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October 2016 **No 306**

National Bank
OF BELGIUM
Eurosystem

THE IMPACT OF SECTORAL MACROPRUDENTIAL CAPITAL REQUIREMENTS ON MORTGAGE LOAN PRICING: EVIDENCE FROM THE BELGIAN RISK WEIGHT ADD-ON*

Stijn Ferrari§, Mara Pirovano‡ and Pablo Rovira Kaltwasser†

Abstract: In December 2013 the National Bank of Belgium introduced a sectoral capital requirement aimed at strengthening the resilience of Belgian banks against adverse developments in the real estate market. This paper assesses the impact of this macroprudential measure on mortgage lending spreads. Our results indicate that affected banks reacted heterogeneously to the introduction of the measure. Specifically, mortgage-specialised and capital-constrained banks increase mortgage lending spreads by a greater amount. As expected, the impact of the measure on mortgage loan pricing has been rather modest in economic terms.

Keywords: Systemic risk, macroprudential policy, bank capital requirements, real estate.

JEL codes: E44, E58, G21, G28

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* The authors would like to thank Alexandre Francart, Marco Lo Duca, Janet Mitchell, Giulio Nicoletti, Cristina Vespro, Patrick Van Roy, Rudi Vander Vennet, Raf Wouters.
The views expressed in this paper are those of the authors and do not necessarily reflect the views of the National Bank of Belgium or any other institution to which the authors are affiliated.

1 INTRODUCTION

In the Basel framework, capital requirements are a key tool to increase the resilience of the banking sector. Whereas the focus of minimum capital requirements is on the solvency position of individual banks, macroprudential requirements on top of the microprudential ones aim at preserving stability of the banking sector and financial stability as a whole. More specifically, the accumulation of capital buffers makes banks more resilient to negative shocks, thereby limiting the impact of downturns on the financial system and on the broader economy.

Macroprudential capital requirements, while sharing the ultimate objective of safeguarding the stability of the financial system, differ in, *inter alia,* their scope of application. On the one hand, capital requirements can have a broad focus, applying to banks' total risk weighted assets (RWA), as in the case of the countercyclical capital buffer and capital surcharges for globally or domestically systemically important institutions. On the other hand, capital requirements can be designed to shield the financial sector from risks emerging from specific sectoral exposures. In such cases, the additional requirement does not apply to banks' total RWA but instead on specific portfolios in their balance sheets.

Due to the detriment that systemic risks stemming from excessive developments in real estate markets can exert on financial stability[1], sectoral capital requirements have been increasingly considered as macroprudential instruments to address vulnerabilities related to real estate exposures. In recent years, several European countries activated capital-based macroprudential instruments targeting real estate assets[2], either directly, by setting higher capital ratio requirements for the concerned segments (e.g. the activation of a countercyclical capital buffer in Switzerland, with its scope of application to assets secured by real estate property), or indirectly, by adjusting parameters, such as risk weights (RW)[3], which affect capital requirements for real estate exposures (e.g. a 25 percent RW floor on mortgage loans in Sweden; tighter criteria for the application of preferential RW to residential property in Croatia, Ireland and the UK; increased RW for exposures secured by commercial real estate properties in Ireland, Norway, Romania and Sweden).

[1] See for example Crowe et al. (2013) and Hartmann (2015). Claessens et al. (2009) show that financial and economic busts preceded by a real estate boom are particularly harmful from a financial stability perspective since they are longer and costlier than the average downturn. On the interplay between mortgage loan financing, leverage, real estate prices and the macro-economy, see for example Kiyotaki and Moore (1997), Aoki et al. (2004), Davis and Heathcote (2005), Iacoviello (2005), Iacoviello and Neri (2010), Forlati and Lambertini, 2011), Kannan and Rabanal (2012).

[2] See ESRB (2016), "A Review of Macroprudential Policy in the EU in 2015" provides for a comprehensive overview of macroprudential policy in Europe.

[3] See Anderson et al. (2012) and Bank of England (2011) on the use of risk weights as macroprudential instruments.

In December 2013, the National Bank of Belgium introduced a macroprudential measure aimed at strengthening the resilience of Belgian banks against adverse developments in the real estate market. The measure imposed a 5 percentage point add-on to the RW on Belgian residential real estate exposures for banks calculating regulatory capital requirements through an internal ratings-based (IRB) approach. While the effects of capital-based measures in terms of increased capital available to absorb potential losses are readily measurable (for example, the Belgian measure entailed an increase in the average RW for IRB banks from 10 percent at the end of 2012 to 15 percent at the end of 2013[4]), their consequences on the supply and pricing of credit, being either intended or unintended, are more difficult to assess. This is due to the challenges of isolating the impact of policy changes from that of other developments that might have affected banks' lending behaviour during the same period.

This paper aims at quantifying the impact of the introduction of the macroprudential add-on to RW for domestic residential real estate exposures in Belgium on the pricing of mortgage loans granted by Belgian IRB banks. Using bank-level data on mortgage lending rates, regulatory capital requirements and bank balance sheet characteristics, we find that the RW add-on has affected IRB banks heterogeneously. In particular, IRB banks that are relatively more affected by the macroprudential measure, i.e. banks that are either mortgage-specialised and/or face higher minimum regulatory capital ratio requirements, raise mortgage loan spreads by a greater amount. In contrast, IRB banks that are less capital-constrained, i.e. banks that have a larger voluntary management buffer to absorb the higher capital requirement implied by the RW add-on, raise lending spreads by less. In terms of economic significance, the impact of the RW add-on on mortgage loan pricing appears to be relatively limited: results based on our full data sample suggest an average increase in mortgage loan spreads of 12 basis points, ranging between 0 and 35 basis points across individual IRB banks. Robustness checks on the length of the control sample suggest a more homogeneous impact across IRB banks, with only a few banks raising spreads by more than 10 basis points.

By analysing the impact of a sectoral macroprudential measure on mortgage loan pricing, this paper contributes to the literature on the impact of capital requirements on bank lending. The vast majority of this literature has focused on the changes to overall capital requirements, either following the introduction of the new Basel regulation, or due to changes in individual banks' capital requirements. The analysis of the effects of sectoral capital requirements in general, and of those targeting real estate exposures in particular, is much less explored. This is not surprising, given the relatively recent experience with the introduction of such instruments, which leads to a scarcity of

[4] See the National Bank of Belgium's "Financial Stability Report", 2014.

observations for a proper ex post policy assessment. To our knowledge, this paper is among the first to provide empirical evidence on the impact of introducing a sectoral macroprudential capital requirement on lending spreads. Documenting the impact of such macroprudential requirements is crucial for gaining experience with these instruments and for improving the effectiveness of macroprudential policies in general.

The rest of the paper is organised as follows. Section 2 provides an overview of the recent literature on the effects of capital requirements on bank lending, with a specific focus on mortgage loan pricing. In Section 3 we explain in more detail the Belgian macroprudential measure that is the focus of this paper. Sections 4 and 5 present the data and empirical specification underlying our analysis, of which the results are discussed in Section 6. Section 7 concludes.

2 LITERATURE ON THE EFFECTS OF CAPITAL REQUIREMENTS ON BANK LENDING

Due to the increased emphasis on macroprudential policy in the aftermath of the financial crisis, a new body of studies examining the costs and the benefits of such policy interventions has flourished. However, a broad consensus has not yet been reached, neither regarding the positive effects of capital requirements on reducing the probability and the cost of crises, nor concerning the transmission of capital-based policy measures on the price and volume of credit (e.g. Galati and Moessner (2014); Tressel and Yuanyan (2016)).

On the benefits side, capital requirements are expected to foster financial stability by reducing the probability of banks' financial distress and by minimizing their losses given default. However, the evidence on both the effect of capital requirements on banks' ex ante risk taking behaviour and on the ex post effectiveness in improving financial system resilience is mixed. While some studies confirm the positive effect of capital requirements in reducing banks' risk taking (e.g. De Haan and Klomp (2012)), banks' financial fragility (e.g. De Jonghe (2010); Miles et al. (2012), Diamond and Rajan (2001)); Baker and Wurgler (2013)) and the cost of banking crises (e.g. Dewatripont and Tirole (1994); Gambacorta and Mistrulli (2004); Albertazzi and Marchetti (2010); Beltratti et al. (2012); Kapan and Minoiu (2013)), others find either non-significant or even opposite results (e.g. Demirgüç-Kunt and Detragiache (2011)).

The costs entailed by higher capital requirements can be quantified in terms of forgone lending and, possibly, reduced economic activity. Banks' behaviour following the policy change is a key determinant of its transmission to lending volumes and lending rates. For an increase in capital requirements to exert an effect on banks' lending decisions, banks need to consider equity more expensive than debt or that their voluntary management buffer held above minimum regulatory requirements falls below an internal or external target level. In a recent theoretical study by Baker and Wurgler (2015), simulations using US data suggest that a one percentage point increase in the ratio of capital RWA leads to a raise of lending spreads between 6 and 9 basis points. In the context of a dynamic stochastic general equilibrium model calibrated with Euro Area data, Mendicino et al. (forthcoming) quantify the effect of a one percentage point increase in the ratio of capital to RWA on mortgage lending spreads to be equal to 2.8 basis points. Focusing more specifically on RW, Anderson et al. (2012), argue that changes in sectoral RW can affect banks' behaviour by altering the relative return on equity from different assets. The asset composition effect of increasing RW is illustrated, for example, by Mendicino et al. (forthcoming). They show that profit maximizing banks tend to rebalance their investment portfolio according to the relative return on equity of different assets. As an increase in RW on domestic residential exposures lowers the return on equity for that asset class, banks may be encouraged to reduce such exposures to the advantage of other exposures (e.g. credit to non-financial corporations).

The empirical assessment of the effect of capital requirements on lending volumes and interest rates is challenging not only due to the shortage and/or strict confidentiality of data on past changes in bank capital requirements, let alone macroprudential capital requirements, but also because, for the observed changes, it is difficult to disentangle the effect of the regulation from other, broader, developments (e.g. Noss and Toffano (2016)). However, the increased availability of policy changes involving capital requirements, led an increasing number of authors to explore their effects on banks' behaviour in terms of supply and pricing of credit. More specifically, this growing strand of literature based on a diversity of countries suggests that capital-based macroprudential regulation does affect bank lending and loan pricing.[5] De-Ramon et al. (2012) estimate the relationship between lending spreads and aggregate bank capital ratios using UK data from 1992 to 2012. They find that, in the long run, UK spreads increased by 9.4 basis points for a one percentage point increase in total capital requirements. Šutorova and Teply (2013) estimate that lending rates increase by 19 basis points for a one percentage point increase in capital resources using a sample of 594 European banks for the period 2006 to 2011. Cosimano and Hakura (2011) find that the new capital requirements introduced under the Basel III framework, by raising banks' marginal cost of funding, lead to higher lending rates. Considering a sample of large banks for 12 OECD countries, they estimate that the average increase in large banks' equity to asset ratio required by the new capital regulation (+1.3 percentage points) would lead large banks to increase their lending rates by 16 basis points. Focusing on a smaller set of 3 OECD countries, Slovik and Cournède (2011) estimate that the

[5] In the discussion of this literature, we focus on the impact of capital requirements on loan pricing. For exhaustive overviews of the literature, including on the impact on lending volumes and growth, see for instance Martynova (2015) and Basel Committe of Banking Supervision (2016).

macroeconomic impact of the implementation of Basel III is mainly driven by an increase in bank lending spreads. More specifically, they find that, to meet the capital requirements effective as of 2019 (7 percent for the common equity ratio, 8.5 percent for the Tier 1 capital ratio) banks would potentially increase lending spreads by about 50 basis points. Still focusing on the implementation of Basel III, King (2010) finds that a representative bank could recover the higher cost of funds associated with a one percentage point increase in the capital ratio by increasing lending spreads by 15 basis points. Using data on large US financial institutions, Kashyap et al. (2010) estimate that a one percentage point increase in banks' capital requirement leads to an increase in bank lending rates comprised between 2.5 and 2.4 basis points in the long-run.

Most of these empirical studies focus on assessing the impact of overall minimum regulatory capital requirements: given the rather recent experience with macroprudential capital requirements, and specifically sectoral capital requirements targeting mortgage lending, evidence on the impact of sectoral macroprudential capital requirements is scarce. Martins and Schechtman (2013) analyse the impact of a macroprudential increase of RW targeting auto loans with long maturities and high LTVs in Brazil. They find that banks increased spreads on affected loans by at least 13 percent compared to spread on loans that were not affected by the measure. While considering neither sectoral nor macroprudential capital requirements, Uluc and Wieladek (2015) investigate the impact capital requirements on mortgage loans in the UK. Their results suggest that a rise in an affected bank's capital requirement of 100 basis points leads to a decline in loan size of about 5.4%, while loans issued by competing banks that are not affected by the change in capital requirement rise by roughly the same amount, suggesting that competition in the local lending market may mute aggregate loan contraction when higher capital requirements are imposed on only a subset of lenders. Finally, Basten and Koch (2015) specifically focus on capital requirements targeting residential real estate exposures. They find that capital-constrained banks with low capital buffers raise their mortgage rates relatively more than their competitors in response to the introduction of a one percent countercyclical capital buffer on mortgage loan exposures in Switzerland.[6] Furthermore, while banks operating a more mortgage-intensive business model also exhibit a more aggressive pricing reaction, liquid banks offer mortgage rates that are on average lower than those offered by less liquid banks. The estimated interaction effects are economically rather small (well below 10 basis points), however.

By providing evidence on the impact of a sectoral macroprudential measure on mortgage loan pricing, we contribute to this scant literature on the impact of sectoral capital requirements on bank

[6] Other studies that find that the size of the effect of tighter capital regulation on bank lending is associated with specific bank characteristics, such as the existing level of bank capitalization and banks' business model, include Carlson et al. (2013) and Aiyar et al. (2014).

loan pricing. Before turning to the empirical analysis, we explain in more detail the Belgian macroprudential measure that is the focus of this paper.

3 THE BELGIAN MACROPRUDENTIAL MEASURE

Macroprudential instruments targeting real estate exposures can be classified as either borrower-based or capital-based. Borrower-based instruments act on the terms and conditions of credit, for example by imposing limits to the loan-to-value (the ratio between the size of the loan and the value of the financed property) or to the borrower's debt service costs.[7] Capital-based instruments affect banks' balance sheets through changes in capital requirements, imposed either directly by setting higher regulatory capital ratio requirements for real estate exposures, or indirectly by acting on parameters, such as RW, which affect capital requirements.

The Basel Accord foresees two possible methods for calculating capital requirements for retail mortgage loan exposures. The standardised (STA) approach applies a fixed RW (35 percent) to all exposures secured by mortgages on residential property, which is then used as a basis for computing the amount of capital required under Pillar I for this exposure class. The IRB approach allows banks to use internal models for estimating the key parameters (notably the probability of default and the loss given default) used as input in the Basel RW function for the calculation of the RW to be applied to the bank's mortgage loan exposure.

In Belgium, the STA approach is mainly used by small credit institutions, covering a small share of total mortgage loans held by the Belgian banking sector. A fact-finding exercise conducted by the National Bank of Belgium in 2012 revealed that RW on mortgage loans of Belgian banks using the IRB approach were not only substantially lower than those resulting from banks applying the STA approach but also on average quite low compared to those of other European countries.[8] While the low level of IRB RW (on average 10 percent) can be justified by the absence of major downturn events in the historical credit loss data of the Belgian real estate market on which the model parameters are calibrated, the presence of pockets of vulnerabilities represented by segments of the outstanding mortgage loan portfolio (characterised by high loan-to-value ratios, high debt service ratios and long maturities) raised concerns over the resilience of Belgian banks against higher than expected losses that could result from abrupt developments in the Belgian real estate market.

Against this background, the National Bank of Belgium introduced in December 2013 a macroprudential measure consisting in a 5 percentage point add-on to the RW on Belgian residential

[7] See for example the ESRB "Handbook on Operationalising macroprudential policy in the banking sector (2010)".
[8] See European Banking Authority, 2013, "Third interim report on the consistency of risk-weighted assets, SME and residential mortgages".

real estate exposures for banks calculating regulatory capital requirements through an IRB approach.[9] The macroprudential measure was primarily aimed at increasing banks' resilience against potential losses stemming from less buoyant conditions on the residential real estate market. The immediate effect of the measure in terms of increased capital to absorb potential losses is readily measurable: as a consequence of the policy, the average RW on mortgage loan exposures used as input for calculating the capital requirements of Belgian IRB banks increased from 10 percent to 15 percent. This implies that each IRB bank is required to hold on average an additional EUR 70 million of capital, ranging between EUR 35 million and almost EUR 150 million. At the sectoral level, the add-on resulted in a total additional capital requirement for all IRB banks in the sample of almost EUR 600 million. This represents on average about 3 percent of these banks' outstanding Tier 1 capital, with a range between 0.3 percent up to almost 8 percent.

The objective of the add-on was not to curb the supply of credit per se. In fact, the calibration of the measure aimed at increasing resilience while at the same time avoiding an unsettling of the market. Yet, to the extent that banks perceive higher capital requirements as increasing their cost of funding (and/or as decreasing their voluntary management buffer above minimum requirements below an internal or external target), they may decide to pass on this perceived increase in funding cost to their customers. In the following sections we aim at quantifying to what extent Belgian IRB banks that were affected by the macroprudential measure indeed responded to its introduction by adjusting their mortgage loan pricing upward.

[9] The choice to operate through RW rather than setting a higher regulatory capital requirement stems from restrictions in European legal framework (the Capital Requirements Regulation and Directive, CRR/CRD IV) laying out the prudential rules for the EU banking system.

4 DATA

In our analysis we consider a sample of 13 Belgian banks, of which 8 use the IRB approach for the calculation of regulatory capital requirement (and are therefore directly affected by the macroprudential measure) and 5 using the STA approach.

The dependent variable considered in the empirical analysis is the spread between the interest rate applied to new mortgage loans over the swap rate. Denoting $r_{b,t}$ the average mortgage loan rate charged by bank b in period (month) t and $s_{b,t}$ the average swap rate corresponding to the repricing profile of bank b's new mortgage production[10], the spread is defined as follows:

$$spread_{b,t} = r_{b,t} - s_{b,t}$$

Data on mortgage rates on new loans are obtained from the National Bank of Belgium's MFI Interest Rate (MIR) statistics and swap rates are taken from Datastream. Figure 1 shows the dynamics of the weighted average mortgage loan spread between January 2003 and December 2015 for IRB and STA banks respectively, whereby the weights are given by the banks' share in total new mortgage loan production. Prior to 2007 mortgage loan spreads followed a declining trend, reaching unsustainably low levels in 2006 and 2007. After the onset of the financial crisis, Belgian banks raised their mortgage loan spreads substantially, mainly reflecting increased risk premia and the need to restore profitability while retrenching to core activities. To provide more background on these differences between the pre- and post-crisis period, the figure also displays the EONIA interest rate. The figure shows that there is a negative relationship between the policy rate and the mortgage loan spreads. In the period before the crisis, strong competition in the mortgage market in an environment of search for yield and general underpricing of risk, resulted in a far from perfect pass through of the increasing policy rate, with a consequent substantial decrease in lending spreads. Banks took the opportunity to restore these unsustainably low lending spreads to more sound levels when the policy rate was drastically cut after the onset of the financial crisis.[11] During the last years of our sample, the low interest rate environment may have exerted further upward pressure on

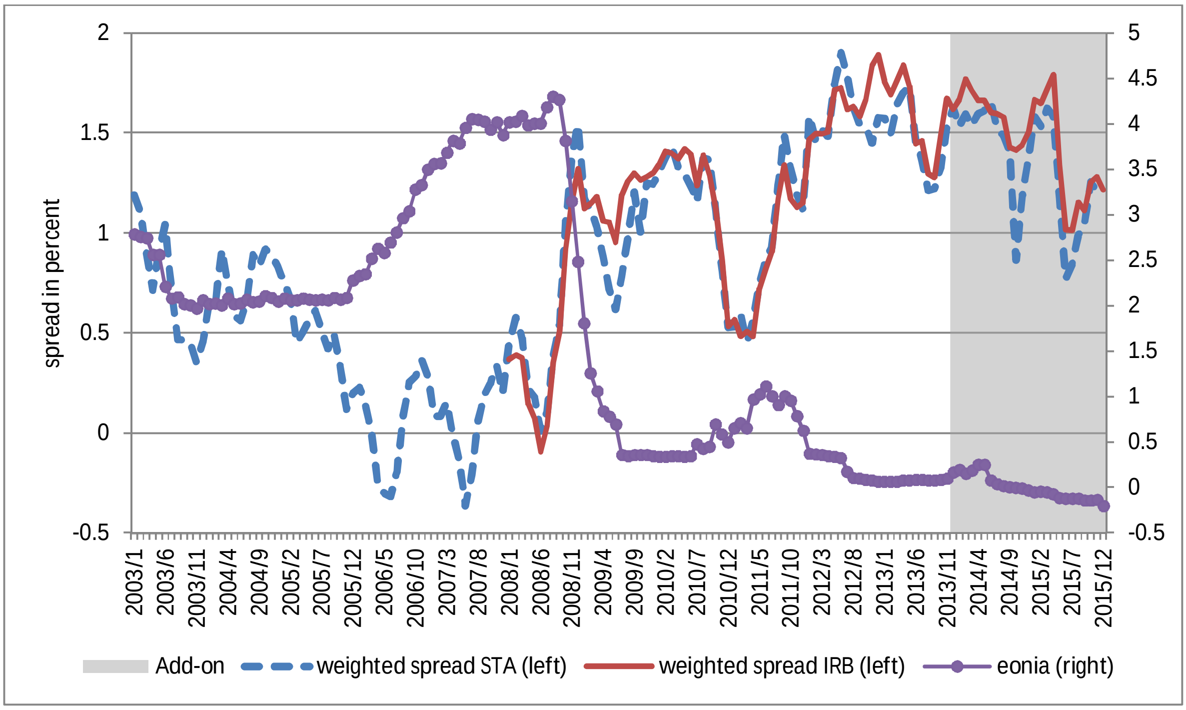
[10] The difference between the mortgage rate and the swap rate is only a proxy for banks' commercial lending margins. We account for the time to repricing in banks' new mortgage loan production by assigning the 1 year swap rate to mortgage loans with time to repricing of at most 1 year, the 5 year swap rate to mortgage loans with time to repricing between 1 and 5 years, the 10 year swap rate to mortgage loans with time to repricing between 5 and 10 years, and the 20 year swap rate to mortgage loans with time to repricing of more than 10 years.

[11] An additional factor could be that during a recession, banks become more capital constrained and consequently are forced to increase lending margins by reducing the pass-through of a decreasing policy rate (see e.g. Roelands, 2012).

lending spreads due to a large amount of renegotiations of existing loan contracts.[12] Nevertheless, average spreads have decreased somewhat again in the last months of the sample, potentially due to increased competition for mortgage loan volumes in an environment of market rates close to the zero lower bound.

Focusing on the differences between STA and IRB banks[13] reveals that, on average, IRB banks tend to charge somewhat higher mortgage loan spreads than STA banks (slightly above 130 basis points compared to 115 basis points). But overall, the lending spreads of IRB banks and STA banks exhibit on average a very large co-movement (the correlation between the two series amounts to 95 percent), suggesting the presence of common factors and/or endogenous behaviour (e.g. due to competition) that lead to very similar dynamics across the entire sector.

Figure 1 - Evolution of mortgage loan spreads (in percentage): 2003m1-2015m12.



Sources: NBB MIR statistics.

In order to assess the effect of the macroprudential measure on IRB banks' mortgage loan spreads, the policy variable included in the analysis is a dummy indicator representing the periods in which

[12] Renegotiated loans, where borrowers fix the interest rate on an existing contract at a lower interest rate, enter the data as new loan contracts. As there is a large administrative costs associated with getting a new credit at a bank different from the one that originally granted the loan, competition for renegotiated loans is likely to be lower, potentially allowing banks to charge higher spreads on this part of the "new" loan production.

[13] Note that the distinction between IRB and STA banks is only possible from 2008 onwards, since the possibility for banks to calculate capital requirements based on internal models was introduced in the Basel II framework.

the 5 percentage point add-on to risk weights on IRB banks' exposures to Belgian mortgage loans is enforced. The *add-on* dummy variable is therefore set equal to one for IRB banks in the period from December 2013 onwards, and is equal to zero otherwise (i.e. before the introduction of the measure as well as for STA banks throughout the sample). This period is marked by the shaded area in Figure 1.

We consider a broad set of bank characteristics obtained from supervisory reporting[14] on a solo basis as control variables that may explain banks' mortgage loan pricing decision as well as the relative strength of their reaction to the introduction of the RW add-on. In Table 1 we present some summary statistics of these variables distinguishing between IRB and STA banks. The first six variables in Table 1 are used as common controls throughout the sample and therefore may affect the average lending spread across banks with different balance sheet characteristics. The table indicates that IRB banks are on average significantly larger than STA banks (EUR 125 billion vs EUR 5.36 billion), but also display a higher variation in terms of balance sheet total. IRB banks tend to be less exposed, at least in relative terms, to Belgian mortgage loans compared to STA banks (18 percent vs. 28 percent). While the dispersion around the mean is very large for both STA and IRB banks, the latter tend to rely more heavily on wholesale funding sources, as revealed by the higher average loan-to-deposit ratio. The average differences between STA and IRB banks seem relatively limited for the remaining three of the first six control variables.

Table 1 Summary statistics of the bank-specific control variables

	IRB banks					STA banks				
Variable	Obs.	Mean	Std. Dev.	Min.	Max.	Obs.	Mean	Std. Dev.	Min.	Max.
Total assets (EUR bill)	700	125.00	114.00	10.60	610.00	351	5.36	2.89	0.48	11.10
Profit / Total assets	700	0.0019	0.0076	-0.0543	0.0126	351	0.0053	0.0050	-0.0066	0.0226
Total loans / Deposits	700	0.9079	0.1865	0.6478	1.5026	351	0.8301	0.3847	0.0341	1.7863
Cost / Income	700	0.6846	0.1958	0.3282	1.7596	351	0.6463	0.3364	0.0861	2.3261
Loan loss / Total loans	700	0.0015	0.0028	-0.0017	0.0229	351	0.0010	0.0026	-0.0009	0.0194
BE mortgage loans / Total assets	700	0.1846	0.1503	0.0183	0.5384	351	0.2809	0.1806	0.0147	0.6289
Tier 1 capital ratio requirement	199	0.1176	0.0238	0.0925	0.1830	NA	NA	NA	NA	NA
Additional capital / RWA	199	0.0049	0.0041	0.0004	0.0145	NA	NA	NA	NA	NA
Additional capital / Total assets	199	0.0013	0.0008	0.0003	0.0026	NA	NA	NA	NA	NA
Capital buffer / RWA	199	0.0369	0.0250	-0.0139	0.1217	NA	NA	NA	NA	NA

Source: NBB.

Notes: The distinction between IRB and STA banks exists only since January 2008. As consequence, the summary statistics presented in Table 1 refer to the sample period 2008-2015. The number of observations for the last four control variables is lower because the Tier 1 capital ratio requirement resulting from the National Bank of Belgium's SREP decisions is only available for the IRB banks in our sample and from 2012 onwards. We therefore only use these as interaction variables with the *add-on* dummy variable and show summary statistics for these observations where the *add-on* dummy is equal to one.

[14] The data on total assets, profits, total loans, deposits, cost-to-income ratio, loan loss ratio and Belgian mortgage loans are obtained from Schema A reports, whereas capital related variables are sourced from COREP. The Tier 1 capital ratio requirement results from the National Bank of Belgium's Supervisory Review and Evaluation Process (SREP) decisions regarding banks' capital requirements.

The last five control variables are interacted with the *add-on* dummy variable to assess to what extent IRB banks' response to the macroprudential measure in terms of mortgage loan pricing differs according to specific characteristics of IRB banks. In particular, the share of Belgian mortgage loan exposures in the banks' total balance sheet, the Tier 1 regulatory capital ratio requirement, the additional capital required[15] by the measure as a share of RWA, the additional capital required by the measure as a share of total assets capture the relative degree to which IRB banks are affected in terms of additional capital requirements following the increase in the risk weight. The capital buffer relative to RWA variable captures the degree to which the affected banks have room to absorb this additional capital requirement by reducing the voluntary management buffer they hold above minimum regulatory requirements. Table 1 shows that the average regulatory capital ratio requirement for the IRB banks in the sample is close to 12 percent and that these banks on average hold a voluntary management buffer of 3.7 percent above this minimum requirement. The RW add-on results in an average 0.5 percent increase in required capital when expressed relative to RWA, but this effect increases up to 1.5 percent for the bank that is most affected by the measure. Similarly, the size of the additional capital required by the RW add-on ranges between 0.03 percent and 0.3 percent of IRB banks' total assets.

Simple correlation analysis (not shown) indicates that IRB banks that are relatively more mortgage-concentrated tend to have a lower Tier 1 capital ratio requirement. Consequently, for some banks these two factors may be balancing each other in determining the additional capital required by the RW add-on. Yet, correlations of these two variables with the two variables based on additional capital required by the RW add-on are positive (ranging between 14 percent and 93 percent). There seems to be no relationship between the size of the capital buffer to RWA and the other four variables capturing the extent to which IRB banks may be affected by the RW add-on (correlation coefficients of at most 10 percent). The correlation analysis also shows that IRB banks that are expected to be affected more by the RW add-on tend to be the smaller IRB banks. Therefore, any finding that these IRB banks respond more aggressively in terms of mortgage loan pricing is unlikely to be driven by market power.

5 EMPIRICAL SPECIFICATION

To assess the impact of the macroprudential RW add-on on mortgage loan pricing, we estimate the following equation:

[15] The additional capital required by the measures is obtained by multiplying the amount of Belgian mortgage loans on the balance sheet with the bank's Tier 1 capital requirement and the change in the mortgage loan RW introduced by the add-on (0.05).

$$spread_{b,t} = \alpha + \beta_{b,t}\ add\text{-}on_t + \delta\ X_{b,t-1} + FE_b + FE_t + \varepsilon_{b,t} \tag{1}$$

where $spread_{b,t}$ denotes the mortgage loan spread charged by bank b in month t, $add\text{-}on_t$ is an indicator variable that equals 1 for banks that use the IRB approach for determining the risk weights on mortgages during the months in which the RW add-on is in place (from December 2013 onwards) and 0 otherwise, $X_{b,t-1}$ is a vector of additional bank-specific control variables, FE_b and FE_t denote bank and time fixed effects, respectively, and $\varepsilon_{b,t}$ is a normally distributed error term.

The impact of the RW add-on on the mortgage loan spread is captured by the difference-in-differences estimator $\beta_{b,t}$, which is defined as

$$\beta_{b,t} = \beta_0 + \beta_1 Z_{b,t-1} \tag{2}$$

where $Z_{b,t-1}$ is a vector of bank specific control variables that we interact with the add-on indicator.

Equation (1) can be rewritten as

$$spread_{b,t} = \alpha + \beta_0\ add\text{-}on_t + \beta_1\ Z_{b,t-1}\ add\text{-}on_t + \gamma X_{b,t-1} + FE_b + FE_t + \varepsilon_{b,t} \tag{3}$$

The parameter $\beta_{b,t} = \beta_0$ is obtained when the add-on indicator is not interacted with any control variables $Z_{b,t-1}$ and therefore captures the average impact of the add-on on the IRB banks in the sample. When the variables in $Z_{b,t-1}$ are included, $\beta_{b,t}$ equals the expression in equation (2), which allows us to quantify the heterogeneous reactions of mortgage loan spreads across IRB banks.

6 RESULTS

This section reports the results of the econometric analysis of the impact of the Belgian macroprudential RW add-on on IRB banks' mortgage loan spreads. We consider several model specifications and three different sample periods.

6.1 Full sample

Table 2 reports the results that are obtained when using the full sample ranging from January 2003 to December 2015. The starting point of our analysis is a baseline model where mortgage loan spreads are regressed on a constant, the add-on indicator variable, a set of bank-specific variables as well as time and bank-specific fixed effects (Model 1). In this baseline specification, the add-on is estimated to have increased mortgage loan spreads, on average, by 11 basis points. Furthermore, some bank characteristics explain differences in mortgage loan pricing in this baseline specification. First, IRB banks on average tend to charge higher mortgage loan spreads (as also apparent in Figure

1), but in economic terms, the difference between IRB and STA banks' lending spreads is rather modest (16 basis points). Also the coefficients on total assets, the loan-to-deposit ratio and the domestic mortgage loan share are positive and statistically significant throughout all model specifications. The first implies that larger banks tend to charge, on average, higher spreads on their mortgage loans, probably due to their market power. Second, a smaller share of deposit funding is associated with higher mortgage loan spreads. In fact, a high loan-to-deposit ratio implies that a large share of loans is funded by sources other than customer deposits. To the extent that market funding is cheaper than deposit funding due to, for example, regulation on the remuneration of saving deposits, a stronger reliance on market funding allows banks to increase lending margins. To conclude, there is some evidence that mortgage-specialised banks tend to charge a higher price for mortgage loans, but this effect is only marginally significant. These results on the bank-specific control variables hold across all model specifications in Table 2.

The subsequent specifications of the model (Model 2 to Model 6 in Table 2) extend the baseline model by adding one control variable at a time. More specifically, these control variables are interactions between the add-on dummy and bank-specific characteristics, such as the share of domestic mortgage loans in total assets, the Tier 1 regulatory capital ratio requirement, the additional capital required by the measure as a share of RWA, the additional capital required by the measure as a share of total assets, and the banks' capital buffer as a share of RWA. These model specifications aim at exploring whether the effect of the RW add-on on mortgage loan spreads differs across IRB banks, depending on their specific characteristics. In particular, the first four control variables are expected to positively affect the impact of the RW add-on on lending spreads, as they capture the relative degree to which IRB banks are affected in terms of additional capital requirements following the increase in the RW. In contrast, the capital buffer variable captures the degree to which the affected banks have room to absorb this additional capital requirement by reducing the voluntary management buffer they hold above the Tier 1 regulatory capital ratio requirement and therefore is expected to negatively affect the impact of the RW add-on on the mortgage loan spread.

The estimates for Model 2 reveal that, in line with the findings of Basten and Koch (2015) for the Swiss countercyclical capital buffer, banks for which the mortgage exposures that are affected by the macroprudential measure account for a larger share of the balance sheet raise the loan spreads significantly more after the introduction of the measure. Due to the specific real estate focus of the add-on, banks with a higher concentration of their assets in mortgage loan exposures experience a relatively stronger increase in their cost of funds, which they in turn pass on, at least partially, to their customers. Consistent with the findings of Carlson, et al. (2013), Aiyar et al. (2014) and Basten and Koch (2015) our results reveal that the capitalization characteristics of banks are a significant determinant of their reaction to increased capital requirements in terms of loan pricing. While the level of the Tier 1 regulatory capital ratio requirement does not significantly lead to a higher increase in mortgage loan spreads (Model 3), we observe that banks for which the additional capital required by the macroprudential measure is relatively larger do react by raising the price of mortgage lending more. This effect is statistically significant only when the additional capital is measured in relation to total assets (Model 5), however. Finally, Model 6 shows that banks that have a lower capital buffer above minimum regulatory capital requirements react more strongly to the additional capital requirement than less capital-constrained banks. The negative and statistically significant coefficient of the capital buffer variable implies that IRB banks that hold a larger voluntary management capital buffer raise mortgage loan pricing by less after the introduction of the RW add-on.

The last four specifications (Model 7 to 10) each consider one of the first four control variables, which capture the relative effect of the macroprudential measure in terms of additional required capital, in combination with the capital buffer variable. These specifications not only confirm the previous findings, but also reinforce them. In particular, in Model 9 the coefficient on the interaction between the add-on dummy and additional capital as a share of RWA is statistically significant (at the 10 percent level).

The aforementioned results indicate the add-on had a heterogeneous impact on IRB banks' mortgage loan spreads. Figure 2 sheds light on the implied impact of the Belgian macroprudential measure across individual IRB banks for different model specifications. In the figure, dots represent IRB banks for which the model implied impact[16] of the add-on is statistically significant (at the 95 percent confidence level), while dashes represent those IRB banks for which the effect is not statistically significant. As already mentioned, the baseline model (Model 1) shows a statistically significant 11 basis points average effect of the RW add-on on mortgage loan spreads. The results for the other model specifications (Model 6 to 10) given an indication of the economic significance of the variation of individual impacts across IRB banks: the increase in mortgage loan spreads as a consequence of the add-on ranges between 0 and 35 bps. Overall, these findings suggest that the impact of the macroprudential measure on mortgage pricing is limited.

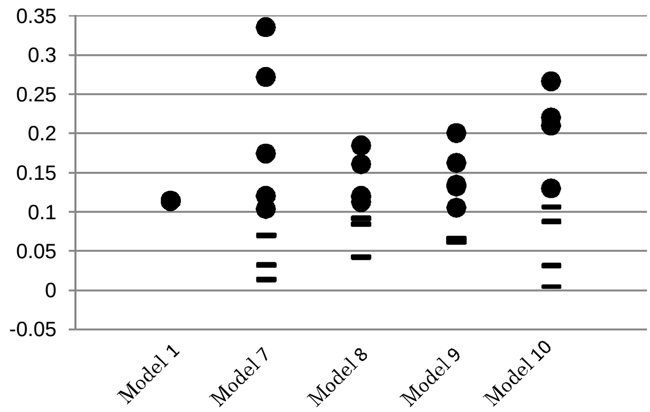
[16] For each IRB bank, the average impact over the months during which the RW add-on is in place is shown.

Table 2 – Impact of the RW add-on on the IRB bank's mortgage loan spread: 2003M1 – 2015M12

	Regression of mortgage loan spread - Full sample (2003M1-2015M12)									
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*	*Model 9*	*Model 10*
Add-on	0.113**	-0.001	0.046	0.088*	0.001	0.198***	0.082	0.154	0.168***	0.083
	(0.048)	(0.063)	(0.095)	(0.053)	(0.062)	(0.051)	(0.063)	(0.102)	(0.054)	(0.061)
Add-on x (BE mortgage loans / Total assets)		0.594***					0.632***			
		(0.225)					(0.224)			
Add-on x Tier 1 capital ratio requirement			0.559					0.355		
			(0.639)					(0.656)		
Add-on x (Additional capital / RWA)				5.122					7.126*	
				(4.092)					(4.246)	
Add-on x (Additional capital / Total assets)					97.054***					104.947***
					(33.705)					(33.518)
Add-on x (Capital buffer / RWA)						-2.254***	-2.422***	-2.225***	-2.384***	-2.438***
						(0.474)	(0.481)	(0.477)	(0.492)	(0.485)
IRB	0.163***	0.162***	0.163***	0.164***	0.162***	0.166***	0.165***	0.166***	0.167***	0.166***
	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)	(0.040)
Log total assets	0.162***	0.131***	0.160***	0.154***	0.132***	0.165***	0.133***	0.164***	0.155***	0.133***
	(0.041)	(0.047)	(0.042)	(0.044)	(0.046)	(0.041)	(0.046)	(0.042)	(0.044)	(0.046)
Profit / Total assets	-1.687	-1.61	-1.617	-1.626	-1.553	-1.45	-1.35	-1.408	-1.352	-1.286
	(1.618)	(1.606)	(1.627)	(1.619)	(1.607)	(1.632)	(1.619)	(1.640)	(1.633)	(1.621)
Total loans / Deposits	0.239***	0.220***	0.236***	0.230***	0.216***	0.234***	0.213***	0.232***	0.222***	0.209***
	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.065)	(0.064)	(0.065)
Cost / Income	0.029	0.023	0.031	0.029	0.025	0.036	0.03	0.037	0.036	0.032
	(0.044)	(0.045)	(0.044)	(0.044)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)	(0.045)
Loan loss / Total loans	3.441	2.6	3.282	3.076	2.426	3.389	2.491	3.289	2.878	2.287
	(3.683)	(3.659)	(3.710)	(3.722)	(3.680)	(3.672)	(3.648)	(3.699)	(3.705)	(3.668)
BE mortgage loans / Total assets	0.261*	0.234	0.265*	0.268*	0.245	0.291*	0.265*	0.293*	0.303*	0.276*
	(0.156)	(0.156)	(0.156)	(0.156)	(0.156)	(0.157)	(0.157)	(0.157)	(0.157)	(0.157)
Constant	0.447***	0.508***	0.450***	0.463***	0.508***	0.437***	0.502***	0.439***	0.459***	0.503***
	(0.099)	(0.105)	(0.099)	(0.101)	(0.105)	(0.099)	(0.105)	(0.099)	(0.101)	(0.105)
Adjusted R-squared	0.835	0.835	0.835	0.835	0.835	0.835	0.836	0.835	0.835	0.836
Log-likelihood	-206.058	-201.576	-205.856	-205.636	-202.259	-202.276	-197.201	-202.195	-201.468	-197.837
Observations	1646	1646	1646	1646	1646	1646	1646	1646	1646	1646

Notes: Standard errors are in parentheses. Add-on equals 1 for IRB banks during the months in which the RW add-on is in place (from December 2013 onwards) and 0 otherwise. IRB equals 1 for IRB banks (from 2008 onwards) and 0 otherwise. All bank-specific control variables are lagged by one period. All specifications include bank and time dummies. Significance: *** 1 percent, ** 5 percent, * 10 percent.

Figure 2 - Model implied impact of the Belgian real estate RW add-on on IRB banks' mortgage loan spreads (full sample)



Note: Dots represent IRB banks for which the model implied impact of the add-on is statistically significant (at the 95 percent confidence level), dashes represent IRB banks for which the effect is not statistically significant.

6.2 Alternative samples

To analyse whether our findings are robust to changes in the control sample considered, we repeat the exercise while shortening the sample before the introduction of the RW add-on to two cut-off points. First, as the distinction between IRB and STA banks begins only with the introduction of Basel II in 2008, we test robustness to excluding the pre-Basel II era by restricting the sample to encompass only the Basel II period (i.e. starting in January 2008). Second, as the financial crisis entailed exceptional circumstances and may have affected banks' lending spreads in a structural manner, we re-estimate the models restricting the sample to the period after the aftermath of the financial crisis (i.e. starting in January 2011).

Table 3 presents the results of the same ten models, relying on the sample ranging from January 2008 to December 2015. First, the average impact of the add-on (8 basis points) estimated in Model 1 is no longer statistically significant. Concerning the relationship between the other bank-specific characteristics and the pricing of mortgage loans, the baseline specification shows that the mortgage loan spread in IRB banks is estimated to be on average about 90 basis points higher than for STA banks. We no longer find a significant effect of bank size and the statistical significance of the loan-to-deposit ratio reduces. Instead, banks' cost to income ratio becomes significantly negative. A possible explanation is that after the financial crisis, in contrast to the buoyant times before the crisis, cost efficiency has increasingly become a point of attention. Therefore, in addition to cutting costs, banks with higher cost to income ratios may aim at raising revenues by increasing mortgage loan volumes through lowering their mortgage lending spreads. In addition, also the negative coefficient of the bank profitability variable becomes marginally significant when the sample period only starts in 2008. The negative relationship between bank profitability and spreads seems to be driven by observations during the financial crisis with extremely low profitability, while at the same time spreads were raised to relatively high levels. As removing the pre-crisis period increases the weight of these observations in the sample, the significance of the negative relationship, which was already present in the full sample, increases somewhat. Again, these findings apply to all model specifications in the table.

Concerning the contribution of bank-specific characteristics in determining the impact of the add-on on mortgage loan spreads (Model 2 to Model 10), the main conclusions obtained from the full sample continue to hold: more mortgage-specialised IRB banks, IRB banks for which the RW add-on results in a larger additional capital requirement relative to total assets, and capital-constrained IRB banks more strongly revise mortgage loan spreads upwards after the introduction of the add-on.

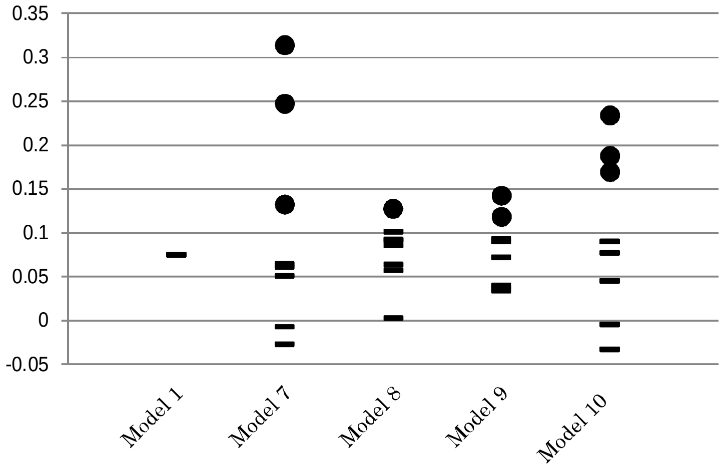
Figure 3 presents the model-implied impacts of the RW add-on on individual IRB banks for the Basel II sample. Compared to Figure 2, the number of IRB banks for which the estimated effect of the macroprudential measure is statistically significant has reduced across all model specifications. Yet, the main finding of heterogeneous impact across IRB banks and the overall limited magnitude of the impact of the measure on lending spread continues to hold: the increase in mortgage loan spreads as a consequence of the add-on ranges between 0 and 30 basis points, with an average of a not statistically significant 8 basis points.

Table 3 - Impact of the RW add-on on the IRB bank's mortgage loan spread: 2008M1 – 2015M12

	Regression of mortgage loan spread (2008M1-2015M12)									
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*	*Model 9*	*Model 10*
Add-on	0.076	-0.053	0.073	0.058	-0.047	0.146***	0.018	0.168	0.125**	0.023
	(0.048)	(0.062)	(0.104)	(0.053)	(0.061)	(0.053)	(0.062)	(0.113)	(0.055)	(0.061)
Add-on x (BE mortgage loans / Total assets)		0.665***					0.689***			
		(0.230)					(0.230)			
Add-on x Tier 1 capital ratio requirement			0.025					-0.183		
			(0.726)					(0.759)		
Add-on x (Additional capital / RWA)				3.68					5.056	
				(4.523)					(4.697)	
Add-on x (Additional capital / Total assets)					106.149***					110.510***
					(34.758)					(34.603)
Add-on x (Capital buffer / RWA)						-1.862***	-2.006***	-1.879***	-1.938***	-1.994***
						(0.519)	(0.510)	(0.533)	(0.529)	(0.509)
IRB	0.878***	0.886***	0.879***	0.886***	0.906***	0.866***	0.873***	0.863***	0.877***	0.894***
	(0.146)	(0.146)	(0.147)	(0.149)	(0.148)	(0.146)	(0.146)	(0.148)	(0.149)	(0.148)
Log total assets	0.061	0.031	0.061	0.055	0.029	0.065	0.035	0.066	0.057	0.033
	(0.063)	(0.067)	(0.064)	(0.066)	(0.067)	(0.063)	(0.066)	(0.064)	(0.066)	(0.067)
Profit / Total assets	-3.477*	-3.315*	-3.474*	-3.438*	-3.279*	-3.240*	-3.054*	-3.266*	-3.176*	-3.018
	(1.844)	(1.835)	(1.855)	(1.844)	(1.838)	(1.853)	(1.843)	(1.863)	(1.853)	(1.846)
Total loans / Deposits	0.165*	0.141	0.165*	0.157*	0.134	0.167*	0.142	0.169*	0.156*	0.135
	(0.089)	(0.087)	(0.089)	(0.088)	(0.088)	(0.089)	(0.088)	(0.089)	(0.088)	(0.088)
Cost / Income	-0.154***	-0.161***	-0.154***	-0.153***	-0.156***	-0.145***	-0.151***	-0.146***	-0.143***	-0.146***
	(0.048)	(0.049)	(0.048)	(0.048)	(0.048)	(0.048)	(0.049)	(0.048)	(0.047)	(0.048)
Loan loss / Total loans	-3.172	-4.206	-3.18	-3.478	-4.424	-3.199	-4.272	-3.139	-3.62	-4.505
	(4.167)	(4.150)	(4.207)	(4.222)	(4.177)	(4.178)	(4.165)	(4.217)	(4.233)	(4.193)
BE mortgage loans / Total assets	0.012	0.022	0.012	0.017	0.018	0.024	0.035	0.023	0.031	0.031
	(0.226)	(0.225)	(0.226)	(0.226)	(0.226)	(0.228)	(0.227)	(0.228)	(0.228)	(0.228)
Constant	1.023***	1.085***	1.023***	1.037***	1.092***	1.005***	1.068***	1.004***	1.024***	1.076***
	(0.142)	(0.146)	(0.143)	(0.146)	(0.147)	(0.142)	(0.146)	(0.143)	(0.146)	(0.148)
Adjusted R-squared	0.78	0.782	0.779	0.779	0.781	0.78	0.782	0.78	0.78	0.782
Log-likelihood	-164.484	-159.391	-164.484	-164.296	-160.409	-162.198	-156.716	-162.18	-161.844	-157.772
Observations	1045	1045	1045	1045	1045	1045	1045	1045	1045	1045

Notes: Standard errors are in parentheses. Add-on equals 1 for IRB banks during the months in which the RW add-on is in place (from December 2013 onwards) and 0 otherwise. IRB equals 1 for IRB banks (from 2008 onwards) and 0 otherwise. All bank-specific control variables are lagged by one period. All specifications include bank and time dummies. Significance: *** 1 percent, ** 5 percent, * 10 percent.

Figure 3- Model implied impact of the Belgian real estate RW add-on on banks' mortgage loan spreads (2008m1-2015m12)



Note: dots represent credit institutions for which the average impact of the add-on as implied by the model is statistically significant (at the 95 percent confidence level), dashes represent non-statistically significant effects.

As a further robustness check, Table 4 reports the results for the sample starting in 2011, thereby excluding the financial crisis. In the baseline specification (Model 1), the average impact of the add-on (4 basis points) remains statistically insignificant. Regarding the additional control variables, the difference between spreads charged by IRB banks and those charged by STA banks further increases to about 150 basis points, when using the sample from 2011 to 2015. Banks with a low cost to income ratio still charge significantly larger mortgage loan spreads and the positive relationship between the loan-to-deposit ratio and lending spreads increases again, confirming that cost efficient banks may feel less pressure to increase mortgage loan volumes through lowering spreads and larger reliance on market funding allows banks to increase their lending margins. Finally, it also emerges that, in contrast with the results based on the full sample (Table 2), banks with a higher share of domestic mortgage loans on their balance sheet priced mortgage credit more aggressively. A possible explanation for this finding is in line with the interpretation for the cost to income ratio: as a consequence of the very accommodative monetary policy stance in the aftermath of the financial crisis, banks may support profitability through increasing mortgage loan volumes. This incentive is stronger for banks with a more mortgage-specialised business model, as they have fewer alternative income sources when net interest income is increasingly under pressure.

While further reducing the control sample does not change the conclusion of statistically heterogeneous effects of the RW add-on across IRB banks, some differences compared to the previous results are noticeable however. In particular, whereas a larger voluntary management buffer above the minimum regulatory requirement still results in a lower increase in IRB banks' lending spreads, the domestic mortgage loan share no longer significantly contributes in explaining the effect of the

RW add-on on lending spreads. Instead, the level of minimum regulatory requirement significantly increases IRB banks' reaction to the add-on, suggesting that banks that are relatively more affected increase spreads by a greater amount. In fact, the coefficient of the additional capital requirement relative to RWA is significant (at the 10 percent level) in Model 9.

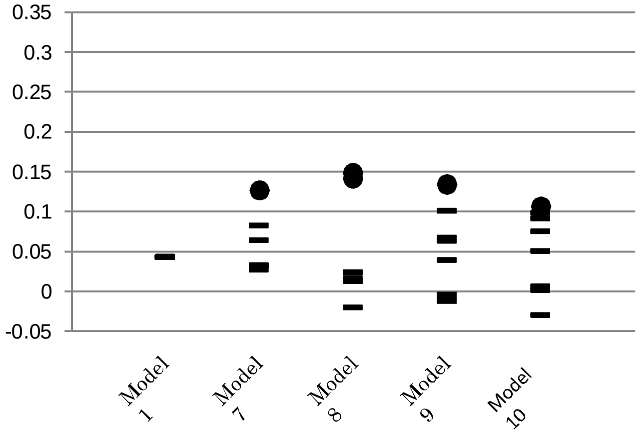
Finally, Figure 4 shows that reducing the control sample results in a further reduction in both the statistical and economic significance of the model implied impacts. Overall, the impact on mortgage loan pricing is relatively limited and is more homogeneous across banks, with only a few banks raising spreads by more than 10 basis points.

Table 4- Impact of the RW add-on on the IRB bank's mortgage loan spread: 2011M1 – 2015M12.

	Regression of mortgage loan spread (2011M1-2015M12)									
	Model 1	*Model 2*	*Model 3*	*Model 4*	*Model 5*	*Model 6*	*Model 7*	*Model 8*	*Model 9*	*Model 10*
Add-on	0.043	0.063	-0.213**	0.019	0.018	0.139***	0.155**	-0.089	0.110*	0.112*
	(0.050)	(0.060)	(0.101)	(0.055)	(0.061)	(0.053)	(0.061)	(0.098)	(0.056)	(0.061)
Add-on x (BE mortgage loans / Total assets)		-0.101					-0.085			
		(0.208)					(0.206)			
Add-on x Tier 1 capital ratio requirement			2.169***					1.865***		
			(0.674)					(0.611)		
Add-on x (Additional capital / RWA)				5.234					6.805*	
				(4.022)					(4.113)	
Add-on x (Additional capital / Total assets)					22.046					23.591
					(32.849)					(32.462)
Add-on x (Capital buffer / RWA)						-2.534***	-2.525***	-2.335***	-2.615***	-2.541***
						(0.489)	(0.494)	(0.477)	(0.493)	(0.486)
IRB	1.540***	1.535***	1.594***	1.570***	1.556***	1.515***	1.510***	1.563***	1.553***	1.531***
	(0.185)	(0.188)	(0.187)	(0.193)	(0.192)	(0.186)	(0.188)	(0.188)	(0.193)	(0.192)
Log total assets	-0.04	-0.031	-0.049	-0.055	-0.052	-0.019	-0.011	-0.029	-0.038	-0.032
	(0.097)	(0.102)	(0.097)	(0.100)	(0.102)	(0.097)	(0.102)	(0.098)	(0.100)	(0.102)
Profit / Total assets	-0.616	-0.806	-0.46	-0.296	-0.379	-0.387	-0.548	-0.271	0.035	-0.134
	(3.752)	(3.768)	(3.767)	(3.778)	(3.771)	(3.741)	(3.757)	(3.754)	(3.765)	(3.759)
Total loans / Deposits	0.566***	0.576***	0.569***	0.556***	0.554***	0.605***	0.613***	0.605***	0.593***	0.592***
	(0.164)	(0.164)	(0.164)	(0.163)	(0.163)	(0.165)	(0.165)	(0.166)	(0.164)	(0.164)
Cost / Income	-0.144***	-0.143***	-0.129***	-0.142***	-0.144***	-0.125***	-0.125***	-0.113***	-0.122***	-0.125***
	(0.040)	(0.040)	(0.040)	(0.041)	(0.041)	(0.039)	(0.039)	(0.039)	(0.039)	(0.039)
Loan loss / Total loans	-1.124	-1.018	-2.272	-1.646	-1.379	-1.063	-0.974	-2.054	-1.739	-1.335
	(5.026)	(5.067)	(5.050)	(5.102)	(5.076)	(5.036)	(5.074)	(5.062)	(5.113)	(5.087)
BE mortgage loans / Total assets	-1.296***	-1.301***	-1.378***	-1.324***	-1.303***	-1.361***	-1.365***	-1.426***	-1.399***	-1.368***
	(0.390)	(0.391)	(0.393)	(0.391)	(0.389)	(0.389)	(0.390)	(0.392)	(0.391)	(0.388)
Constant	1.202***	1.183***	1.218***	1.233***	1.229***	1.137***	1.121***	1.156***	1.176***	1.166***
	(0.226)	(0.233)	(0.227)	(0.231)	(0.234)	(0.227)	(0.234)	(0.228)	(0.232)	(0.235)
Adjusted R-squared	0.843	0.843	0.845	0.843	0.843	0.846	0.846	0.847	0.846	0.846
Log-likelihood	68.541	68.706	72.408	69.084	68.791	75	75.119	77.872	75.932	75.293
Observations	649	649	649	649	649	649	649	649	649	649

Notes: Standard errors are in parentheses. Add-on equals 1 for IRB banks during the months in which the RW add-on is in place (from December 2013 onwards) and 0 otherwise. IRB equals 1 for IRB banks (from 2008 onwards) and 0 otherwise. All bank-specific control variables are lagged by one period. All specifications include bank and time dummies. Significance: *** 1 percent, ** 5 percent, * 10 percent.

Figure 4 - Model implied impact of the Belgian real estate RW add-on on banks' mortgage loan spreads (2011m1-2014m12)



Note: dots represent credit institutions for which the average impact of the add-on as implied by the model is statistically significant (at the 95 percent confidence level), dashes represent non-statistically significant effects.

7 CONCLUSION

By analysing the impact of a sectoral macroprudential measure on mortgage loan pricing, this paper contributes to the understanding of the potential impact of sectoral macroprudential capital requirements. Such evidence is crucial for improving the effectiveness of macroprudential policies, especially as analysis of the effects of sectoral capital requirements in general, and of those targeting real estate exposures in particular, is scant.

Our results suggest that, in line with previous findings in the literature, (sectoral) macroprudential capital requirements are likely to have a heterogeneous impact across banks. In particular, we find robust evidence that less capital-constrained IRB banks react less strongly to the introduction of the RW add-on in terms of mortgage loan pricing. There is also evidence that the RW add-on has stronger effects on IRB banks more exposed to the macroprudential measure, i.e. those banks that are mortgage-specialised and/or face a higher minimum regulatory capital requirement.

In terms of economic significance, the impact of the RW add-on on mortgage loan pricing appears to be relatively limited. As such, this is not surprising, as the objective of the measure was not to curb credit supply per se. In fact, the calibration of the measure aimed at increasing resilience while at the same time avoiding an unsettling of the market. Unfortunately, due to potential non-linearities in banks' reactions to regulatory requirements, our estimates do not allow drawing conclusions on whether a stronger calibration of the measure would have had a much stronger impact on mortgage loan pricing. Therefore, future work is needed on further assessing whether (sectoral) capital requirements are effective in curbing credit supply, or whether instead, alternative measures, such as borrower-based instruments (e.g. LTV caps) would be needed to achieve this objective.

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Limited liability company
RLP Brussels – Company's number: 0203.201.340
Registered office: boulevard de Berlaimont 14 – BE-1000 Brussels
www.nbb.be

Editor

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Governor of the National Bank of Belgium

Layout: Analysis and Research Group
Cover: NBB AG – Prepress & Image

Published in October 2016