and property prices. The results show that firms are constrained mostly by their income when applying for a loan. The results also suggest that a tightening of macroprudential instruments can reduce both the credit availability and prices on the commercial real estate market. However, we find important limitations in using the LTV, LTI and DSR limits as macroprudential instruments for firms when addressing the risks on the commercial real estate market. The loan-level indicators should be complemented by firm-level indicators when setting up macroprudential policy for the commercial real estate market.

1. Introduction

Macroprudential instruments are set as a part of macroprudential policy with a key aim to contribute to the stability of the financial system. Macroprudential instruments, currently available in the European Union for addressing the risks arising from the real estate market are capital-based measures, targeting the capital structure of credit institutions[1] and measures, targeting the borrowers, that restrict the granted loan in regards to the value of the real estate or the borrower income and requirements on loan maturity and amortisation. These instruments aim to "prevent and mitigate excessive credit growth and leverage", dampen the pro-cyclical effects of the real estate markets and in turn enhance the resilience of both credit institutions and borrowers to possible financial shocks (ESRB, 2013; ESRB, 2016).

In the last years, it has become increasingly common for the regulatory authorities in the European Union to set borrower-based macroprudential instruments for the housing market. Both the loan-to-value ratios and income-based ratios are often set in order to decrease the likelihood of default and the losses given default at banks as well as the probability of default of the borrowers through ensuring that the borrower can sustainably service the repayment of the loan. The risks on the commercial real estate (CRE) market are currently most often addressed by capital-based measures[2], however a few countries introduced borrower-based measures, especially the limits to the loan-to-value ratio (ESRB, 2017). Due to an increasing use of macroprudential instruments for the real estate markets, understanding the link between macroprudential policy, credit allocation and the real estate markets is of significant importance to financial stability in the European Union.

A large body of research links credit flows to house prices, however only more recent literature attempts to measure the impacts of borrower-based macroprudential measures in the housing market. The authors (Claessens et al., 2013, Jacome and Mitra, 2015) find borrower-based measures, such as the loan-to-value and debt-service-to-income ratios effective in reducing housing credit growth, but not always in curbing housing price growth. Furthermore, studies mostly use cross-country or single country macroeconomic data, loosing the complexity of micro-data variation across borrowers, missing the borrower-specific variations and heterogeneous impacts across different borrowers. An exception are two studies that do test the impact of macroprudential instruments based on micro-data on borrowers in the housing market; Igan and Kang (2011) and Kelly et al. (2015, 2017). Kelly et al. is the first research to use micro-data to link credit supply, macro-prudential instruments and house prices. The authors use loan-level data on mortgages from 2003 to 2010 in Ireland and find the introduction of macroprudential measures would have had substantial impacts on house prices and stress the importance of both the level at which they are set and the timing of their introduction. The existing literature on the macroprudential measures in the CRE market is still scarce.

Macroprudential instruments, that address the risks arising from the CRE market are limits to the loan-to-value (LTV) ratios, the loan-to-income (LTI) ratios, debt-service-coverage ratio (DSR) and interest-coverage ratio (ICR) (with debt-service-to-income (DSTI) as equivalents for the housing market). The choice of macroprudential instruments and their calibration is more complex when it is used for the CRE market in comparison to the housing market. For example, the heterogeneity of the CRE and a small market size in Slovenia are factors in considerable price volatility, as individual large contracts

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[1] sectoral capital requirements through higher risk weights or losses given default floors for exposures secured by the real estate or general tools, such as the countercyclical capital buffer (CCB), systemic risk buffer (SRB) or adjustments to Pillar II capital requirements

[2] In 2007, the Bank of Slovenia introduced a stricter criteria of 50% risk weights for exposures secured by mortgages on commercial property, based on a standardised approach (for banks and savings banks, including branches of foreign banks from the EEA based on Article 125(2)(d) of the CRR)

have a significant impact on the prices and can in turn influence the LTV ratios. Furthermore, as households typically have a positive and by large a stable income, firm income is more volatile and can be negative, which can have a considerable influence on the income-based ratios. Moreover, credit institutions assess household and firm creditworthiness differently, as they in greater extent look also at other firm indebtedness indicators, other real estate and assets, which can influence their decision to grant a specific loan. Furthermore, there are considerable data gaps for the CRE markets making a proper monitoring of the risks on the market difficult.

Monitoring developments on the CRE market is of crucial importance to the financial stability. In Slovenia, firm indebtedness increased rapidly in the pre-crisis period, peaking in 2008. Following the onset of the crisis, bank's ability to continue lending to firms decreased along the tightening of the credit standards. An abrupt shrinkage of financing possibilities left firms financially constrained and in turn reduced their profitability, investment growth and survival prospects, which led to a sharp fall in the economic activity. Banks being reluctant to take up additional credit risk and not renewing many firm bank loans from the past, left many firms unable to repay their loans and the banking system with a raising number of non-performing loans and large credit losses. Firms in construction and real estate related activities, the key borrowers of loans for the CRE, were particularly hit by the last crisis. From a peak in 2008, firm indebtedness has come down significantly. Firms had to go through a process of considerable deleveraging, that influenced their decisions to invest in the CRE, resulting in low liquidity on the market. However, up to now, firms deleveraged to a pre-crisis level, are less burdened by debt and more open for investments. The current favourable economic situation and the low interest rates environment can further contribute to a gradual reversal to growth in prices and volume on the CRE market.

The key aim of the paper is to study the impact of a hypothetical introduction of borrower-based macroprudential measures on credit availability and prices on the CRE market in Slovenia. In doing so, we use loan-level data on the reporting of all monetary financial institutions in Slovenia from the Bank of Slovenia. From the reporting, we use data on all loans, granted to non-financial firms for the CRE with information on the value of the loan, the value of the collateral, interest rate and maturity. In addition, we use firm financial statements and business register data from AJPES[3]. Firm financial statements provide annual data on balance sheet item such as assets, liabilities (loans and creditors), as well as profit and loss accounts, such as EBITDA and interest paid.

In the paper we apply the methodology developed by Robert Kelly, Fergal McCann and Conor O'Toole (2015, 2017) on the impact of a macroprudential intervention in the housing market on credit supply and house prices. The original methodology is set for the housing market, however we adapt it to suit the CRE market framework. First, we construct a measure of firm credit availability that varies at the firm level and is determined by the prevailing credit standards LTV, LTI and DSR at the loan level. Second, we suggest a CRE price model and use the coefficients from the model to measure the impact of various possible scenarios of macroprudential restrictions of the LTV, LTI and DSR, on credit availability and property prices. In the paper, we first considered using firm-level indicators as macroprudential measures, instead of loan-level indicators and tested several other indicators as a possible credit standards ratios for firms on the CRE market, such as debt-to-assets, financial debt-to-EBITDA[4] and interests to EBITDA. In order to best suit the methodology, in the paper, we use loan-level indicators for credit standards ratios instead of firm-level indicators. Our definitions are the

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[3] AJPES stands for Agency of the Republic of Slovenia for Public Legal Records and Related Services
[4] EBITDA stands for Earnings before interest, tax, depreciation and amortisation

following: LTV is the value of the loan to the value of collateral (where collateral refers to CRE, RRE and other collateral), LTI is the value of the loan to a 3-year-average EBITDA and DSR is the yearly repayments of the loan (principal and interests, taking into account the value of the loan, the maturity term and the annual interest rate of the loan) to a 3-year-average EBITDA.

To preview the findings, the results of a simulation of an introduction of macroprudential measures on the CRE market suggest that the tightening of macroprudential instruments LTV, LTI and/or DSR can reduce both the credit flows and prices on the CRE market. The results also show the income-related restrictions have a greater impact as the LTV constraints. Furthermore, the level at which instruments are set in regards to the prevailing market conditions is crucial to assess the magnitude of the possible impact on credit flows and prices on the CRE market. However, we find important limitations in using the LTV, LTI and DSR limits as macroprudential measures for firms when addressing the risks on the CRE market. The loan-level indicators should be complemented by firm-level indicators on firm performance when setting up macroprudential policy for the CRE market.

The main contribution of the paper to the literature is that this research is to our knowledge one of the first attempts to understand the calibration of macroprudential instruments, LTV, LTI and DSR for firms on the CRE market and the impacts of the introduction of instruments on credit availability and prices on the CRE market. This research represents a novelty in assessing the impacts of the macroprudential approach to mitigating risks stemming from the CRE market given a novelty of the methodology (and also adapting it for the CRE market) and of the CRE data usage. In the paper, we use granular data at the loan-level on the bank loans to firms for CRE with the value of the collateral, the loan interest rates and maturity and micro-link it with data on firm assets and cash flows. In this view, results on the impact of the introduction of macroprudential instruments on the CRE market in Slovenia should be interpreted with caution.

The paper is structured as follows: Chapter 2 presents a literature review, Chapter 3 discusses data sources, Chapter 4 presents the methodology, Chapter 6 presents the results of the simulation of the introduction of macroprudential measures and Chapter 7 concludes.

2. Literature review

Several years ago, Galati and Moessner (2011) found limited empirical analysis on the effectiveness of macroprudential tools and difficulties in obtaining data for the empirical work on macroprudential tools. The authors stressed the importance of studying the effectiveness of macroprudential tools, including quantifying the effect of macroprudential policy (MPP) instruments on credit growth, leverage, asset prices, and asset price bubbles. Furthermore they made an assessment of data that should be collected and of empirical analysis on the effectiveness of macroprudential tools in avoiding financial instability. Up to now, the effectiveness and the impact of macroprudential measures has been documented in a small but fast evolving body of research.

Various studies have looked into the link between credit flows and house prices and mostly found a positive correlation between bank lending and real estate property prices (Duca et al., 2011b; Fitzpatrick and Mcquinn, 2007; Gerlach and Peng, 2005; Avouyi-Dovi et al., 2014, Lindner, 2014). However, these studies do not test the impact of the introduction of macroprudential measures on credit flows and real estate prices, which is the focus of our research. In the more recent literature, several studies do attempt to measure the impact of macroprudential measures to house prices by using cross-country or single country macroeconomic data (Kuttner and Shim, 2013; Cerutti et al., 2015). Kuttner and Shim (2013) use a cross country panel data from 57 countries to test the effectiveness of

non-interest rate policy tools, including macroprudential measures, in stabilising house prices and housing credit. They find credit growth significantly affected by changes in the maximum debt-service-to-income (DSTI) ratio, the maximum LTV ratio, limits on exposure to the housing sector and housing-related taxes. But only the DSTI limit has a significant effect on housing credit growth when valid econometric techniques are used. Depending on the method used, an incremental tightening in the DSTI ratio is associated with a 4 to 7 p.p. deceleration in credit growth over the following year. Cerutti et al. (2015) measure the effectiveness of macroprudential instruments in dampening credit and financial cycles by using a cross-country panel data. They find macroprudential instruments generally associated with lower credit growth, in particular for households, suggesting that MPPs have significant mitigating effects on credit developments. As noted, a limitation of these studies is that they only aggregate data to study the impact of macroprudential measures in the housing market. In such a way, studies lose the complexity of micro-data variation across borrowers and miss the borrower-specific variations and heterogeneous impacts across different borrowers.

Our work, as noted in Kelly et al. (2015), complements a broader research, which have studied the link between MPP and financial outcomes at the aggregate level, without looking specifically at the impact on house prices. Such studies include Claessens et al. (2013) and Jacome and Mitra (2015). By using panel data regressions at the bank-country level in the period 2000-2010, Claessens et al. (2013) find borrower-based measures, such as DSTI and LTV ratios effective in reducing asset growth. Jacome and Mitra (2015) study the use of LTV and DTI measures in six different countries and find growth in high-LTV loans with long maturities or in the number of borrowers with multiple mortgages can be signs of build-up in systemic risk. They stress monitoring non-performing loans by loan characteristics can help in calibrating changes in the LTV and DTI limits. They find LTVs and DTIs in most cases effective in reducing loan-growth and improving debt-servicing capacity of borrowers, however not always in curbing house price growth.

An exception to the above mentioned studies are two studies that do test the impact of macroprudential instruments based on micro-data on borrowers; Igan and Kang (2011) and Kelly et al. (2015, 2017). Igan and Kang (2011) use survey micro-data to examine the impact of LTV and DTI limits in Korea and find them associated with a decline in house price appreciation and transaction activity. Furthermore, tighter limits curb house price expectations, which play a key role in bubble dynamics. Kelly et al. (2015, 2017) provide a micro-empirical link between a large literature on the credit flows and house prices and the growing literature on MPP. It is the first research to quantitatively estimate the impact of the introduction of various possible MPP restrictions scenarios on house prices in the housing market. The authors use loan-level data on Irish mortgages from 2003 to 2010 to measure the impact of the restrictions on house prices in Ireland, where they impose two separate regimes and then apply these regimes at periods of tighter and looser market conditions. The model estimates that the Regime 1 in 2003 (75 LTV, 4 LTI and 37 DSR) would have led to a fall in average house prices from observed levels of 6.4 per cent after four quarters. During the high-growth period of 2006, this regime would have led to one-year falls of 12.1 per cent. The less restrictive regime, Regime 2 (85 LTV, 4.5 LTI and 45 DSR) is estimated to have a one-year effect of just over 1 per cent when switched on in 2003, with this effect rising to 8.7 per cent when switched on in 2006. The findings therefore imply an important role for MPP in cooling a rapidly growing housing market. Authors stress the importance of the choice of the macroprudential instruments as well as the specific calibration of the parameters. They find in Ireland LTI in general a more binding instrument than LTV and DSR, however that is reversed when a tighter cap on LTV and DSR is introduced. Furthermore, they find that the point in the credit cycle when calibrating instruments is important; macroprudential measures would have a smaller impact in tighter market conditions (earlier in the credit cycle, before the peak). The results

suggest that it may be beneficial to introduce the instruments away from the peak of the housing cycle; if introduced in the period of weak house price growth, it may bolster borrower and lender resilience to future shocks, without large impact on housing values.

Finally, as noted in Kelly et al. (2015), our paper looks at the studies that provide a micro-level evidence of a causal effect of credit on house price (Favara and Imbs, 2015; Di Maggio and Kermani, 2014; Adelino et al., 2012; Labonne and Welter-Nicol, 2015). We build on this research by linking credit to house prices at the loan-level to obtain a credit-house price elasticity that is further used in our macroprudential assessment.

The above mentioned literature is however related only to one segment of the real estate market; the housing market. Our work looks specifically at firms on the CRE market. The existing body of research on the CRE market is still scarce. The impacts of macroprudential measures on the CRE market and also a broader link between financial outcomes and developments in the CRE market in general has yet not been well documented. Understanding the impact of macroprudential measures on the CRE market is, however of great importance to financial stability policy both globally and in the European Union. Unsustainable developments in the CRE markets can result in severe losses for the financial system. For example in the UK, commercial property had a significant role, causing destabilising losses for banks in the last financial crisis; a rapid build-up of debt tied to commercial property investments pre-crisis supported a boom in prices and the consequent bust led to a sharp rise in non-performing loans (Benford and Burrows, 2013). Olszewski (2012) points out some lessons learned from the previous crisis that might be useful for the effective MPP, such as, that the proper valuation of property is of great importance and will restrict both investors and banks from running into a cycle in which credit growth leads to property price growth and vice versa. Furthermore, prices of CRE in different market segments and regions need to be tracked, as they might be quite different. Barrel et al. (2010) suggest that restrictions on LTV values and proper capital adequacy on property loans might help to reduce the likelihood of the emergence of a crisis. As noted by the ESRB (2015) in contrast to the housing market, CRE markets tend to be more cyclical, with CRE lending typically having higher default rates than lending on housing markets. Building-up firm debt due to commercial property investments can lead to a sharp rise in bank non-performing loans in a crisis period. However, when assessing risks related to CRE and the most appropriate strategies to mitigate them, currently there are important data limitations present. Data for the CRE market is in general scarce, incomplete or inconsistent, especially compared to the housing market data, making it difficult to describe accurately and compare risks in and across national markets (ESRB, 2015a).

In the paper we also discuss the efficiency of the borrower-based macroprudential measures for the CRE market. We define the efficiency by "achieving the aim at the minimum costs". In the view of macroprudential instruments LTV, LTI and DSTI/DSR, a key issue is the trade-off between resilience (of both borrowers and banks) and growth, since increasing resilience is not cost-free. The instruments that support long-term growth while containing systemic risk, and instruments that have a lower impact on other policy instruments, are preferable (in line with a definition as in the ESRB Recommendation (2013))[5]. Caldera-Sánchez et al. (2016) find growth-fragility trade-offs present in macroprudential measures and suggest that constraints on household debt-to-income ratios, counter-cyclical buffers and capital surcharges on systemically-important financial institutions would help reduce fragility without hampering growth. Other macro-prudential policies (taxes on revenues of financial institution, limits to foreign currency loans) might reduce growth by distorting incentives or reducing the efficiency of financial markets.

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[5] It shall be noted, that the criteria for the efficiency of macroprudential instruments should be further developed.

3. Data

To study the impact of a macroprudential intervention on the CRE market we use data from the reporting of all monetary financial institutions in Slovenia, as collected by the Bank of Slovenia. Data is collected monthly and runs from June 2010. It is a loan-level data on the borrower, financial information and interest rates, other parameters regarding bank credit risk and other variables. From the dataset, we use loan-level data on all loans for CRE to non-financial firms, issued by all credit institutions in Slovenia. In addition, we use firm financial statements and business register data, as collected by the Agency of the Republic of Slovenia for Public Legal Records and Related Services (AJPES). Firm financial statements provides annual data on balance sheet item such as assets, fixed assets, liabilities (loans and creditors), as well as profit and loss accounts, such as Earnings before interest, tax, depreciation and amortisation (EBITDA) and interests paid.

In the paper, the CRE market relates to any commercial property intended for the business activities of economic entities and includes the sale of industrial buildings, office premises, and premises for hotels and restaurants, retail and other service activities. We define the CRE price as the value of the commercial property for firms that collateralized the loan with commercial property and as the value of the residential property for firms that collateralized the loan with residential property (and not with commercial property). Our definitions of the LTV, LTI and DSR ratios are the following: Loan-to-value (LTV) is the value of the loan to the value of collateral; where collateral is a sum of the value of CRE, RRE and other collateral. Loan-to-income (LTI) is the value of the loan to firm income. Debt-service-ratio (DSR) is the yearly repayments of the loan (principal and interests), taking into account the value of the loan, the maturity term and the annual interest rate of the loan to income. Income is defined as a 3-year-average EBITDA[6] for the three years prior to the year the firm took the loan. Firm age is defined as a sum of years from the establishment, up to the year the firm took the loan. Deposit is defined as the collateral value minus the value of the loan and stands as an estimation of the down-payment of the borrower.

Our sample in the paper covers the period from the third quarter 2010 to the fourth quarter 2015 and we adjust the original series to quarterly bases (the monthly data on the firm loan characteristics and the annual data on firm financial statements). The loan characteristics are available at origination. The original sample size consists of 1,975 observations. In order to eliminate outliers we apply a number of selection criteria[7]: we exclude observations with CRE price lower than 10,000 EUR. We also restrict the sample to observations for which the LTV, LTI and DSR ratios are available by eliminating the top and bottom one percent of the observations (for the variables CRE price, loan deposit and income) and observations with negative or no values (on income, deposit or age). After data cleaning, our final sample comprises 800 observations. It has to be noted, that in the process of elimination, many loans to firms were unfortunately excluded. For example, in 2013, new loans to firms for CRE stood at EUR 557 million in the original dataset, in comparison to EUR 197 million in our sample or over two thirds less in the value of new loans.

Figure 1 shows the value of new loans to firms for CRE from Q3 2010 to Q4 2015 as observed in the sample and firm indebtedness, as measured by the debt-to-equity ratio from 2006 to 2014. The value of new loans to firms for CRE has decreased from EUR 200 million 2010 Q4 to EUR 11 million in 2015 Q3. An important factor in firm decision to invest in CRE is the level of firm indebtedness.

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[6] EBITDA for the three years prior to the year the firm took the loan was used instead of EBITDA in the one year prior in order to keep more firms in the sample (since several firms had negative income in the one year prior to the loan origination).

[7] Our aim was however, to include as many observations as possible in the final sample.

Figure 2 shows firm indebtedness, as measured by the debt-to-equity ratio, from 2006 to 2014. Firm indebtedness increased rapidly in the pre-crisis period in Slovenia, peaking in 2008. Following the onset of the crisis, bank's ability to continue lending to firms decreased along the tightening of the credit standards. An abrupt shrinkage of financing possibilities left firms financially constrained and in turn reduced their profitability, investment growth and survival prospects, which led to a sharp fall in economic activity. Banks being reluctant to take up additional credit risk and not renewing many firm bank loans from the past, left many firms unable to repay their loans and the banking system with a raising number of non-performing loans and large credit losses. Firms in construction and real estate related activities, the key borrowers of loans for CRE, were particularly hit by the last crisis. However, from a peak in 2008, firm indebtedness has come down significantly and by 2014 reduced to the pre-crisis level. Firms had to go through a process of considerable deleveraging which influenced also their decisions to invest in CRE. In the last years, the liquidity on the CRE market was low, which is also a consequence of firm deleveraging processes that started after the onset of the crisis. Up to now, firms deleveraged to a pre-crisis level, are less burdened by debt and more open for investments.

Figure 1: The total value of new loans to firms for CRE
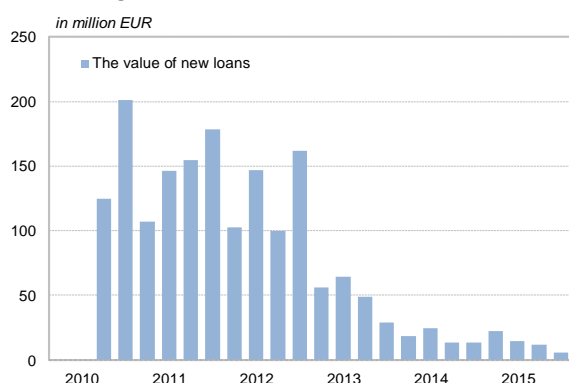
Source: Bank of Slovenia, own calculations

Figure 2: Debt-to-equity ratio for firms by selected activities
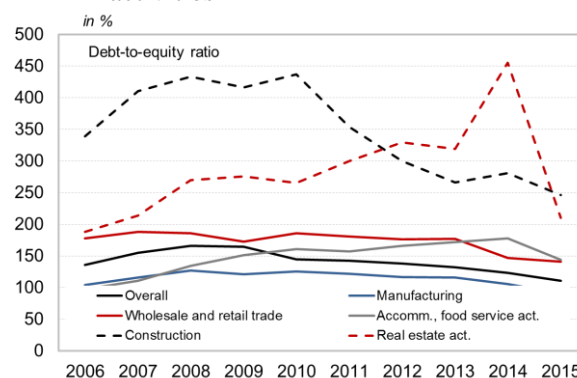
Source: AJPES, own calculations

Figure 3: The average CRE price in the credit contract
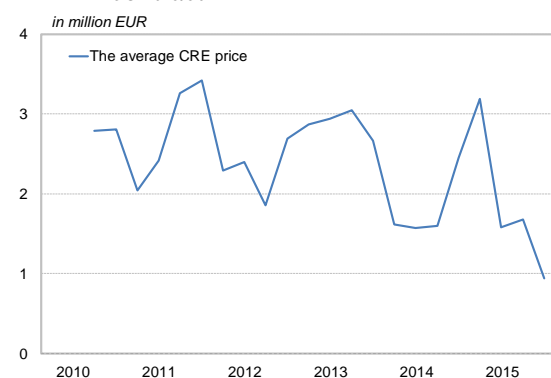
Source: Bank of Slovenia, own calculations

Figure 4: The average CRE price with the number of transactions
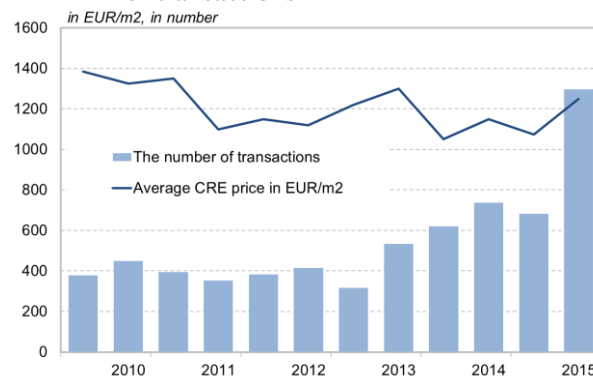
Source: SMARS

Figure 3 shows the average CRE price in the period from Q3 2010 to Q4 2015 as observed in the sample. Two features are evident. First, the average price fluctuates significantly, primarily as a result of the low liquidity on the market and the heterogeneity of the CRE. Commercial property is very diverse since it includes office premises, hotels, industrial buildings, etc., moreover due to a small number of transactions in a quarter, larger transactions can have a substantial influence on the average

price. Second, the average price has been decreasing in the observed period. A factor in a decrease in the CRE prices are also public sales from bankruptcy estates that started in 2014. Due to a rise in firm bankruptcies over the last few years, sales of the CRE, held by the bank, accounted for a significant proportion of the CRE transactions. Furthermore, the CRE market is relatively small and concentrated in the centres of larger cities. To complement our results, Figure 4 shows the average CRE price, as measured by the Surveying and Mapping Authority of the Republic of Slovenia (SMARS). According to SMARS, in the last years, there has been a downward trend in CRE prices. After a build-up of CRE prices before the crisis, up to the end of 2016, they have decreased by a third from a peak in 2008 (SMARS, 2017).

4. Methodology

We use the approach developed by Robert Kelly, Fergal McCann and Conor O'Toole (2015) for the loan-level data for the housing market and adapt it to fit the CRE market. In doing so we use loan-level data on loans for CRE from the Bank of Slovenia and firm financial statements data and business register data from AJPES. The methodology consists of four steps.

First, we study the distribution of the credit standard ratios LTV, LTI and DSR. We determine the maximum possible values LTV, LTI and DSR ratios as allowed by banks for each period to proxy for credit supply. We assume the maximum ratios are determined by the 70th percentile of their distributions in a given quarter.

Second, we construct the measure Credit Available (CA) so that it can incorporate three types of credit conditions by allowing all borrowers to have three potential loans. The three potential loans, which are a measure of the supply of credit available to each firm for the borrowed loan, are:

$$Loan_{LTV} = \frac{Deposit}{1 - LTV_{Max}} - Deposit \quad (1)$$

$$Loan_{LTI} = Income * LTI_{Max} \quad (2)$$

$$Loan_{DSR} = \frac{Income * DSR_{Max}}{(1 + r * TERM)} \quad (3)$$

where $Deposit$ represents the down-payment of the borrower, $income$ is the borrower's 3-year-average EBITDA for the three years before the origination of the loan, r is the interest rate at origination and $TERM$ is the maturity of the loan at origination. When the LTV is higher or equal to 100, we consider the amount of credit available along the LTV channel to be infinite. It is then only the LTI or the DSR channel which can determine credit available.

The measure of 'available credit' is the loan value the bank is willing to grant to the borrower considering all three credit standards. It is calculated as the minimum of the three potential loans as follows:

$$Credit\ Available = Min(Loan_{LTV}, Loan_{LTI}, Loan_{DSR}) \quad (4)$$

The innovation of in the Kelly et al. research is the construction of a measure Credit Available (CA). The credit available is calculated by using the levels of LTV, LTI and DSR that were available by lenders and represents supply-side availability of credit. We calculate also the maximum amount of credit that each borrower could access when applying for a loan. The measurement has two key characteristics. First, it differs for every borrower as a function both of the borrower characteristics

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and prevailing bank lending conditions. Second, it is a function of supply-side credit conditions, that can be limited by macroprudential policy ratios LTI, LTV and DSR. These features make the measure of credit available well-suited to incorporating the impact of macroprudential limits (Kelly et al., 2015). By taking the higher-order percentile of observed originating LTV, LTI or DSR in the CRE market in a given quarter, we can proxy the credit available to any borrower, should they have wished to access such a large volume of credit.

Third, we estimate the response of CRE prices to the amount of available credit, where we estimate the relationship between CRE prices and available credit by performing a regression of CRE prices on available credit. This step consists of the estimation of a panel data regression of the following form:

$$CRE\ prices_{it} = f(CA_{it}, D_{it}, BA_{it}, A_{it}, T, C_{it})\ (5)$$

where $CRE\ prices_{it}$ is CRE price of a firm i at a time t, CA_{it} is credit available, D_{it} is deposit, BA_{it} is borrowers age, A_{it} is firm assets, T is a vector of time control variables and C_{it} are firm and loan characteristics that we include as control variables.

Fourth, we simulate a macroprudential intervention by tightening the observed values for the LTV, LTI or DSTI ratios in a given quarter. Under this new assumption, we compute a new value of available credit for each borrower with the new LTV, LTI or DSTI value. We compare the value of the new available credit to the observed credit, to describe the borrowers who have to exit the market due to the new constraint (if available credit is smaller than observed credit). We then use the new credit available measure as an input in the CRE price equation. We also update the deposits available to each firm and the change in deposit value is considered to be equal to the percentage change of CRE prices. These two new variables – credit available and deposits – are then included in the CRE price equation. Thus, we simulate the counterfactual price dynamics under the assumed macroprudential intervention., In this step, we can focus on the short term effects only. The limitation of the methodology is that given numerous general equilibrium effects cannot be captured in our framework (CRE supply response, impact of the changes in CRE prices on firm income, responses of the rental market etc.), we only assume MPP to impact CRE prices for up to four quarters after introduction.

In order the original methodology to suit a simulation of the introduction of credit restrictions to firms on the CRE market, instead of households on the housing market, we applied certain changes to the original methodology. As macroprudential instruments are targeting the demand side of the market, they target households on the housing market and firms on the CRE market. Borrowers on both markets behave differently and banks assess their creditworthiness differently. Therefore, the characteristics of bank credit lending to firms on the CRE market differ as regards to bank credit lending to households on the housing market[8]. Nevertheless, we tried to follow the original methodology as closely as possible.

First, borrowers on both markets differ in regards to their income. As households typically have a positive and by large a stable yearly income, firm income is more volatile and can have negative values. Since the onset of the crisis, firm profits fell substantially, leading to a considerable loss in earnings. In the sample, many firms have negative values for income, so in the calculation of the measure Credit Available (CA), as proposed in the original methodology, negative values for income lead to negative Credit Available values and therefore inconsistent results in the CRE price regression

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[8] for the characteristics of the housing market, please see Bank of Slovenia Financial Stability Report (2018) and ESRB Report on residential real estate and financial stability in the EU (2015b)

model. Instead of using a yearly income as in households in the housing market, we use a 3-year-average EBITDA before the firm took the loan.

Second, in the CRE market, age is not as relevant as in the housing market. In calculating a potential loan, a measure of supply of credit available to each borrower, from the observed loan amount that was borrowed, based on the DSR constraint, we changed the original methodology to exclude the "maximum term". Kelly et al. (2015) compute the maximum term as a difference between borrowers' age and the 98th percentile of the maximum age at the maturity.

Third, the characteristics of the property that borrowers on both markets use for the collateralization of the bank credit differs substantially. In the housing market, collateral is usually the residential real estate a household intends to purchase with the loan. In the CRE market, collateral is more heterogeneous and may take place as commercial property, such as office spaces, industrial buildings, etc., but also as a residential property, stocks and various other forms of collateral. The original methodology proposes that the house price is defined by the value of the residential real estate, taken as a collateral. Therefore, in the paper, the value of the CRE price is defined by the value of the commercial property for firms that collateralized the loan with commercial property and by the value of the residential property for firms that collateralized the loan with residential property (and not also with commercial property). Furthermore, compared to the housing market, in the CRE market, there is a higher share of uninsured loans (such loans were excluded from the sample). Furthermore, there is a higher percentage of loans with an LTV higher than 100% in the CRE market as in the housing market, so we applied a change of the model for allowing the LTV to have values above 100%.

Fourth, in the determination of the maximum possible values for the ratios LTV, LTI and DSR allowed by banks for each period, assumed by a higher-order percentile of their distributions, we use the 70th percentile. Kelly et al. propose to use the 98th percentile. The chosen percentile can however vary due to national specificities, and would generally be above the 90th percentile for the housing market. However, in our research we use the 70th percentile to create a smoother data series since a small size and heterogeneity of CRE with high CRE price volatility in Slovenia. The results of macroprudential simulation may therefore encompass an underestimated impact due to exclusion of loans with very high LTVs, LTIs and DSRs in the simulation.

Fifth, the length of loan maturities to firms on the CRE market differs considerably, compared to household loans on the housing market. In 2015, as average maturity of new loans to households in the housing market stood at 19 years, average maturity of new loans to firms for CRE was less than 2 years. Furthermore, many observations has maturity of less than a year. Due to shorter loan maturity in the CRE market, in income-based measures, the LTI and DSR ratios differ much less as the LTI and DSR ratios in the housing market. Short maturities of many loans to firm on the CRE market suggests that loans will be renewed after a certain period and therefore entail a high renewal risk.

Furthermore, in comparison to the housing market, the CRE market is very fragmented due to the heterogeneity of the CRE and the supply and demand for a particular property segment may vary significantly. The heterogeneity of the CRE and a small market size in Slovenia are factors in price volatility, as individual large contracts can have a significant impact on the prices.

In the building-up of the original methodology to fit firms on the CRE market, we considered various metrics. While the original methodology uses loan-level metrics for the choice of macroprudential instruments, we also considered firm-level metrics for the CRE macroprudential intervention. Since banks assess creditworthiness of firms differently than of households we tested several other indicators in order to use them as possible credit constraints indicators for the CRE market. We therefore tested

using firm-level metrics for CRE macroprudential interventions instead of loan-level metrics. The firm related indicators we used are debt-to-assets, financial debt-to-EBITDA and interests to EBITDA. When including firm whole debt related indicators for LTI and DSR instead of loan level indicators, when calculating the measure Credit Available (CA) the coefficient becomes negative and statistically insignificant and unable to explain the relationship between the variables in the model. In order to best suit the model we use loan-level indicators for LTV, LTI and DSR.

5. Results

5.1 The credit conditions for firms in the CRE market

Figures from 5 to 7 show the distributions of the LTV, LTI and DSR ratios in the sample of data by the 50th, 70th and 90th percentile of the ratios. Two features are evident. First, the LTI and DSR ratios distributions follow a similar pattern over time and show how credit conditions loosened along these two limits between 2010 and 2012. The 90th percentile of LTI stood at 100 years and of DSR at 80 years in 2011. In the last years, the 90th percentile has decreased, indicating a more prudent lending with tighter credit conditions. However, since 2014 firm profitability increased, which can affect the LTI and DSR ratios to decrease. Second, the median values of the three ratios are almost at the same level in the observed period, while the higher the percentile of the LTV, LTI and DSR, the more the ratios fluctuate, resulting in some loans to certain firms being granted at significantly loosened credit conditions. In comparison to households, banks therefore apply more loosened credit standards to certain firms in the CRE market, with a large tail of observations at LTV above 100% and LTI or DSR above 40 and even up to 400 years. Figure 8 also shows the average credit available in the period from Q3 2010 up to Q4 2015. Average credit available to firms in the sample has been decreasing since 2012, which is consistent with the CRE market developments and the tightening of credit conditions as seen by LTI and DSR distributions. Furthermore, we find that many firms had low income or were experiencing losses in the years prior when they were granted the loan.

Figure 9 shows the binding credit conditions as it shows the percentage of borrowers constrained by each measure over time. The majority of firms are constrained by the DSR limit, however LTI has been most binding in certain periods in 2013 and 2014. Therefore, in regards to credit conditions on the CRE market, firms are limited mostly by their income when applying for a loan.

Figure 5: The distribution of the LTV ratios
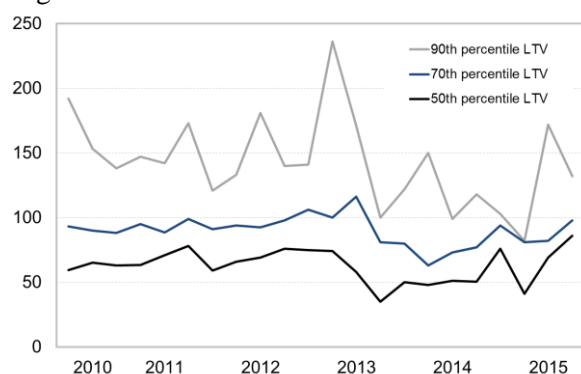
Source: Bank of Slovenia, own calculations

Figure 6: The distribution of the LTI ratios
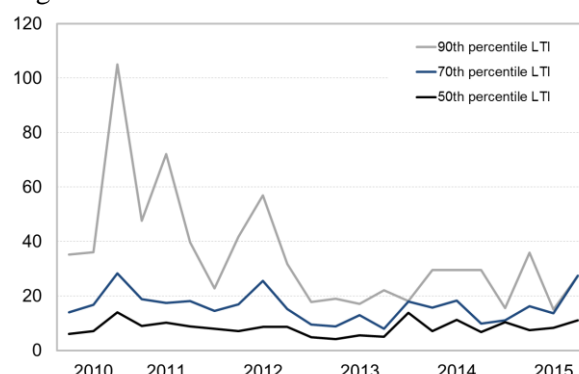
Source: Bank of Slovenia, own calculations

Figure 7: The distribution of the DSR ratios

Source: Bank of Slovenia, own calculations

Figure 8: The average credit available

Source: Bank of Slovenia, own calculations

Note: After data cleaning, some firms still have high ratios (for example LTV between 200 and 400, LTI up to 400 and DSR from 100 up to 400). However if we apply further data cleaning, the sample can loose on valid observations and miss on the diversity of applied credit standards in CRE credit borrowing and therefore the indication that banks apply more loosened credit standards to certain firms in the CRE market as to households in the housing market.
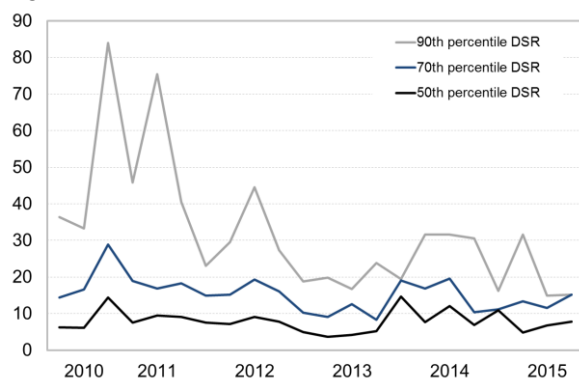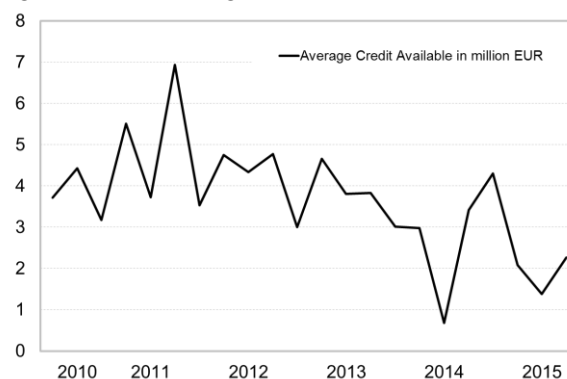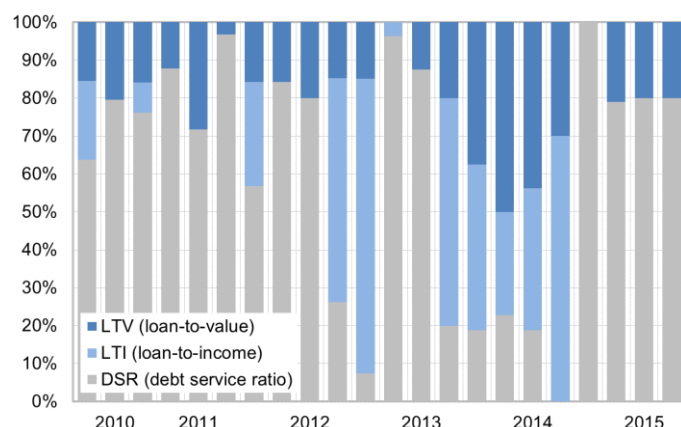
Figure 9: The binding LTV, LTI and DSR limits among borrowers

Source: Bank of Slovenia, own calculations

5.2 The CRE price regression model

Table 1 presents summary statistics for key variables included in the CRE price model: CRE price, credit available, deposit, income and firm age. The average CRE price in the sample is EUR 2.6 million, while the average credit available is EUR 4.2 million. As expected, average credit available is higher than the average loan size in the data and shows the value of the credit the bank would have been willing to grant according to the borrower characteristics. Average borrower age is 13.7 years. In the model, we also use the maturity term and the annual interest rate applied to the loan for the calculation of the DSR. In addition, we use several control variables, such as the location of a firm (if a firm is located in or outside of the capital city) and the firm main activity, defined as manufacturing, construction, trade, real estate activities, professional, scientific and other technical activities and other activities. Furthermore, we use as control variables the characteristics of the credit institutions (15 banks and savings banks are included) as defined in the following groups: large domestic bank, small domestic bank, foreign bank and savings banks. Two important features are evident. First, almost 60

per cent of CRE loans were granted to firms in Ljubljana, indicating, that the CRE market is highly concentrated in the capital city. Second, the key borrowers on the CRE market are firms in the construction and real estate activities as they account for over a half of all borrowers. In regards to the composition of the borrowers, large domestic banks granted a half of the loans in the sample. We use quarterly data (adjusted to quarterly basis from monthly and yearly data) with the time span of the dataset from the third quarter 2010 to the fourth quarter 2015. We use only a sample of loan-level data for which all three credit standard ratios are available.

Table 1: Summary statistics of the variables included in the CRE price model

Variable	Observations	Mean	Std. Dev.
CRE price	800	2,557,242	3,610,120
Credit availability	800	4,192,351	5,920,922
Deposit	800	1,318,697	2,774,166
Income	800	332,422	455,536
Firm age	800	13.7	8.1
Sample shares for categorial variables (in %)			
Large domestic banks	800	54	
Small domestic bank	800	27.5	
Foreign bank	800	18.3	
Savings bank	800	0.2	
Region 1 (Ljubljana)	800	58.5	
Region 2 (Other)	800	41.5	
Manufacturing	800	2.6	
Construction	800	35.5	
Trade	800	12.1	
Real estate activities	800	19.8	
Prof., scient., tech. act.	800	24.9	
Other	800	5.1	

Source: Bank of Slovenia, own calculations

Table 2 shows the estimated CRE price model. The coefficient on the credit available is relatively stable across columns (1), (2) and (3), with a significant and positive relationship between credit available and CRE prices. Our preferred specification is regression in column (1) and we use the coefficients of this specification for the macroprudential simulations in the next chapter. The estimated coefficient on credit available is 0.175, which means, that a one-euro increase in the credit available is associated with an increase in the value of the purchased CRE for 17.5 cents. Older firms purchase less expensive CRE. One additional year in age is associated with a fall in house value of 17,589 EUR. The coefficient on firm age appears high due to relatively high average value of CRE and the relatively low average borrower age as compared to the housing market. Additionally, in the regression in column (1), firm assets are used to proxy for firm size and show larger firms tend to buy more expensive CRE. All regressions from one to four include bank group, region, firm activity and time dummies; we therefore tested the specifications with different dummy variables and the results did not change significantly.

In the regression in column (3), we also test whether firms with higher income buy more expensive CRE and find firms that are more profitable do tend to buy more expensive CRE. However, the coefficient on credit available decreases to 0.1. Our preferred specification therefore does not include firm income, since credit available and income are highly correlated (0.84). In the sample period, most

of the firms were DSR or LTI constrained (as seen in the next chapter) and consequently the amount if credit available is a function of income.

Column (4) of Table 2 runs a log specification where credit available and deposit are in logarithmic form. The coefficients are interpretable as elasticities, with a 10 per cent increase in the credit available estimated to lead to a 2.7 per cent increase in CRE prices. In the column (4), the sample size is smaller than in the other three columns due to missing values for log deposit as deposit values can be negative for loan-level observations with LTV higher than 100.

Table 2: Estimation results

VARIABLES	(1) CRE Prices	(2) CRE Prices	(3) CRE Prices	(4) Log CRE Prices
Credit Available	0.175***	0.198***	0.100**	
	(0.029)	(0.028)	(0.041)	
Deposit	0.637***	0.637***	0.643***	
	(0.059)	(0.059)	(0.058)	
Firm income			1.564***	
			(0.440)	
Firm age	-17,589.782	-13,382.496	-21,262.585*	-0.001
	(13,219.119)	(13,480.649)	(12,903.990)	(0.006)
Firm assets	0.012***			
	(0.003)			
Credit Available (log)				0.268***
				(0.045)
Deposit (log)				0.252***
				(0.043)
Observations	800	800	800	639
R-squared	0.492	0.483	0.492	0.493
Bank dummies?	YES	YES	YES	YES
Time dummies?	YES	YES	YES	YES

Robust standard errors in parentheses

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

Note: We compute OLS estimators using BS and AJPES loan-level quarterly data between Q3 2010 and Q4 2015 (adjusted to quarterly basis from monthly and yearly data). We use only a sample of loan-level data for which all three credit standard ratios are available. All models include a full set of bank and firm activity specific time fixed effects and region fixed effects. Source: Bank of Slovenia, own calculations

6 Simulation of the introduction of macroprudential measures

In this chapter we test how the introduction (or the tightening) of macroprudential policy measure can impact the credit available and the CRE prices through the credit channel. Macroprudential simulation is based on the estimated relationship between credit available and house prices; we determined the relationship between credit availability and CRE prices in the previous chapter. Each simulation consists of applying a restriction on a single credit condition and assessing its impact on credit available and house prices.

In our macroprudential simulation, we impose six different scenarios of LTV, LTI and DSR limits (Table 4) and assess their effects on the credit available and CRE price one quarter and four quarters ahead. The shocks are applied as of the third quarter 2010. The effects are assessed one quarter and

four quarters ahead. Before introducing these shocks, the prevailing CRE market limits are for LTV 93 %, for LTI 14 years, and for DSR 14.4 years. Under these limits, 67.1 % of borrowers are constrained by the DSR restriction, 17.7 % of borrowers are constrained by the LTV restriction and 15.2 % of borrowers are constrained by the LTI restriction.

Table 4: Macroprudential limits imposed under policy scenarios in the third quarter 2010

	Initial ratio	Looser limits	Tighter limits
LTV	93	90	88
LTI	14	13.5	13
DSR	14.4	13.9	13.4

Source: Bank of Slovenia, own calculations

The methodology allows us to impose any combination of restrictions of LTV, LTI and DSR ratios that we wish to test. The macroprudential scenarios we present in the paper are limits to the LTV ratio by 3 and 5 p.p. and limits to the LTI and DSR ratios by 0.5 and 1 year of income in the third quarter 2010. In the simulation, we restrict each macroprudential measures at a time, while keeping other measures as observed in the data. For example, in the scenario (1), when we restrict LTV for 3 p.p., we assume that this restriction remains the same over four quarters, while allowing the LTI and the DSR to change according to the observed values in each quarter. Then, a new share of borrowers constrained by each measure is re-calculated. Finally, the change in the credit available and the CRE price is re-calculated given the imposed macroprudential scenario. Table 5 shows the results of macroprudential simulation. In the appendix, we present several sets of additional results.

Table 5: Results of the macroprudential simulation

Restriction of	Initial value in Q3 2010	Restricted value	LTV constrained	LTI constrained	DSR constrained	Credit available change		CRE price change	
			in % of borrowers			after 1 quarter	after 4 quarters	after 1 quarter	after 4 quarters
LTV	93	90	23.7	0.0	76.3	-10.4	-9.6	-2.2	-3.8
	93	88	27.1	0.0	72.9	-14.9	-12.8	-3.1	-5.5
LTI	14	13.5	15.3	81.4	3.4	-1.2	-21.9	-0.3	-13.1
	14	13	15.3	84.8	0.0	-4.3	-24.6	-0.9	-14.5
DSR	14.4	13.9	15.3	0.0	84.8	-2.8	-25.7	-0.6	-14.8
	14.4	13.4	15.3	0.0	84.8	-5.8	-28.2	-1.2	-16.1

Note: Under the prevailing limits in the third quarter 2010, 18 % of borrowers are constrained by the LTV restriction, 15 % of borrowers are constrained by the LTI restriction and 67 % of borrowers are constrained by the DSR restriction. The initial value refers to the 70th percentile of the ratios.

Source: Bank of Slovenia, own calculations

In the first scenario, we restrict the LTV ratio. In the third quarter 2010, the initial LTV ratio stood at 93 %. In the scenario (1), the LTV ratio is limited by 3 p.p. to 90 %. Setting up this restriction, 24 % of borrowers are LTV constrained, while no borrowers are constrained by LTI and the share of borrowers constrained by DSR increases to 76 %. In the first year after the imposed shock, the credit available decreases by 10 % and CRE prices decrease by 4 %. In the scenario (2), LTV is restricted by 5 p.p. to 88 %. After the first quarter, the credit available decreases for 15 % and CRE prices for 3 %. However, a decrease in the change of the credit available and CRE price is smaller after four quarters

as after one quarter, 13 % and 6 % respectively, due to fluctuations of the observed LTV ratios across the sample (the observed 70th percentile of LTV stood at 88% in the third quarter 2011).

In the second scenario, we restrict the LTI ratio. In the third quarter 2010, the initial LTI value stood at 14 years. In the scenario (3) and (4) LTI is limited by 0.5 years income and by 1 year income, which reduces the 70th percentile of LTI to 13.5 and 13 years income. By imposing a restriction to LTI ratio, most borrowers become limited by LTI restriction instead of DRS restriction, 81% and 85% respectively, while the share of borrowers, constrained by DSR drops to 3 % and 0 % respectively. The credit available and CRE prices decrease less after the first quarter, but the fall is more significant after the four quarters. After four quarters, credit available decreases by 22 % and 25 % respectively, while CRE prices decrease by 13 % and 15 % respectively.

In the third scenario, we restrict the DSR ratio. In the third quarter 2010, the initial DSR value stood at 14.4 years. Due to shorter loan maturities in the CRE market, the LTI and DSR ratios for a given loan stand at similar values. In the scenario (5) and (6) DSR is limited by 0.5 years income and by 1 year income, which reduces the 70th percentile of DSR to 13.9 and 13.4 years income. The results are similar to the results for the restrictions of LTI. The share of constrained borrowers increases to 85 %, while after the first year of restriction, the credit available falls by 28 % and CRE prices fall by 16 %.

The results suggest that the introduction of borrower-based macroprudential restrictions, LTV, LTI and/or DSR, that target the demand side of the market, can reduce both the credit flows and prices on the CRE market. The results also show the income-related restrictions appear have a greater impact as the down-payment constraints. For example, in both the LTI and DSR scenarios the share of borrowers where income-related constraints becomes binding increases significantly after the first year and leads to a considerable reduction in credit available. Furthermore, the level at which instruments are set is crucial to determine the magnitude of the impact on credit flows and prices on the CRE market. Since even small restriction of income-related measures (for example by 0.5 p.p.) can significantly reduce the credit available and CRE prices, the calibration of instruments and the level at which they are set can profoundly impact the credit flows and prices on the market.

The results also suggest there are important limitations to using the LTV, LTI and DSR ratios (as defined in the paper) as macroprudential measures for the CRE market. First, given a relatively high share of loans with the value of the loan exceeding the value of the collateral and uninsured loans, we assume that the credit institutions use also other criteria when assessing firm creditworthiness and the risks associated with granting a loan for commercial property. Second, income-based measures are harder to calibrate due to the volatility of firm income (firms can experience large losses, especially in the crisis periods and can have a negative LTI or DSR ratio) as well as to follow the impacts. If income-based macroprudential measures were set, the regularity authorities might need to calibrate and change the level of the introduced measure more often.

7 Conclusion

In the paper we study the impact of a hypothetical introduction of borrower-based macroprudential measures on credit flows and property prices on the CRE market in Slovenia. In doing so we use loan-level data on loans to firms for CRE from the Bank of Slovenia and firm financial statements data and business register data from AJPES. We build on the methodology developed by Robert Kelly, Fergal McCann and Conor O'Toole (2015, 2017) on the impact of a macroprudential intervention in the housing market on credit supply and house prices. The original methodology is set for the housing market, however we adapt it to suit the CRE market framework.

The approach presents a novel measure of credit availability at the loan level, where credit supply is bounded by three constrains, LTV, LTI and DSR. Then, the relationship between CRE prices and available credit is estimated by performing a regression of CRE prices on available credit, where the transaction CRE price is a function of credit available, down-payment, firm age and firm assets, with firm and loan characteristics included as control variables. The results on a sample of firms show, first, over a half of loans were granted to firms in Ljubljana, indicating the market is highly concentrated in the capital city and second, over a half of loans were granted to firms in the construction and real estate activities, that are most burdened by high indebtedness. Furthermore, larger and more profitable firms are more likely to buy more expensive CRE. The results also show that in the period 2010-2015, the majority of firms were constrained by the DSR condition, however LTI has been most binding in certain periods in 2013-2014. In regards to credit conditions on the CRE market, firms are therefore limited mostly by their income.

The results indicate that banks apply more loosened credit constraints to firms in the CRE market as to households in the housing market, given a large tail of observations at LTV above 100 %, uninsured loans and firms with a high DSR ratios or negative profits. The original maturity of many loans to firm for CRE in the sample is very short, suggesting loans are expected to be renewed after a certain period, which entails a high renewal risk. Furthermore, we find that many firms had low income or were experiencing losses in the years prior when they were granted the loan. The results also indicate, especially at LTI and DSR, a more prudent lending with tighter credit conditions in the last years (it has to be noted that firm profits increased in 2014 and 2015, which can affect the LTI and DSR values to become lower).

In the recent literature, borrower-based macroprudential instruments such as LTV, LTI and/or DSTI, have been mostly found effective for reducing the risks on the housing market. The results of a simulation of an introduction of macroprudential measures on the CRE market suggest that the tightening of macroprudential instruments LTV, LTI and/or DSR can reduce both the credit flows and prices on the CRE market. The results also show the income-related restrictions have a greater impact as the down-payment constraints. Furthermore, the level at which instruments are set in regards to the prevailing market conditions is crucial to assess and regulate the magnitude of the possible impact on credit flows and prices on the CRE market. Since even small restriction of income-related measures can significantly reduce the credit available and CRE prices, the calibration of instruments and the level at which they are set can profoundly affect the credit flows and prices on the market.

The results also suggest there are important limitations to using the LTV, LTI and DSR ratios (as defined in the paper) as macroprudential measures for the CRE market. First, given a relatively high share of loans with the value of the loan exceeding the value of the collateral and uninsured loans, we assume that the credit institutions use also other criteria when assessing firm creditworthiness and the risks associated with granting a loan for commercial property. Second, income-based measures are harder to calibrate due to the volatility of firm income (firms can experience large losses, especially in the crisis periods and can have a negative income-based ratio) as well as to follow the impacts. If income-based macroprudential measures were set, the regularity authorities might need to calibrate and change the level of the introduced measure more often.

The results are important for macroprudential policy makers in understanding both for the choice and in the calibration of macroprudential instruments to address the risks on the CRE markets. Monitoring of the credit standards and assessing the risks on the CRE market is more difficult as in comparison to the housing market. These bank investments entail higher risks due to a high value of the loans for the CRE, difficulties in the valuation of the commercial property and volatility of firm income. Given our

findings, when choosing a macroprudential instruments for the CRE market, the policy makers should first target loan-to-value ratios instead of loan-to-income/debt-service ratio indicators in terms of efficiency of the macroprudential policy. Furthermore, when introducing income-based measures, the policy makers should opt for debt service ratios instead of loan level ratios and for the criteria on debt use the whole firm debt and not only the value of the loan. Given a limitations in suing these rations for firms on the CRE market and the high entailed risk of these loans, macroprudential measures should be complemented by other firm-level indicators, such as debt-to-assets, financial debt-to-EBITDA or other indicators on the firm performance. The results stress the importance of the choice and the calibration of macroprudential instruments, since if set too restrictively, they can significantly reduce the credit flows and put unnecessary constraints to the supply of credit and firm investments. Therefore, we could achieve our aim of restricting excessive credit growth and building-up resilience of banks and borrowers, but the costs might be relatively high.

Using loan-level data for measuring the impact of the introduction of macroprudential instruments, both LTV and LTI/DSR measures, is one of the first attempts to assess the impact of the introduction of borrower-based macroprudential instruments for the CRE market. This research represents a novelty in assessing the impacts of the macroprudential approach to mitigating risks stemming from the CRE market. In this view, results on the impact of the introduction of macroprudential instruments on the CRE market in Slovenia should be interpreted with caution. For the future research, linking loan-level data on loans to firms for CRE with firm characteristics and data from the credit register on non-performing exposures could give a broader view on the choice and calibration of the indicators for macroprudential purposes. Such insight might form a ground for development of firm-based indicators, that can be more efficiently used for monitoring and regulating the risks to the financial stability, stemming from the CRE market.

8 Appendix

Table 1: More restrictive limits to the LTV, LTI and DSR ratios in the third quarter 2010

Restriction of	Initial value in Q3 2010	Restricted value	LTV constrained	LTI constrained	DSR constrained	Credit available change		CRE price change	
				in % of borrowers		after 1 quarter	after 4 quarters	after 1 quarter	after 4 quarters
LTV	93	88	27.1	0	72.9	-14.9	-12.8	-3.1	-5.5
	93	83	40.7	0	59.3	-24.1	-19.2	-5.0	-9.8
LTI	14	12	15.3	84.8	0.0	-10.6	-30.2	-2.2	-17.6
	14	11	15.3	84.8	0.0	-16.9	-35.7	-3.5	-20.5
DSR	14.4	12.4	15.3	0	84.8	-11.8	-33.4	-2.5	-19.1
	14.4	11.4	15.3	0	84.8	-17.7	-38.5	-3.7	-21.8

Source: Bank of Slovenia, own calculations

Table 2: More restrictive limits to the LTV, LTI and DSR ratios in the third quarter 2010 (1)

Restriction of	Initial value in Q3 2010	Restricted value	LTV constrained	LTI constrained	DSR constrained	Credit available change		CRE price change	
			in % of borrowers			after 1 quarter	after 4 quarters	after 1 quarter	after 4 quarters
LTV	93	88	27.1	0.0	72.9	-14.9	-12.8	-3.1	-5.5
	93	83	40.7	0.0	59.3	-24.1	-19.2	-5.0	-9.8
LTI	14	9	13.6	86.4	0.0	-29.5	-46.8	-6.1	-26.4
	14	4	8.5	91.5	0.0	-65.3	-75.6	-13.6	-41.6
DSR	14.4	9.4	13.6	0.0	86.4	-29.8	-48.8	-6.2	-27.2
	14.4	4.4	8.5	0.0	91.5	-63.8	-75.3	-13.3	-41.4

Source: Bank of Slovenia, own calculations

9   References

Avouyi-Dovi, S., C. Labonne, and R. Lecat (2014): The housing market: the impact of macroprudential measures in France," Financial Stability Review, (18), 195{206.

Bank of Slovenia (2018): "Financial Stability Report". Bank of Slovenia, Financial Stability and Macroprudential Policy Department.

Bank of Slovenia (2017): "Macroprudential policy for the banking sector. Strategic framework". Bank of Slovenia

Barrell, R., Davis, E.P., Karim, D. and Liadze, I. (2010): "Bank regulation, property prices and early warning systems for banking crises in OECD countries". Journal of Banking and Finance Nr. 34, p. 2255-2264.

Benford J., and Burrows, O. (2013): "Commercial property and financial stability". Bank of England, Financial Stability Directorate, Quarterly Bulletin, 2013 Q1

Caldera-Sánchez, Aida, de Serres, Alain, Gori, Filippo, Hermansen, Mikkel and Röhn, Oliver (2016): Strengthening economic resilience: Insights from the post-1970 record of severe recessions and financial crises. OECD, December 2016 No. 20

Cerutti, Eugenio, Stijn Claessens, and Luc Laeven. 2015. "The Use and Effectiveness of Macroprudential Policies: New Evidence." IMF Working Papers, International Monetary Fund. http://EconPapers.repec.org/RePEc:imf:imfwpa:15/61.

Claessens, Stijn, Swati Ghosh, and Roxana Mihet. 2013. "Macro-prudential policies to mitigate financial system vulnerabilities." *Journal of International Money and Finance* 39 (C): 153-185. http://EconPapers.repec.org/RePEc:eee:jimfin:v:39:y:2013:i:c:p:153-185.

Di Maggio, Marco, and Amir Kermani (2014): Credit-Induced Boom and Bust". Research Paper, Columbia Business School.

Duca, John V., John Muellbauer, and Anthony Murphy. 2011. "{House Prices and Credit Constraints: Making Sense of the US Experience}." *Economic Journal* 121 (552): 533-551. http://ideas.repec.org/a/ecj/econjl/v121y2011i552p533-551.html

ESRB (2013): Recommendation of the European Systemic Risk Board of 4 April 2013 on intermediate objectives and instruments of macro-prudential policy. ESRB/2013/1

ESRB (2017): A Review of Macroprudential Policy in the EU in 2016. https://www.esrb.europa.eu/pub/pdf/other/20170413_esrb_review_of_macroprudential_policy.en.pdf

ESRB (2015): "ESRB Handbook on Operationalising Macro-prudential Policy in the Banking Sector". https://www.esrb.europa.eu/pub/pdf/other/150625_esrb_handbook_addendum.en.pdf

ESRB (2015a): "Report on commercial real estate and financial stability in the EU". ESRB. https://www.esrb.europa.eu/pub/pdf/other/2015-12-28_ESRB_report_on_commercial_real_estate_and_financial_stability.pdf?176e1d2bc979c6215d3217eb9179c93d

ESRB (2015b): "Report on residential real estate and financial stability in the EU". ESRB.

ESRB (2016): Recommendation on closing data gaps. ESRB https://www.esrb.europa.eu/pub/pdf/recommendations/2016/ESRB_2016_14.en.pdf

Favara, Giovanni, and Jean Imbs (2015): "Credit Supply and the Price of Housing." American Economic Review 105 (3): 958-92.

Fitzpatrick, Trevor and Kieran Mcquinn (2007): House Prices And Mortgage Credit: Empirical Evidence For Ireland," Manchester School, 01, 75 (1), 82{103.

Galati, Gabriele and Richhild Moessner (2011): Macroprudential policy: a literature review," BIS Working papers, No. 337. Monetary and Economic department.

Gerlach, Stefan and Wensheng Peng (2005): Bank lending and property prices in Hong Kong," Journal of Banking & Finance, 2005, 29 (2), 461{481.

Igan, D., and Kang, H. (2011): "Do Loan-To-Value and Debt-To-Income Limits Work? Evidence From Korea". IMF Working Papers, International Monetary Fund. http://ideas.repec.org/p/imf/imfwpa/11-297.html.

Jacome, L., and Mitra, S. (2015): "LTV and DTI Limits - Going Granular". IMF Working Paper, International Monetary Fund

Kelly, R, F. McCann, and C. O'Toole (2015): "Credit Conditions, Macroprudential Policy and House Prices." Research Technical Papers, 15RT06, Central Bank of Ireland.

Kelly, R, F. McCann, and C. O'Toole (2017): "Credit conditions, macroprudential policy and house prices". Working Paper Series, No. 36, ESRB

Kuttner, K. N., and Shim, I. (2013): "Can non-interest rate policies stabilise housing markets? Evidence from a panel of 57 economies". BIS Working Papers, Bank for International Settlements. http://ideas.repec.org/p/bis/biswps/433.html

Labonne, Claire, and C\'ecile Welter-Nicol (2015):"Cheap Credit, Expensive Houses?." Mimeo, ACPR \ Banque de France.

Lindner, Fabian (2014): The Interaction of Mortgage Credit and Housing Prices in the US," IMK Working Paper 133-2014, IMK at the Hans Boeckler Foundation, Macroeconomic Policy Institute 2014.

Olszewski, K. (2012): "The impact of commercial real estate on the financial sector, its tracking by central banks and some recommendations for the macro-financial stability policy of central banks". Warsaw, Economic Institute, National Bank of Poland, Working paper, No. 132

Surveying and Mapping Authority of the Republic of Slovenia (SMARS) (2017): "Annual report on the Slovenian property market for 2016". http://www.trgnepremicnin.si/media/2014_annual-reportcc.pdf