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The Effect of Higher Capital Requirements on Bank Lending: The Capital Surplus Matters

Dominika Kolcunová and Simona Malovaná *

Abstract

This paper studies the impact of higher additional capital requirements on growth in loans to the private sector for banks in the Czech Republic. The empirical results indicate that higher additional capital requirements have a negative effect on loan growth for banks with relatively low capital surpluses. In addition, the results confirm that the relationship between the capital surplus and loan growth is also important at times of stable capital requirements, i.e. it does not serve only as an intermediate channel of higher additional capital requirements.

Abstrakt

Tento článek se zabývá dopadem vyšších dodatečných kapitálových požadavků na růst úvěrů soukromému sektoru u bank v České republice. Empirické výsledky ukazují, že v případě bank s relativně nízkým kapitálovým přebytkem mají vyšší dodatečné kapitálové požadavky záporný vliv na růst úvěrů. Dále výsledky potvrzují, že vztah mezi kapitálovým přebytkem a růstem úvěrů je významný také v dobách, kdy jsou kapitálové požadavky stabilní, a není tedy pouze zprostředkujícím kanálem transmise vyšších dodatečných kapitálových požadavků.

JEL Codes: C22, E32, G21, G28.
Keywords: Bank lending, banks' capital surplus, regulatory capital requirements.

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1. Introduction

Understanding the relationship between bank capital, capital requirements and bank lending is crucial for assessing the linkages between the banking sector and real economic activity. The impact of banks' capital on bank lending activity and consequently on real economic activity was one of the main motives behind the various quantitative easing programmes introduced during the global financial crisis. These programmes were usually designed with the intention of providing support to lending and of improving conditions in financial markets more generally (see, for example, Fawley and Neely, 2013). More recently, attention has been given to the effect of the Basel III capital requirements, in particular the costs associated with stricter capital requirements as compared to the benefits resulting from greater financial and macroeconomic stability (Martin-Oliver et al., 2013; MAG, 2010a,b).

Higher additional capital requirements could have a wide range of effects on bank lending, depending, for example, on banks' capitalisation and funding costs, on the phase of the business cycle or on the size of the non-banking sector providing loans. The empirical literature has not been conclusive so far. It provides a broad spectrum of empirical estimates differing in the strength and direction of the effect. This is due to, among other things, the fact that these studies use different time spans, different selections of banks and countries, different model specifications and – most importantly – different proxy variables for higher additional capital requirements; in some studies the authors estimate the effect of higher additional capital requirements directly, while in other studies they use the capital adequacy ratio (Tier 1 capital plus Tier 2 capital divided by risk-weighted exposures), the common equity capital ratio (common equity Tier 1 capital divided by risk-weighted exposures) or even the ratio of equity to total assets as a proxy for capital requirements, usually because of limited data availability. However, different capital ratios can be only used as a reasonable proxy for capital requirements if the difference between the capital requirements and banks' capital adequacy ratio is relatively small, i.e. banks' capital surplus is sufficiently low. This issue is discussed in more detail in section 2.

This paper studies the impact of higher additional capital requirements on loan growth for banks in the Czech Republic. The analysis draws on a unique supervisory panel dataset covering 14 banks on a consolidated basis between 2004 Q1 and 2017 Q4. The detailed information on individual banks allows us to take into consideration heterogeneity among banks and to control for different effects with respect to banks' capitalisation. The Czech National Bank ranks among the most active macroprudential authorities in the EU (see CNB, 2018, Table V.4); it currently applies three capital buffers – a conservation buffer (2.5% since July 2014), a systemic risk buffer (1%–3% for the four systemically most important banks with effect from October 2014 and for the five systemically most important banks with effect from January 2017) and a countercyclical capital buffer (0.5% since January 2017).[1] The Czech National Bank has also set an additional Pillar 2 requirement since 2014 Q1 with a 3-year phase-in period for selected banks (1.7% on aggregate as of 2017 Q4).

The contribution of this paper is twofold. First, we add to an important stream of literature analysing the relationship between bank capital and lending activity with an emphasis on the recent period of increasing additional capital requirements. To the best of our knowledge, this is the first paper to analyse these effects using a detailed supervisory dataset on banks in the Czech Republic.

[1] A countercyclical capital buffer of 0.5% was applied at the end of 2017 Q4, i.e. the end of our estimation sample. It will move to 1.0% in July 2018, 1.25% in January 2019, 1.5% in July 2019 and 1.75% in January 2020. For more information on the macroprudential policy tools applied in the Czech Republic and their purpose, see the Czech National Bank website, section Financial Stability – Macroprudential Policy. The overall regulatory capital requirements applying to banks in the Czech Republic are displayed in Figure A1 in Appendix A.

Using this dataset, we are able to distinguish between individual banks' overall regulatory capital requirements, capital adequacy ratios and capital surpluses; as mentioned above, this is an important prerequisite for estimating and understanding the transmission of higher additional capital requirements correctly. Second, we use different approaches and estimation methodologies to provide a comprehensive picture. We analyse the relationship at the macro-level, using a Bayesian vector autoregression model, and at the micro-level, using a dynamic panel data model.

The remainder of this paper is organised as follows. Section 2 discusses the transmission mechanism of higher additional capital requirements and related literature. Sections 3 and 4 present the econometric framework, describe the data and provide simulations of the hypothetical development of banks' capital adequacy ratios, implicit risk weights and capital surpluses under different scenarios. Section 5 reports the estimation results. Section 6 concludes.

2. Transmission Mechanism and Literature Review

In general, banks can react to higher additional capital requirements in various ways. If their total capital surplus[2] is sufficiently high, they can use it to cover the additional capital requirements; if the total capital surplus is not sufficiently high, or if banks want to maintain some voluntary capital cushion above the requirements, they can react in one or a combination of the following ways:

- by slowing down the growth, or even reducing the absolute size, of their balance sheets/loan portfolios,
- by changing the risk composition of their assets to less risky,
- by raising equity through, for example, increasing stated capital (or capital issued) or increasing their interest rate margins, which transmits to higher retained earnings,
- by increasing their retained earnings through, for example, reducing their dividend payout ratio or postponing planned re-investment activities.

One of the crucial factors influencing the particular way a bank chooses to adjust its capital adequacy ratio is the state of the economy and the prospects for the near future (Brei and Gambacorta, 2016). Under favourable economic conditions, banks may be more likely to increase their capital adequacy ratios through higher interest rate margins or by issuing equity, while in worse economic conditions they may prefer to shift their asset structure towards less risky assets (for example, government securities bearing a low risk weight) or to reduce their total exposures (Dahl and Shrieves, 1990; Jackson, 1999; Heid et al., 2004; Brei and Gambacorta, 2016). Pfeifer et al. (2018) identify four channels through which a bank's capital position may be affected, namely asset quality, asset volume, asset structure and asset profitability channel.

The literature studying the effect of higher additional capital requirements[3] is not new and is usually focused on their impact on lending (see, for example, Francis and Osborne, 2012; Aiyar et al., 2014; Noss and Toffano, 2014; Bridges et al., 2015) or real economic activity (Berrospide and Edge, 2010; MAG, 2010b,a). However, many studies have focused on analysing the impact of changes in banks' *capitalisation* rather than the *capital requirements* themselves (see, for example, Bernanke et al., 1991; Jimenez et al., 2013; Albertazzi and Marchetti, 2010; Fonseca et al., 2010). Some of these

[2] The total capital surplus is defined as the excess of regulatory capital (Tier 1 capital plus Tier 2 capital) over the overall regulatory capital requirements in relation to risk-weighted exposures.

[3] We discuss predominantly empirical literature; there are also a few theoretical studies building dynamic models and analysing the impact of higher capital requirements. These are, however, less relevant for this paper. We therefore do not mention them, or devote only limited attention to them.

studies interpret changes in various capital ratios as being a result of changes in capital requirements, which is a simplifying assumption and might not always be correct (see the discussion below). The reason is usually a lack of observable changes in capital requirements in past data or limited access to such data.[4]

Most of the pre-crisis studies only cover the links between bank lending and capital (not capital requirements) and are mostly focused on credit crunches during the early 1990s crisis period (Bernanke et al., 1991; Hancock and Wilcox, 1993, 1994; Peek and Rosengren, 1995).[5] In the wake of the global financial crisis of 2008–2009, the relationship between bank capital and lending has gained greater attention. First, the link appeared relevant, as it was believed that financial difficulties related to mortgage-backed securities might severely affect lending by U.S. banks. For example, Albertazzi and Marchetti (2010) find evidence of a contraction of credit supply in Italy as a result of low bank capitalisation and scarce liquidity after the Lehman collapse. Second, in recent years, macroprudential policy – having capital requirements as one of its key tools – has become increasingly integral to any considerations about regulatory reforms aimed at preventing the occurrence of a crisis similar to that of 2008–2009.

The post-crisis empirical literature can be divided into three groups based on their empirical results. The first group identifies a negative effect of higher *capital requirements* on banks' lending (see, for example, Aiyar et al., 2014; Bridges et al., 2015; de Ramon et al., 2016). All three papers analyse the effects using rich micro-level datasets for UK banks. Aiyar et al. (2014) provide evidence that regulated banks reduce loan growth in response to tighter capital regulation (by 6–8 pp in the long run in response to a 1 pp increase in the capital requirements); however, they also find considerable leakage to foreign bank branches not regulated by the UK regulator, which increase their lending. Bridges et al. (2015) find that capital requirements influence banks' capital adequacy ratio permanently and credit supply temporarily. Specifically, banks tend to gradually rebuild the capital surplus that they initially held (i.e. they increase their capital adequacy ratio) and simultaneously renew loan growth; this points to an important link between banks' capital surplus and lending growth. In terms of loan type, higher additional capital requirements are reflected mainly in lower growth of loans to the commercial real estate and corporate sectors and household secured lending. The effect of a 1 pp increase in the capital requirements on bank loan growth in the short run varies between 1 pp and 8 pp. de Ramon et al. (2016) find a negative effect of higher capital requirements on bank lending and asset growth and a positive effect on banks' capital ratios even when their capital surplus

[4] Some researchers focus on the overall macroprudential stance (i.e. the mix of macroprudential policies) instead of the capital requirements (see, for example Cerutti et al., 2015; Bruno et al., 2017; Gambacorta and Murcia, 2017; Akinci and Olmstead-Rumsey, 2018). In general, their results show that macroprudential policy tightening is associated with lower bank credit growth and house price inflation. Some of the literature pursues only some components of the capital requirements. For example, Drehmann and Gambacorta (2012) provide a simulation of the effect of the countercyclical capital buffer on bank lending and find it could materially reduce credit booms and attenuate contraction in busts and thereby dampen procyclicality (this is another example of the multiple effects of some resilience-aimed macroprudential tools, as classified by Gambacorta and Murcia (2017) and as mentioned above). Basten and Koch (2015) also focus on the countercyclical capital buffer.

[5] A pioneering work in the empirical literature examining the nexus between capital and lending is Bernanke et al. (1991). The authors find that insufficient capitalisation of U.S. banks limited their ability to provide loans, leading to a credit crunch in the early 1990s in the United States. As the shortage of bank capital contributed to the emergence of the crisis, the authors coin the term "capital crunch". The capital crunch is also described by Peek and Rosengren (1995), who find that the decrease in capital in the 1990s in fact led banks to reduce their lending. They formulate a theoretical model stating that banks behave differently if the loss of bank capital results in binding capital requirements as compared to when the requirements are not binding. Other pre-crisis studies include, for example, Hancock and Wilcox (1993) and Hancock and Wilcox (1994), who measure the effect of loan demand and bank capital on loan growth.

is relatively high. Their results suggest, similarly to the previous study, that banks re-build their capital surplus; however, they tend to raise their capital ratios in the long run by only about 90% of the change in their capital requirements, i.e. they do not re-build their capital surplus in full. This is consistent with the concept of bank capital targets (see below).

The second group of studies identifies a negative effect of higher *capital ratios* on banks' lending (see, for example, De Nicolo, 2015; Noss and Toffano, 2014; MAG, 2010b). De Nicolo (2015) finds that changes in the equity-to-assets ratio have a negative impact not only on bank lending, but also on real activity, in both the short run and the long run.[6] The author interprets changes in the equity-to-assets ratio as changes in capital requirements without considering the existence of a capital surplus. Noss and Toffano (2014) study the joint movement of the historical capital-to-assets ratio[7] and macro-financial variables in order to identify the effects of changes in capital requirements; they provide a "top-down" complement to the "bottom-up" micro-studies using aggregate data and a VAR model with sign restrictions. They come to the conclusion that an increase in the capital-to-assets ratio during better times leads to a reduction in lending, the effect being higher for corporate loans than for loans to households. Similarly to De Nicolo (2015), they interpret changes in the capital-to-assets ratio as changes in capital requirements. The paper by MAG (2010b) estimates the effect of a higher ratio of total common equity to risk-weighted exposures (CET ratio; described in the paper as target capital) on lending spreads and lending volumes.[8] The results suggest that, on average, a 1 pp increase in the CET ratio implemented over four years leads to a decline in the lending volume of 1.4% over 18 quarters and 1.9% over 32 quarters. In addition to the empirical part, the authors discuss the importance of the transition (implementation) period for higher additional capital requirements: if the transition period is relatively short, banks may choose to reduce their credit supply in order to raise their capital ratios quickly; if the transition period is relatively long, the effect on banks' credit supply may be mild, as they may find another way to increase their capital, for example by drawing on retained earnings or issuing new equity.

Last but not least, the third group identifies a positive effect of higher *capital ratios* on bank lending (see, for example, Berrospide and Edge, 2010). The authors use data on U.S. bank holding companies in a sample period starting with the implementation of the first Basel Accord (the early 1990s) and ending with the outbreak of the global financial crisis in 2008. They find a positive effect of various bank capital ratios (the ratio of equity to total assets, the risk-based total and Tier 1 capital ratio and the tangible common equity ratio) and the capital surplus on credit growth, indicating that higher bank capitalisation leads to higher credit supply. Quantitatively, the effect varies between 0.25 pp and 2.75 pp.[9]

The inconsistency in the relationship identified between higher capital ratios and bank lending (the second and third groups) stems most likely from different reasons behind changes in bank capital ratios. If the capital ratio increases in response to higher capital requirements and the bank capital

[6] The author uses two panel datasets based on bank-level and country-level data with a long time dimension.

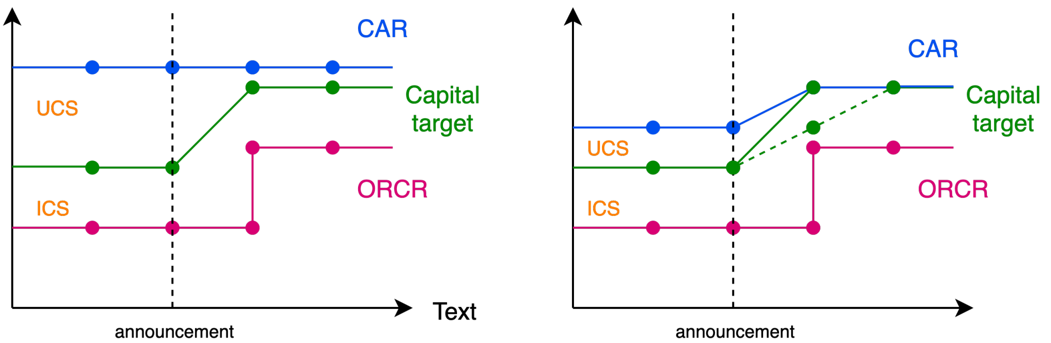
[7] Capital in this study comprises all ordinary and preference shares constituting banks' share capital.

[8] In the first step, the paper uses accounting identities; in the second step, it estimates the effect of change in lending spreads and volumes on macroeconomic variables (consumption and investment) in standard macroeconomic forecasting models, with imputed forecast paths for lending spreads and volumes from the first step.

[9] In the long run, a capital surplus (shortfall), defined as the deviation of the actual level of capital from the target capital ratio, which is a function of bank-specific control variables, increases (reduces) annualised loan growth by 0.25 pp when capital is above (below) its target level by 1%. As for the various capital ratios, a 1 pp increase in the capital ratio leads to a long-run increase in annualised loan growth of between 0.7 and 1.2 pp. In other words, this effect is not large in magnitude, especially in comparison with the estimated effects of capital injections at that time (2010). On the contrary, their magnitudes are consistent more with the view that banks actively manage their assets to maintain comparatively constant capital ratios (e.g. Adrian and Shin, 2010)).

surplus does not change or even shrinks, then the expected effect on bank lending is negative, as the bank would try to avoid the higher costs of financing loans by capital. On the other hand, if the capital ratio increases as a result, for example, of bank profit accumulation and the capital requirements remain stable, the bank capital surplus increases and creates space for additional balance sheet expansion; the expected effect on bank lending is then positive. Uncertainty in response to a higher capital ratio was also identified by Malovaná and Frait (2017), who find mixed responses of the credit-to-GDP growth ratio and real GDP growth to an increase in banks' capital-to-assets ratios using a time-varying panel VAR model of six European countries. All in all, banks' capital ratio seems to be a not entirely suitable proxy variable for capital requirements. It could possibly be used as a proxy for banks' capital requirements only if the difference between the capital requirements and banks' capital adequacy ratio is relatively small, i.e. if a bank has to increase its capital adequacy ratio in response to higher additional capital requirements. However, this is not the case for many banks, including those in the Czech Republic.

Figure 1: Higher Additional Capital Requirements and Capital Surplus



Note: ORCR – overall regulatory capital requirements; CAR – capital adequacy ratio. Intentional capital surplus (ICS) – difference between capital target and ORCR; unintentional capital surplus (UCS) – difference between CAR and capital target.

As discussed above, banks usually maintain their capital adequacy ratios in excess of the regulatory requirements, i.e. they maintain a capital surplus. The preservation of capital surpluses and the underlying motives for this behaviour have important policy implications (see, for example, Malovaná, 2017). The importance of existing capital surpluses for the banks' reaction to the capital regulation reform package was pointed out also by Pfeifer et al. (2018). In particular, an increase in the additional capital requirements might be expected to have a limited effect on banks' capital adequacy ratio if banks have a high capital surplus, simply because they would use the extra capital and shrink the surplus. But if banks intentionally target a higher capital adequacy ratio than the level required by their regulator and form an intentional capital surplus – for example in order to match a planned future asset expansion or change in asset structure[10] – higher additional capital requirements could actually lead them to increase their capital adequacy ratio in an effort to preserve the existing surplus. Therefore, it is important to distinguish not only between banks' capital adequacy ratio and capital surplus, but also between intentionally and unintentionally formed capital surpluses to be able to analyse the transmission of higher additional capital requirements and to better understand the behaviour of banks.

We can expect various responses with respect to intentional and unintentional capital surpluses and with respect to time. Figure 1 shows two possible reactions of the intentional and unintentional

[10] A bank may also target a higher capital adequacy ratio than that required by the regulator as a consequence of its dividend policy.

capital surpluses to higher additional capital requirements. Higher capital buffers (such as a countercyclical capital buffer) are usually announced one year before they become effective; therefore, banks may start to react even before the actual increase in capital requirements occurs.[11] If a bank maintains a sufficiently large unintentional capital surplus, simply due to the long-run accumulation of high earnings, it can use it to maintain its intentional capital surplus (the left-hand panel of Figure 1). If the unintentional capital surplus is not sufficiently large, the bank may react by increasing its capital adequacy ratio via a combination of the responses listed above (the right-hand panel of Figure 1). These are just two very simple examples of possible reactions; however, the bank may choose to react differently, for example by shrinking its intentional capital surplus permanently, by increasing its capital adequacy ratio even before the date of effect, or by re-building its intentional capital surplus over a much longer period.

If the bank forms an intentional capital surplus in order to match a planned increase in credit supply, then higher additional capital requirements may slow down or even decrease lending growth via its effect on the intentional capital surplus. The bank may tend to re-build the intentional capital surplus in the long run and to restore the lending growth, as shown, for example, by Bridges et al. (2015); Berrospide and Edge (2010); Adrian and Shin (2010).

3. Econometric Framework

We analyse the effect of higher additional capital requirements from two perspectives – the macro (aggregate) level and the micro (bank) level. While the analysis at the macro-level provides information on macro-financial linkages, the micro-level analysis allows us to explore the heterogeneity among banks. Different views are also offered by the two different methodologies we use. First, the Bayesian VAR model allows us to analyse the dynamics of the whole system in response to an exogenous shock by means of impulse response functions. Moreover, the model is by nature immune to endogeneity issues. On the other hand, the complexity of the system of equations makes it impossible to reasonably interpret the individual estimated coefficients, while the form of the impulse response function depends on the shock identification. Second, the dynamic panel data model allows us to use detailed supervisory bank-level data and is much simpler for interpretation. Conclusions about causal effects can be drawn directly from the estimated coefficients. A potential disadvantage of this method is the possibility of endogeneity problems, which we try to mitigate.

3.1 Macro-level Analysis

We employ a VAR model estimated using the Bayesian approach with an independent Normal-inverse Wishart prior distribution (for more technical details, see Appendix B).

The VAR model contains two main variables of interest – year-on-year growth of bank loans to the private sector and banks' capital surplus. The selection of other variables is based on the discussion in section 2: a proxy for the business cycle (year-on-year growth of nominal GDP), the year-on-year change in implicit risk weights[12] and a proxy for banks' profitability or leverage ratio. Implicit risk weights are defined as the ratio of total risk-weighted exposures to total assets. As a proxy for banks' profitability and leverage ratio, we use either return on assets (ROA, the ratio of net profit to total assets), the ratio of retained earnings to total assets, or the ratio of regulatory capital (Tier 1

[11] Pillar 2 capital add-ons may be announced only a few months before they take effect. However, there may be a phase-in, or transitional, period during which banks may be required to fulfil higher Pillar 2 capital add-ons only partly.

[12] The year-on-year change is defined as $\Delta RW_t = RW_t - RW_{t-4}$.

capital plus Tier 2 capital) to total assets (the relationship between these variables is described in section 4).

We analyse the effect of a shock to the capital surplus rather than a shock to the additional capital requirements, because the history of changes in the overall regulatory capital requirements (ORCR) is relatively short. It is possible to study the effect of higher ORCR directly at the micro-level, because we can use the information on individual banks' behaviour and we have a larger panel data set for empirical estimation. The empirical analysis at the macro-level provides a valuable view of the overall aggregated effects and the role of the capital surplus in transmission in the Czech banking sector. As shown in section 2, the capital surplus plays an important role in the transmission of higher additional capital requirements in other countries.

Shock identification and ordering. We use Cholesky decomposition and perform a robustness analysis with respect to variable ordering. In the baseline analysis, the variables are ordered as follows:

$$\begin{aligned} Y = [&yoy\ nominal\ GDP\ growth,\ yoy\ growth\ of\ loans\ to\ private\ sector,\\ &proxy\ for\ profitability\ or\ leverage\ ratio,\ yoy\ change\ in\ implicit\ RW,\ capital\ surplus]. \end{aligned}$$

We assume that the prudential authority (when setting the ORCR) or commercial banks (in their capital planning process) take into account all the available information and react contemporaneously, while the impact of the capital surplus on other banking sector variables and the macroeconomy is lagged. This reflects the assumption that higher additional capital requirements and changes in banks' capital surplus have a delayed effect on the real economy and lending, whereas variables characterising the real economy and credit growth affect prudential policy and banks' capitalisation immediately.

We check the robustness of the results with respect to variable ordering. First, we assume that the capital surplus has a contemporaneous impact on bank loan growth. Second, we assume that the capital surplus has a contemporaneous impact on all bank-specific variables. In additional exercises, we also control for the real monetary conditions (using the real monetary conditions index, RMCI)[13] and the lending rate.

3.2 Micro-level Analysis

As discussed in section 2, banks can react to higher additional capital requirements in different ways. They can use their existing capital surplus or increase their capital adequacy ratio through, for example, raising equity capital or increasing their interest rate margins (which transmits to retained earnings), reducing the size of their balance sheets/loan portfolios or changing the risk composition of their assets. We thus first analyse the effect of higher additional capital requirements on each of the listed components and then focus in more detail on the effect on bank loan growth. The

[13] The RMCI is calculated as a weighted average of the deviations of domestic ex ante real interest rates and the real exchange rate from their equilibrium levels. A positive value of the RMCI refers to easy monetary conditions and a negative value to tight monetary conditions. The RMCI is constructed and used by the Czech National Bank (for more details, see CNB, 2015a).

specifications are formulated as follows:

$$EA_{i,t} = \alpha_1 EA_{i,t-1} + \beta_1 ORCR_{i,t} + \gamma_1 X_{i,t-1} + \nu_{1,i} + \varepsilon_{1,i,t} \quad (1)$$

$$REA_{i,t} = \alpha_2 REA_{i,t-1} + \beta_2 ORCR_{i,t} + \gamma_2 X_{i,t-1} + \nu_{2,i} + \varepsilon_{2,i,t} \quad (2)$$

$$CA_{i,t} = \alpha_3 CA_{i,t-1} + \beta_3 ORCR_{i,t} + \gamma_3 X_{i,t-1} + \nu_{3,i} + \varepsilon_{3,i,t} \quad (3)$$

$$CS_{i,t} = \alpha_4 CS_{i,t-1} + \beta_4 ORCR_{i,t} + \gamma_4 X_{i,t-1} + \nu_{4,i} + \varepsilon_{4,i,t} \quad (4)$$

$$RW_{i,t} = \alpha_5 RW_{i,t-1} + \beta_5 ORCR_{i,t} + \gamma_5 X_{i,t-1} + \nu_{5,i} + \varepsilon_{5,i,t} \quad (5)$$

$$\%\Delta loans_{i,t} = \alpha_6 \%\Delta loans_{i,t-1} + \beta_6 ORCR_{i,t} + \gamma_6 X_{i,t-1} + \nu_{6,i} + \varepsilon_{6,i,t} \quad (6)$$

where $CS_{i,t}$ is the total capital surplus, defined as the excess of regulatory capital (Tier 1 capital plus Tier 2 capital) over the capital requirements in relation to risk-weighted exposures; $\%\Delta loans_{i,t}$ is the percentage year-on-year change in loans to the private sector excluding interbank loans; and $RW_{i,t}$ are implicit risk weights, defined as the ratio of risk-weighted exposures to total assets. The implicit risk weights serve as a proxy for change in the risk composition of banks' balance sheets. $EA_{i,t}$ is the ratio of equity to total assets and $REA_{i,t}$ is the ratio of retained earnings to total assets. Due to the limited availability of data on dividends, we do not study their relationship with higher additional capital requirements separately. $CA_{i,t}$ is the ratio of regulatory capital (Tier 1 capital plus Tier 2 capital) to total assets; $ORCR_{i,t}$ are the overall regulatory capital requirements, consisting of the regulatory capital minimum, capital buffers and Pillar 2 capital add-ons; $X_{i,t-1}$ is a vector of control variables specific to each equation; ν_i stands for bank fixed effects; and $\varepsilon_{1,i,t}$ is the error.

We assume that the dependent variables react instantly to changes in the capital requirements. The justification of this assumption lies in the fact that changes in the capital requirements are usually announced in advance. Nevertheless, we also test for additional lags and leads in the response.

Control variables. Equity usually consists of stated capital (or capital issued and share premium), retained earnings, other comprehensive income, non-controlling interests and other reserves. As such, it can be influenced by banks' profitability, credit risk, the macroeconomic situation and the situation on the financial market. Therefore, we use five control variables in equation (1) – return on assets (ROA, the ratio of net profit to total assets), the ratio of loan loss provisions to total assets, real GDP growth, PX stock index growth and the spread between the 10-year Czech government bond yield and the 3-month interbank rate (3-month Pribor); this spread serves as a proxy for the yield curve slope. The same set of control variables is used in equations (2), (3) and (4).

Risk-weighted exposures can be affected by a number of factors; among the most important are the regulatory approach, the asset structure, credit risk and the macroeconomic and financial conditions (see, for example, Cannata et al., 2011; Mariathasan and Merrouche, 2014; CNB, 2015b; Behn et al., 2016). Therefore, in equation (5) we control – in addition to real GDP growth, PX stock index growth, the spread and the ratio of loan loss provisions to total assets – for the structure of banks' financial assets and the regulatory approach used to calculate the capital requirements; we include a dummy variable which takes the value of 1 if the bank uses the IRB approach for at least some part of its exposures and 0 if it uses solely the STA approach in the given quarter.[14] We include the control variables for banks' financial asset structure and the dummy variable for the regulatory approach in equation (4) as well, since the capital surplus also depends on risk-weighted exposures (the denominator of the formula for the capital surplus).

[14] The transition between the STA approach and the IRB approach can be gradual; in that case, the binary dummy variable might be a reasonable approximation rather than a precise indicator. The use of this dummy is supported by the fact that banks in the Czech Republic in many cases switched abruptly to the IRB approach (in terms of total exposures on a consolidated basis) and only one bank made a gradual transition.

Last but not least, the control variables in equation (6) comprise a proxy variable for credit risk (the ratio of loan loss provisions to assets), a proxy variable for banks' leverage (the ratio of capital to total assets), a proxy variable for banks' lending rate (the ratio of annualised interest income from loans to total loans) and a variable controlling for the business cycle (real GDP growth). In addition, we experimented with including proxy variables for monetary policy and the monetary conditions (the 3-month interbank rate, the real monetary conditions index, the estimated shadow rate and the spread described above), but we did not obtain a statistically significant relationship.

The chosen sets of control variables are in line with the bank-capital and bank-lending channel literature, which assumes that certain bank-specific characteristics influence banks' capital ratios, their choice of target capital ratios and their loan supply (see, for example, Malovaná, 2017; Brei and Gambacorta, 2016; Borio et al., 2017).

Next, we focus more on the relationship between the capital requirements, the capital surplus and credit growth, which is the main aim of this paper. In order to do so, we employ an empirical specification in accordance with the literature (see Bridges et al., 2015; Berrospide and Edge, 2010; Martin-Oliver et al., 2013; Šútorová and Teplý, 2013; Malovaná, 2017). We employ two different approaches – direct estimation in a single-equation model and simultaneous estimation via a system of equations. In addition, we assume that the relation may differ with respect to different levels of banks' capital surplus. We thus define an interaction variable between the overall regulatory capital requirements and a dummy for banks with relatively low capital surpluses. The single-equation specification is as follows:

$$\begin{aligned}\%\Delta loans_{i,t} = {} & \alpha_7 \%\Delta loans_{i,t-1} + \beta_7 ORCR_{i,t} * dLowCS + \beta_8 ORCR_{i,t} * (1 - dLowCS) \\ & + \gamma_7 X_{i,t-1} + \nu_{7,i} + \varepsilon_{7,i,t} \end{aligned} \tag{7}$$

where *dLowCS* is a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons.[15]

In a two-equation system, we assume that higher additional capital requirements affect bank loan growth via the capital surplus. While we assume that the capital requirements affect the surplus contemporaneously, the reaction of bank loan growth to the change in the capital surplus is delayed by one quarter.

$$CS_{i,t} = \alpha_8 CS_{i,t-1} + \beta_9 ORCR_{i,t} + \gamma_8 X_{i,t-1} + \nu_{8,i} + \varepsilon_{8,i,t} \tag{8}$$

$$\%\Delta loans_{i,t} = \alpha_9 \%\Delta loans_{i,t-1} + \beta_{10} CS_{i,t-1} + \gamma_9 X_{i,t-1} + \nu_{9,i} + \varepsilon_{9,i,t} \tag{9}$$

Similarly to the single-equation model, we introduce interaction terms between dLowCS and ORCR.

In line with the discussion in section 2, we further differentiate between intentional and unintentional capital surpluses following Malovaná (2017). The author estimates individual bank-specific capital targets for banks in the Czech Republic using a partial-adjustment model. The intentional capital surplus (ICS) is then defined as the difference between the target capital ratio and the overall regulatory capital requirements, while the unintentional capital surplus (UCS) is defined as the

[15] The set of banks was chosen arbitrarily. These banks also exhibit a relatively large change in their average capital surplus in the period of changing overall regulatory capital requirements as compared to the previous period. The results were tested to the inclusion of individual banks and remained robust.

difference between the capital adequacy ratio and the target capital ratio.[16] In order to analyse the transmission via the ICS and the UCS, we add a third equation to the two-equation model:

$$ICS_{i,t} = \alpha_{10} ICS_{i,t-1} + \beta_{11} ORCR_{i,t} + \gamma_{10} X_{i,t-1} + \nu_{10,i} + \varepsilon_{10,i,t} \quad (10)$$

$$UCS_{i,t} = \alpha_{11} UCS_{i,t-1} + \beta_{12} ORCR_{i,t} + \gamma_{11} X_{i,t-1} + \nu_{11,i} + \varepsilon_{11,i,t} \quad (11)$$

$$\%\Delta loans_{i,t} = \alpha_{12} \%\Delta loans_{i,t-1} + \beta_{13} ICS_{i,t-1} + \beta_{14} UCS_{i,t-1} + \gamma_{12} X_{i,t-1} + \nu_{12,i} + \varepsilon_{12,i,t} \quad (12)$$

The set of control variables in the equation for the ICS is the same as in the equation for the total capital surplus. On the other hand, the control variables in the equation for the UCS are chosen to capture its different nature. The UCS is assumed to be a result of shifts in accumulated earnings or other factors unintentionally changing the level of capital held, in particular profitability and cost ratios.

Estimation techniques. The single-equation specifications are estimated using the standard least square dummy variable (LSDV) estimator and the bootstrap-based bias-corrected (BBBC) estimator proposed by De Vos et al. (2015).[17] A dynamic panel is used to control for potential persistence in the relationships. However, as shown by Nickell (1981), there is potential for endogeneity bias in dynamic panels.[18] Endogeneity bias becomes especially serious in panels with a high number of individuals (large N) and a low number of time periods (low T). This bias, however, shrinks substantially with higher T. Simulations by Judson and Owen (1999) suggest that the bias is minor in panels with more than 30 observations. In our case, the short data sample consists of 14 individuals and 20 time periods, which creates potential for a minor bias.

In addition to the LSDV and BBBC estimators, the two- and three-equation systems are estimated using the three-stage least squares (3SLS) procedure.[19] 3SLS can be interpreted as a combination of two-stage least squares, used to account for endogeneity of left and right-hand side variables, and seemingly unrelated regression (SUR), used to account for correlation of errors across equations. The reason why we estimate the system of equations simultaneously stems from the potential endogeneity of the variables. For example, equation (8) contains different types of loans to control for the bank's asset structure as explanatory variables. In equation (9), loan growth depends on the capital surplus, so the capital surplus might well be assumed to be endogenous, i.e. correlated with the error $\varepsilon_{11,i,t}$ in equation (9). Typically, the endogenous explanatory variables are dependent variables from other equations in the system.

Suggestions whether to estimate two equations separately or jointly differ within the literature with respect to the exact specification and data used. We test for endogeneity using the Hausman procedure, as described in Wooldridge (2015): we save the residuals from the reduced form of equation (8) (with all exogenous variables on the right-hand side) estimated as a single-equation fixed-effects regression and test the significance of these residuals when included as another variable in

[16] For more details on the estimation of the target capital ratio and the intentional and unintentional surpluses, see Malovaná (2017).
[17] The estimator is implemented by the *xtbcfe* Stata routine. For more details on the implementation of this routine and a description of the methodology, see De Vos et al. (2015).
[18] The Nickel bias is introduced by applying the within (demeaning) transformation in attempt to remove unobserved heterogeneity in the panel data – subtracting the individual's mean from the relevant variable creates a correlation between the regressor and the error term.
[19] 3SLS is a default option in the *reg3* STATA command. The fixed-effects structure of the panel data is estimated by introducing a dummy variable for each cross-sectional unit in each equation in the system. The command is meant to estimate a system of structural equations where some equations contain endogenous variables among the explanatory variables.

equation (9). The residuals prove to be significant, pointing to a need for two-stage least squares. The covariance between the error terms of the two equations obtained from the variance-covariance matrix is different from zero, pointing to a need for seemingly unrelated regression. In each case, we provide sensitivity checks by estimating the system both simultaneously and equation by equation. The results are mostly similar.[20]

4. Data

At the end of 2017, the Czech banking sector consisted of 19 banks, 5 building societies and 21 foreign bank branches.[21] The foreign bank branches are excluded from the analysis, as they are not subject to domestic capital regulation. Four building societies and two mortgage banks belong to the same bank group as five other domestic banks; together with individual banks the data sample consists of 14 banks and bank groups on a consolidated basis. That accounts for almost 90% of the total assets of the whole banking sector as of December 2017. Consolidated bank statements are considered, because banks usually formulate their capital planning strategies at the whole-group level. In addition, the regulatory capital requirements in Pillar 2 are expressed on a consolidated basis. With respect to time span, the sample covers 56 quarters from 2004 Q1 to 2017 Q4, giving an unbalanced panel of 630 observations in total.[22] For part of the analysis, we use a restricted sample starting in 2013 Q1.

It is worth mentioning a few distinct characteristics of the Czech banking sector which are essential for understanding banks' behaviour and for discussing the empirical results. First, the Czech banking sector is characterised by high liquidity stemming from its strong client deposit base and growth in exposures to the central bank.[23] This provides banks with sufficient resources to ensure a stable and/or increasing credit supply. Second, the low-yield environment has restricted the number of reasonable investment opportunities, while relatively strong competition on the domestic credit market has limited the ability of banks to increase their interest rate margins more than their competitors. Given their sufficient resources, banks have therefore tried to compensate for their low margins by lending in larger volumes. However, the supply of credit may exceed the demand for it, especially after a few recent years of relatively rapid credit growth. Together with higher additional capital requirements, saturated credit demand may be another factor potentially restricting credit growth even though banks have enough resources.

[20] The Hausman test does not reject the null hypothesis of no systematic differences when comparing the OLS, 2SLS and 3SLS estimates, though, suggesting that OLS is both consistent and more efficient than 2SLS. The previous evidence of correlation of errors and the procedure suggested by Wooldridge (2015), however, yields a different outcome. We thus provide both OLS and 3SLS estimates and compare, as well as bootstrap-based bias-corrected estimates.

[21] ICBC Limited and Creditas were excluded from the analysis due to their very short data history; the Czech Export Bank and the Czech-Moravian Guarantee and Development Bank were excluded because they are wholly owned by the Czech state (which provides implicit state guarantees for their liabilities) and have different business models.

[22] Bank-level data are obtained from the CNB's internal database (FINREP and COREP reporting statements). The capital adequacy ratio was adjusted for outliers, i.e. the unreliably high values of a few small banks in the first few quarters after they entered the market. The capital adequacy ratio of one medium-sized universal bank is adjusted for a structural break in its capital caused by an unusually high dividend payout in 2015; this payout did not constitute a permanent change in the bank's dividend policy, but was a one-time tax-related issue before an IPO.

[23] At the end of 2017, the ratio of quick assets to total assets was 41.6%, the liquidity coverage ratio was 182.8% and the net stable funding ratio was 126% (both well above the regulatory requirement). For more details, see CNB (2018).

As discussed in section 2, banks may generally react to higher additional capital requirements in different ways, for example by reducing their capital surplus, raising their stated capital (or capital issued), increasing their interest rate margins (which transmits to higher retained earnings), reducing the size of their balance sheet/loan portfolio or changing the risk composition of their assets to less risky. We discuss some of these factors and their significance in more detail in the next subsections.

4.1 Capital Adequacy Ratio and Capital Surplus

Figure 2 depicts the capital adequacy ratio (i.e. total regulatory capital divided by risk-weighted exposures) and the ratio of total regulatory capital to total assets. We can see rather different trends: while the capital adequacy ratio has been increasing constantly since 2007, the ratio of capital to assets has decreased slightly in recent years. This is due to decreasing risk-weighted exposures in response to a changing asset structure (see Figure 8 below) and also to decreasing average implicit risk weights in individual credit exposure categories under the IRB approach (for further discussion, see subsection 4.3).

Figure 3 presents the decomposition of total regulatory capital. It can be seen that it consists mainly of retained earnings (50–60%). Accurate prediction of banks' future profitability is therefore a key factor for their capital planning. The remaining Tier 1 capital comprises other comprehensive income and Common Equity Tier 1 (CET1) instruments. CET1 instruments consist of issued share capital and share premium. Tier 2 equity makes up only a very small part of the total regulatory capital of banks in the Czech Republic.

Prior to 2014, retained earnings grew by 20% annually on average. Following a decrease in monetary policy rates to technical zero in late 2013, banks' margins on client loans and consequently their profitability in relation to total assets (both ROA and net interest earnings-to-total assets) decreased. This was mirrored in slower growth of retained earnings, which fell to zero between 2014 and mid-2016. In the second half of 2016, year-on-year growth in retained earnings started rising slowly again.

Figure 2: Regulatory Capital (Tier 1 Capital plus Tier 2 Capital)

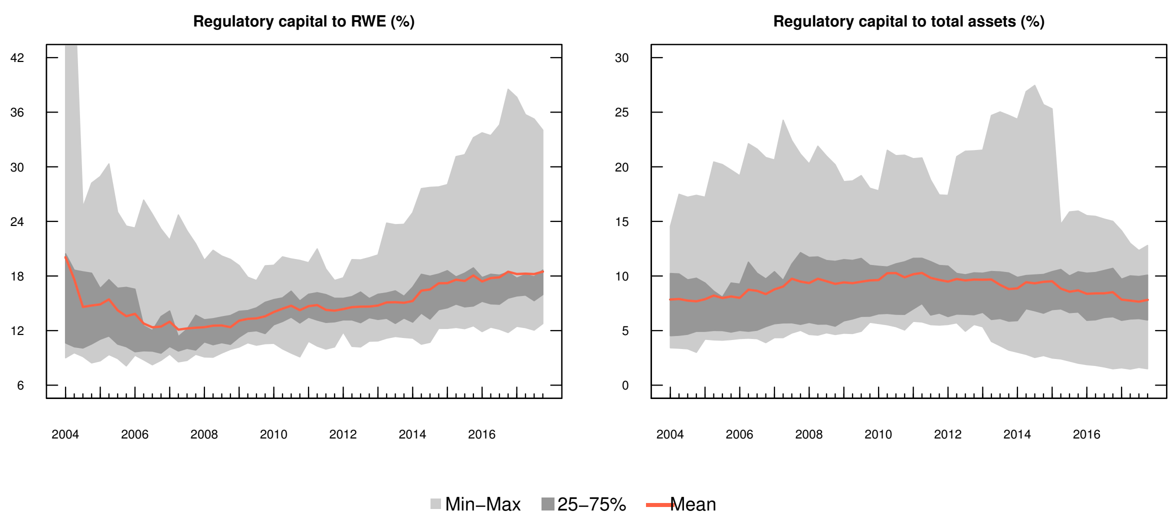
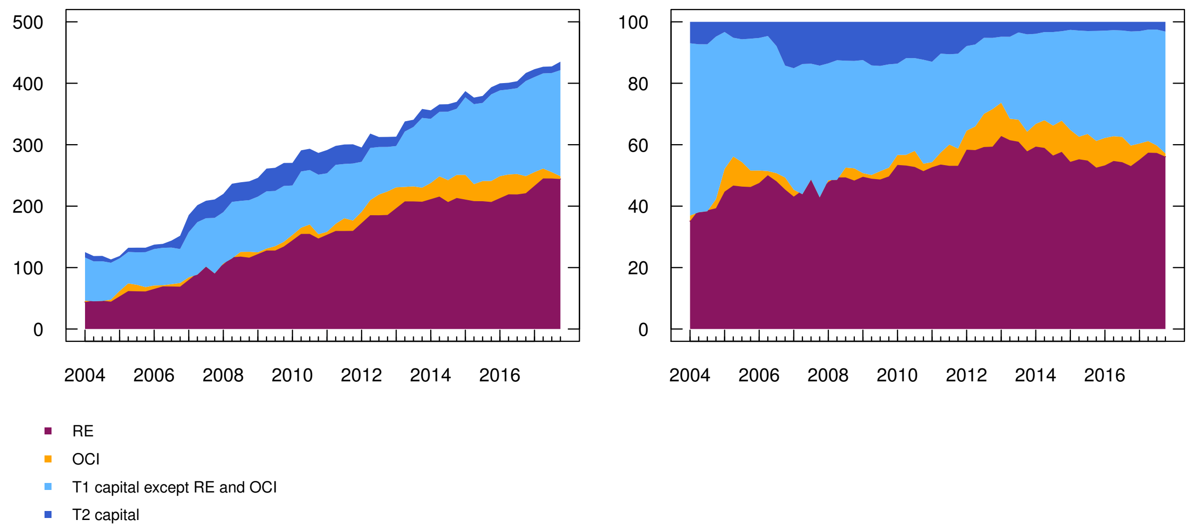


Figure 3: Decomposition of Total Regulatory Capital (Left Chart: Amount in CZK Billions; Right Chart: Share in %)

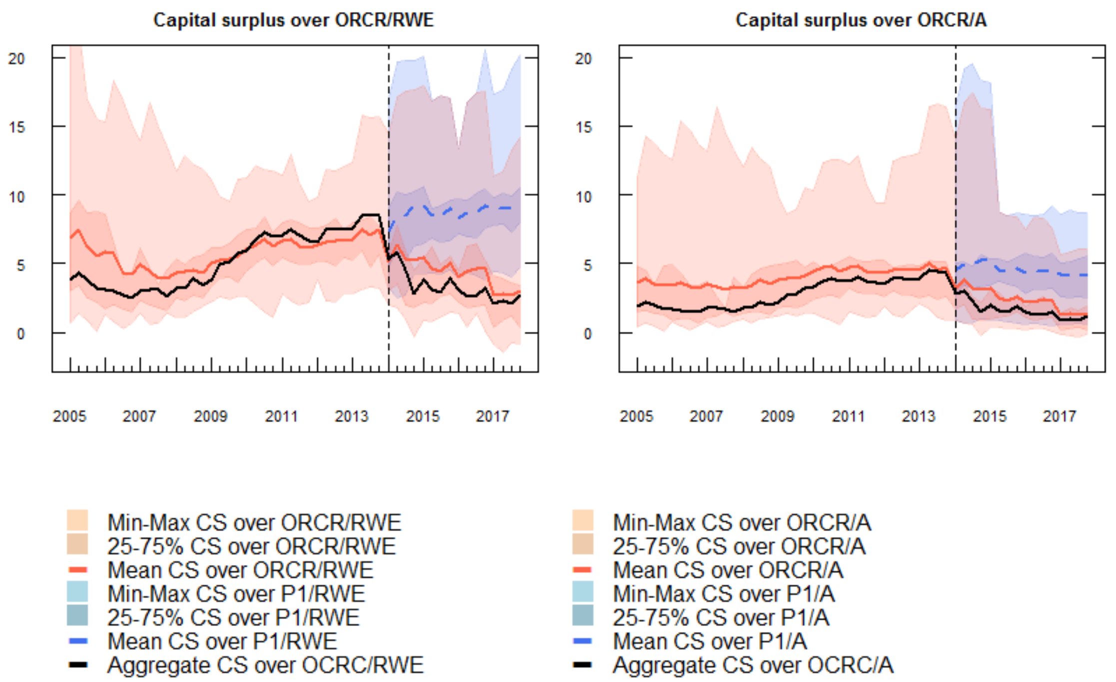


Note: RE – retained earnings; OCI – other comprehensive income (other comprehensive income comprises items that have an effect on the balance sheet amounts, but the effect is not reported in the company's income statement; it includes, for example, unrealised gains/losses on hedge/derivative financial instruments, foreign currency translation adjustments and unrealised gains/losses on post-retirement benefit plans.

Figure 4 depicts banks' capital surplus in relation to their risk-weighted exposures and total assets; the capital surplus is defined as the difference between the capital adequacy ratio and the overall regulatory capital requirements. Banks in the Czech Republic maintained their capital adequacy ratios well in excess of the regulatory minimum until 2014. The aggregated capital surplus was CZK 180 billion (8.4% of risk-weighted exposures and 4.3% of total assets) at its peak in 2013 Q4. Afterwards, additional capital requirements stemming from capital buffers and Pillar 2 add-ons were introduced. This led to a decrease in the aggregated capital surplus to CZK 67 billion (2.8% of risk-weighted exposures and 1.1% of total assets) as of 2017 Q4. While the minimum-maximum range is fairly wide (individual banks have held their surpluses somewhere between zero and 18% over the last three years), the 25th–75th percentile range is relatively narrow at between 0.4% and 3.4% as of 2017 Q4. The average capital surplus across banks in relation to both risk-weighted exposures and total assets also decreased, reaching 3.0% and 1.3% respectively as of 2017 Q4.

The blue area and the blue dashed line in Figure 4 show the hypothetical evolution of the capital surplus had no additional capital requirements been introduced, i.e. the capital surplus over the minimum 8% Pillar 1 capital requirement, holding all else equal. It can be seen that the higher additional capital requirements have taken a significant part of banks' capital surplus; if they had not been introduced, the hypothetical average capital surplus over the Pillar 1 capital minimum would have reached almost 10% by the end of 2017. However, this additional increase in the capital surplus after 2014 is due to decreasing total implicit risk weights amid a stable or slightly decreasing ratio of capital to total assets.

Figure 4: Capital Surplus in Relation to Risk-Weighted Exposures and Total Assets



4.2 Financial Asset Structure, Loan Growth and Implicit Risk Weights

We can approach banks' financial assets from two perspectives – the balance sheet perspective and the capital regulation perspective. In the first case, we can divide banks' financial assets as shown in Figure 5. It is apparent that they consist mainly of loans granted to the private sector (excluding interbank loans; approximately 60%) and debt securities (a 26% share on average).

We use year-on-year growth of loans to the private sector (excluding interbank loans) as a dependent variable when analysing the effect of higher additional capital requirements; we exclude loans to government and the central bank from our analysis, as they may be influenced by factors which are beyond the scope of this paper (such as the exchange rate commitment of the Czech National Bank between 2013 and 2017). Figure 6 shows there is significant heterogeneity among banks; loan growth has been significant in the last decade for some of them, but close to zero or even negative for others. Nevertheless, it can be seen that loan growth has slowed noticeably since 2014 for some banks. A drop in the growth rate is apparent in 2014, i.e. when the additional capital requirements were introduced. Since then, the average growth rate seems to have been stable, but the dispersion has decreased significantly, i.e. the growth has continued to slow after 2014 for some banks.

In the second case, banks' exposures are divided into categories according to CRD IV to reflect different types of risks; total risk-weighted exposures are then used to set the capital requirements. The total risk-weighted exposures of banks in the Czech Republic consist predominantly of exposures for credit risk (about 90%), which can be divided into further exposure categories (see Figures 7 and 8).

Figure 5: Financial Assets (Left Chart: Amount in CZK Billions; Right Chart: Share in %)

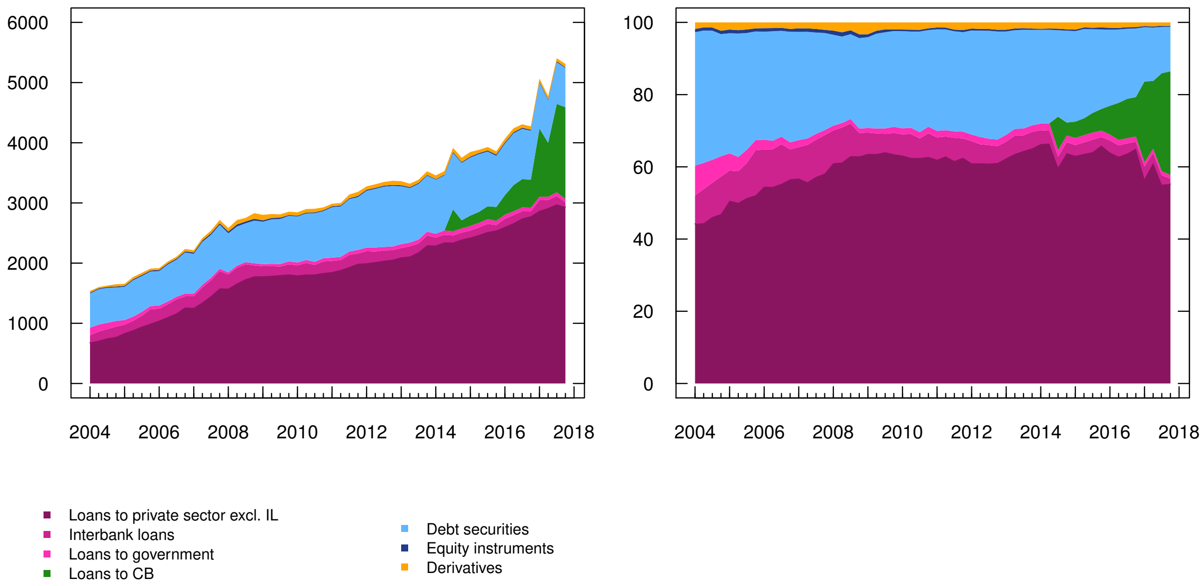


Figure 6: Year-on-Year Growth of Loans to Private Sector Excluding Interbank Loans

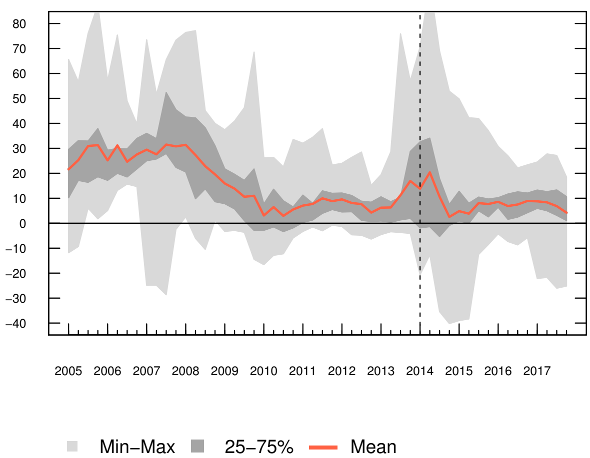


Figure 7: Risk-Weighted Credit Exposures (Left Chart: Amount in CZK Billions; Right Chart: Share in %)

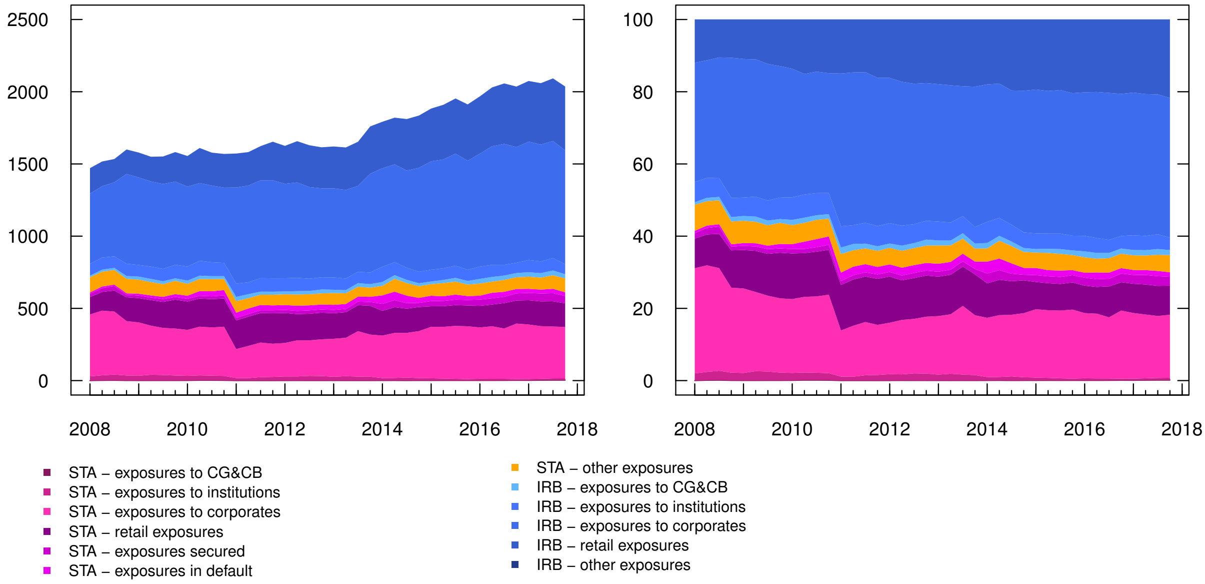
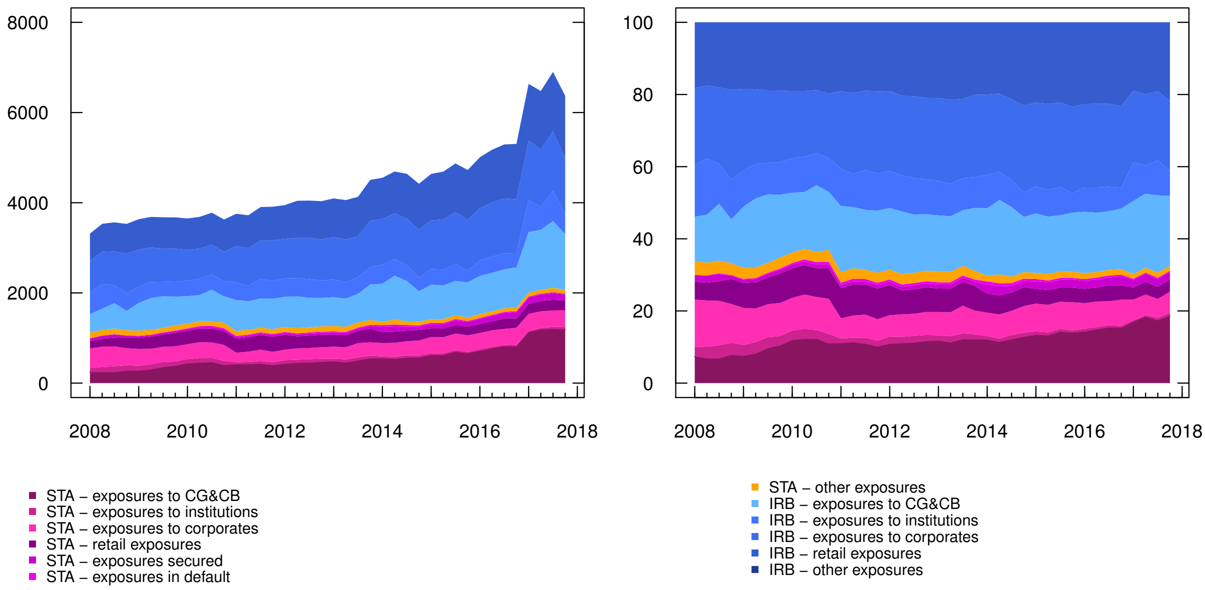


Figure 8: Non-Risk-Weighted Credit Exposures (Left Chart: Amount in CZK Billions; Right Chart: Share in %)



First, we need to distinguish between two regulatory approaches to determining capital requirements for credit risk – the standardised (STA) approach and the internal ratings based (IRB) approach. While the STA approach takes into account the type of exposure, its external rating and the quality of collateral, the IRB approach is based on the internal ratings set by banks and takes into account the perceived risk of various asset classes in a given economic environment.[24]

In the Czech Republic, five out of 14 banks on a consolidated basis use the IRB approach. Those banks have a combined market share of approximately 80%. They switched gradually to the IRB approach between 2007 and 2011 but have kept some part of their asset portfolio under the STA approach. In terms of total exposures, the transition to the IRB approach was in some cases relatively abrupt and in other cases rather gradual. No bank was using solely the IRB approach as of 2017.

According to CRD IV, banks' credit exposures under the IRB approach can be divided into four main exposure classes: (i) exposures to central governments and central banks, (ii) exposures to institutions, (iii) exposures to corporates and (iv) retail exposures. The remaining credit exposure categories under the IRB approach are equity exposures, items representing securitisation positions and other non credit-obligation assets; all these exposures are categorised as "other credit exposures". The categorisation of banks' credit exposures under the STA approach is more complicated, because there are 17 different credit exposure categories (as compared to seven under the IRB approach; for more details, see Appendix B). To simplify the analysis and make the credit exposure classes more or less comparable under the two approaches, we categorise the STA credit exposures as follows: (i) exposures to central governments or central banks,[25] (ii) exposures to institutions, (iii) exposures to corporates, (iv) retail exposures,[26] (v) exposures secured by mortgages on immovable property, (vi) exposures in default and (vii) other exposures.[27]

Risk-weighted exposures can be used to calculate implicit risk weights. Total implicit risk weights are defined as total risk-weighted exposures divided by total assets. The implicit risk weights in different exposure categories can be calculated as the risk-weighted exposures in a particular category divided by the relevant exposure value. Figure 9 shows that the implicit risk weights of banks using solely the STA approach started to decrease slowly a few quarters later than those of banks using the IRB approach. In the case of STA banks, the decline can be explained by a change in the asset structure to less risky. The fall in the implicit risk weights of IRB banks, on the other hand, cannot

[24] The current rules for determining risk-weighted exposures can be found in the implementing act of Basel III in Europe: the CRD IV/CRR regulatory framework. CRD IV – the Capital Requirements Directive – refers to Directive 2013/36/EU of the European Parliament and of the Council of 26 June 2013 on access to the activity of credit institutions and the prudential supervision of credit institutions and investment firms; CRR – the Capital Requirements Regulation – refers to Regulation (EU) No 575/2013 of the European Parliament and of the Council of 26 June 2013 on prudential requirements for credit institutions and investment firms.

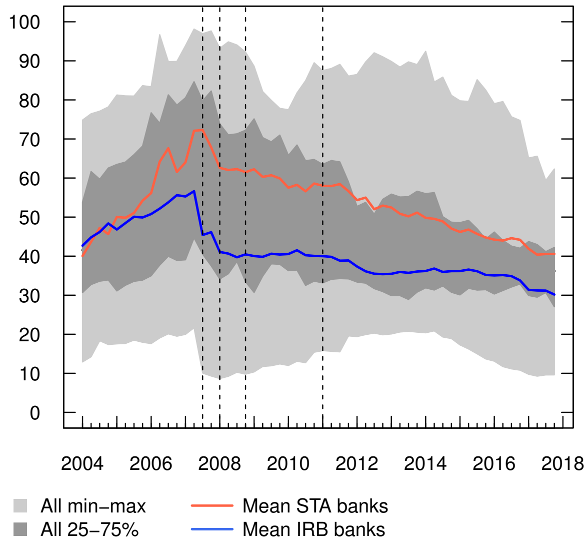
[25] Exposures to central governments or central banks consist of exposures to central governments or central banks, exposures to regional governments or local authorities, exposures to public sector entities, exposures to multilateral development banks and exposures to international organisations as defined by Article 112 of CRR/CRD IV. This is in line with the categorisation under the IRB approach (see Article 147(3) and (4) of CRD IV).

[26] Retail exposures comprise exposures to natural persons and exposures to SMEs, which are treated by the institution in its risk management consistently over time and in a similar manner. They are not managed just individually as exposures in the corporate exposure class and they each represent one of a significant number of similarly managed exposures. In addition, the total amount of exposures to an SME owed to the institution and parent undertakings and its subsidiaries cannot exceed EUR 1 million (see Article 146(5) of CRD IV for IRB retail credit exposures and Article 123 of CRD IV for STA retail credit exposures. With respect to that, the retail exposure category usually consists of special-purpose and non-special-purpose consumer loans, mortgage loans, credit card loans and loans to SMEs which meet the aforementioned conditions.

[27] For more details, see either CRD IV/CRR or the discussion in Malovaná (2018).

be explained solely by a change in the asset structure, so migration to the IRB approach also played a role (for a more detailed discussion, see, for example, Malovaná, 2018).

Figure 9: Implicit Risk Weights under the STA and IRB Approaches (%)



Note: Shaded areas show the variance in the implicit risk weights for the total exposures of all banks; coloured lines refer to the average implicit risk weights of banks using solely the STA approach or the IRB approach as of 2017 Q4. Vertical lines – banks' switches to the IRB approach.

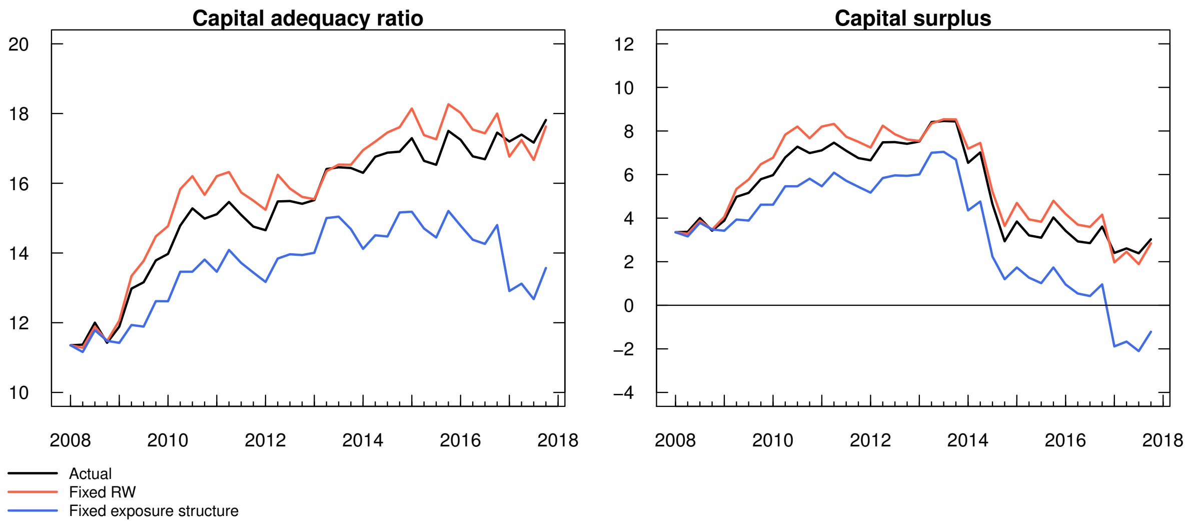
4.3 Simulations

As shown in previous subsections, banks' profitability (or more precisely, the amount of profit going to capital in the form of retained earnings), the exposure structure, the implicit risk weights in individual exposure categories and the overall regulatory capital requirements are key determinants of banks' capital surplus. In this subsection, we show how important each of these factors is in determining the capital adequacy ratio and capital surplus of the banks analysed.

To see the effect of change in the asset structure, risk weights and retained earnings on banks' capital surplus, we conduct three simple experiments. First, we fix the risk weights for the different credit exposure categories at their level in 2008 Q1 and calculate the level of risk-weighted exposures, the capital adequacy ratio and the capital surplus; the asset structure and the level of regulatory capital evolve according to the actual data. Second, we fix the asset structure at its level in 2008 Q1 and again calculate the level of risk-weighted exposures, the capital adequacy ratio and the capital surplus; the risk weights and the regulatory capital are kept at their actual levels. And third, we calculate different levels of regulatory capital corresponding to different levels of retained earnings: (i) we fix retained earnings at their level in 2008 Q1 to see its importance; and (ii) we fix retained earnings between 2014 and 2017 at their level in 2014 Q1, mimicking a prolonged period of low profitability. These simple simulations allow us to gain a deeper understanding of the importance of these factors in banks' decision making and to be able to better identify possible transmission channels of higher additional capital requirements.

Figure 10 nicely shows that the exposure structure plays a very important role. If the exposure structure was fixed at the level in 2008 Q1 while the implicit risk weights and regulatory capital evolve according to their actual values, the capital adequacy ratio would be significantly lower than its actual value and the capital surplus would reach negative territory at the end of 2017. In particular, the total regulatory ratio would decrease to about 13% (as compared to the actual 18%) and capital surplus to about −2% (as compared to the actual 2%). On the other hand, if we fixed the implicit risk weights in the individual categories at their level in 2008 Q1, the risk-weighted exposures would change only very modestly.

Figure 10: Aggregate Capital Adequacy Ratio and Capital Surplus; Fixed to 2008 Q1



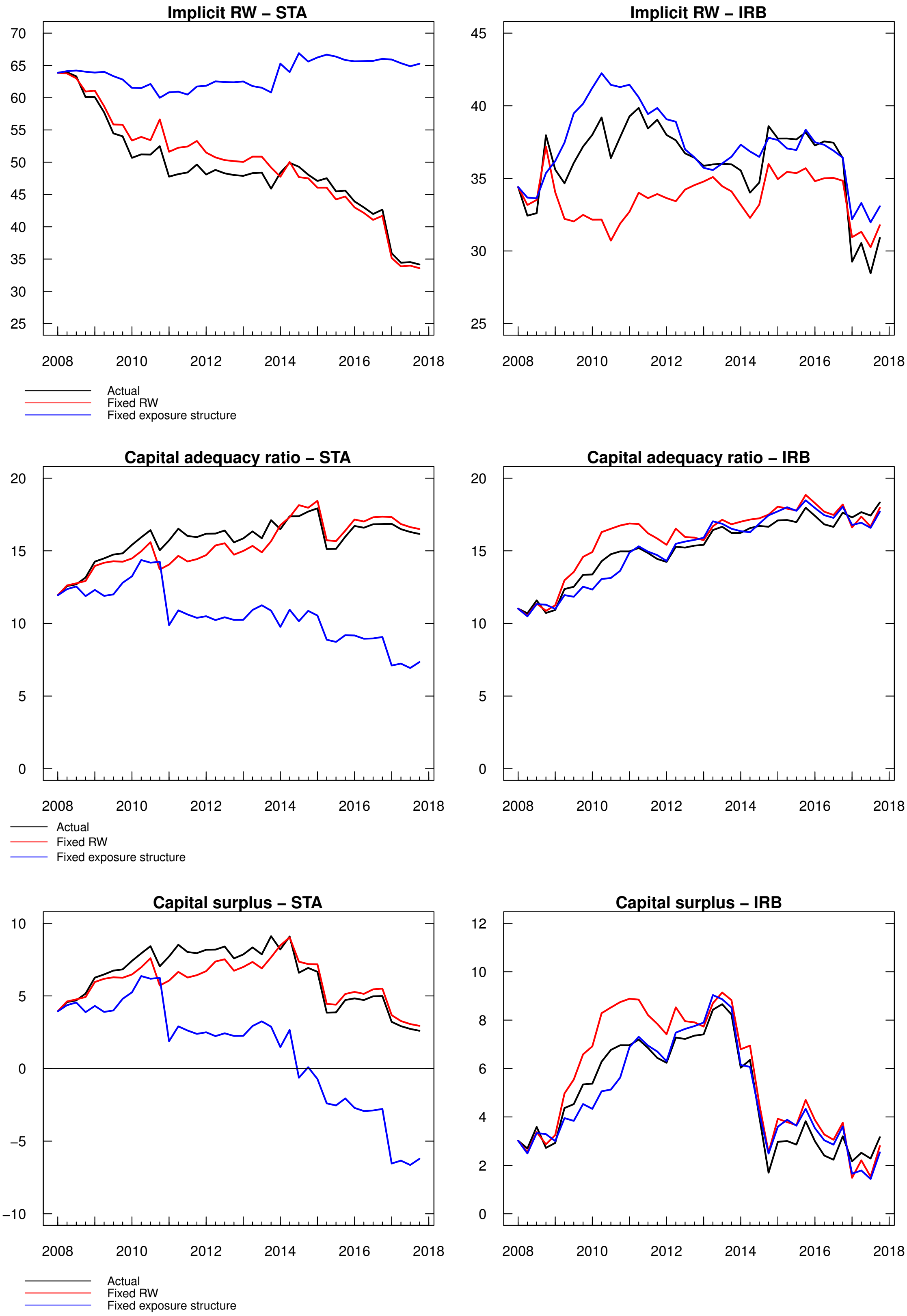
Note: The abrupt change at the end of 2016/beginning of 2017 is due to a sharp increase in exposures to the central bank in response to the approaching expected end of the CNB's exchange rate commitment (see Figures 5 and 8).

Figure 11 illustrates the role of regulatory approaches, i.e. the difference in the simulation results between the STA and IRB approach. It can be seen that the exposure structure plays an important role in determining risk-weighted exposures and consequently the capital adequacy ratio and capital surplus under the STA approach. This is due to the fact that the STA risk weights were generally stable over time (Malovaná, 2018), while the exposure structure shifted significantly to less risky exposures, predominantly exposures to central banks and central governments, which are usually assigned a zero risk weight under the STA approach (see, for example, Malovaná et al., 2018). The sudden shift at the end of our sample is caused by a sharp increase in loans to the central bank caused by FX interventions at the end of the CNB's exchange rate commitment (see the green area in Figure 5).

Under the IRB approach, total risk-weighted exposures are influenced not only by changing the exposure structure, but also by changing the implicit risk weights, or more precisely, by changing the estimates of the risk parameters entering the calculation of the capital requirements and implicitly also the risk weights (for more details, see Malovaná (2018), Appendix A). From Figure 11 it can be seen that changing the exposure structure shifts the implicit risk weights lower than the actual value (red line), while changing the estimates of the risk parameters shifts the implicit risk weights higher (blue line) under the IRB approach.[28]

[28] The presented simulations provide an aggregate view. This does not necessarily mean that the risk weights in the individual exposure categories or the risk weights of individual banks do not pose a potential risk to financial stability. As discussed in CNB (2018), a continued downward trend in the risk weights set by banks using internal models for loans secured by residential property may amplify the risks associated with current developments in the residential property market in the future. As discussed in Malovaná et al. (2018) and CNB (2017), the risk weights of building societies and mortgage bank subsidiaries (i.e. banks whose business model is focused almost

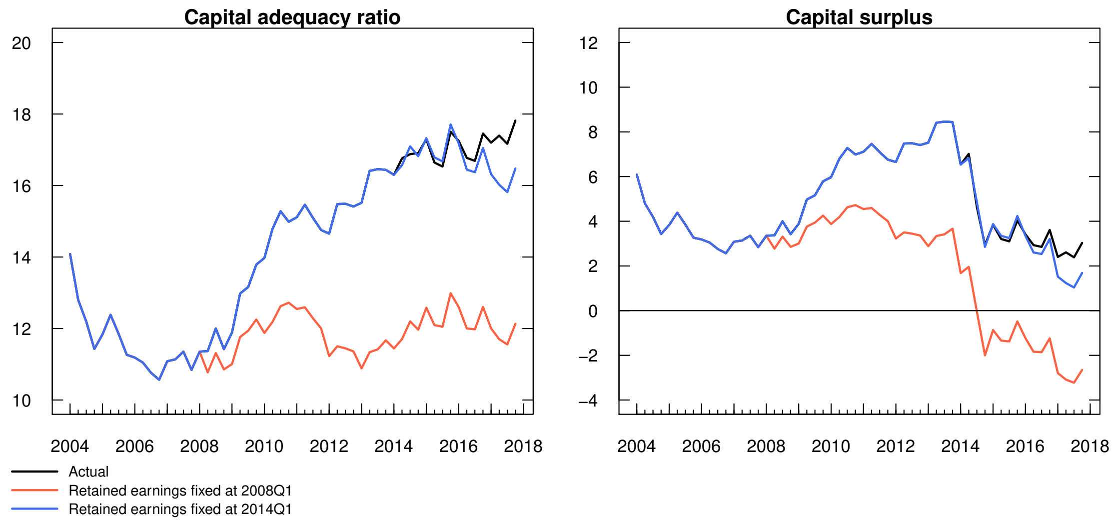
Figure 11: Aggregate Capital Adequacy Ratio, Capital Surplus and Implicit Risk Weights – IRB vs STA; Fixed to 2008 Q1



Note: The abrupt change at the end of 2016/beginning of 2017 is due to a sharp increase in exposures to the central bank in response to the approaching expected end of the CNB's exchange rate commitment (see Figures 5 and 8).

Figure 12 shows that the amount of retained earnings is essential in determining the capital surplus or capital adequacy ratio. With the low retained earnings as of 2008, the aggregate capital adequacy ratio would be almost 6 pp smaller, implying an insufficient level of capital and a negative capital surplus. If the prolonged period of low interest rates and consequently low profitability persisted after 2014, the capital surplus would be about 2 pp lower at the end of 2017 relative to its actual level and only about 1.5 pp above zero.[29]

Figure 12: Aggregate Capital Adequacy Ratio and Capital Surplus; Fixed Retained Earnings



5. Empirical Results

5.1 Macro-level Analysis

In this section, we study the dynamics of bank loan growth, other bank specific variables and nominal GDP growth in response to a 1 pp negative shock to banks' capital surplus. We report the 32nd, 50th and 68th percentiles of the distribution of the impulse response functions and use different proxies for banks' profitability or leverage ratio (see Figure 13).[30] All the presented relationships also apply in the opposite direction, because the model is linear and the impulse response functions are symmetrical. For more details on the methodology and variable selection, see section 3.1.

A negative shock to the capital surplus[31] leads to a decrease in bank loan growth and consequently in nominal GDP growth. The intuition is straightforward. With a lower capital surplus, banks have less space for balance sheet expansion and credit growth thus decreases. Furthermore, the change in the implicit risk weights decreases too, indicating that banks react to a lower capital surplus by changing their asset structure to less risky. This is in line with the negative response of credit growth,

exclusively on providing loans for house purchase) are, on average, significantly lower than those of other banks. This may signal that the risk weights in IRB building societies may potentially be undervalued.

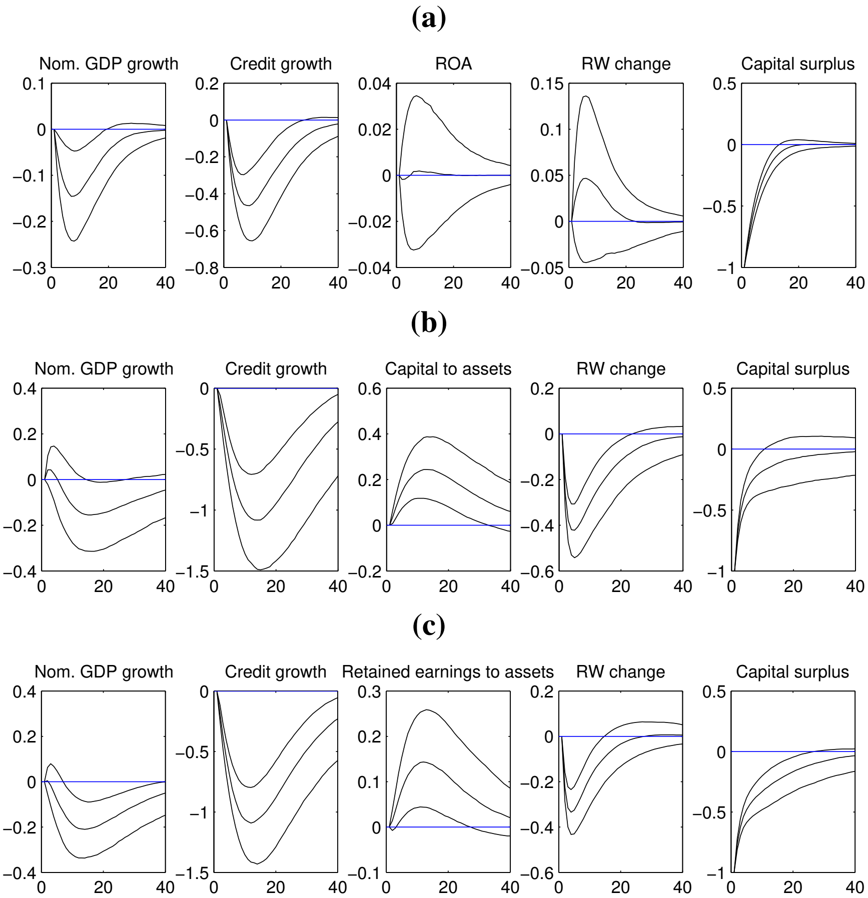
[29] The Pillar 2 capital add-ons, which are part of the overall regulatory capital requirements, are phased in, so that banks usually have 3 years to fulfil the requirements.

[30] We use either ROA (the ratio of net profit to total assets in %), the ratio of retained earnings to total assets (in %) or the ratio of regulatory capital (Tier 1 plus Tier 2) to total assets (in %).

[31] Such shock may consist in an increase in the capital requirements or an unexpected decrease in capital adequacy ratio.

as loans to the private sector are considered generally more risky than the other financial assets on banks' balance sheets.

Figure 13: Impulse Response Functions – Negative Shock to Capital Surplus



Note: 32nd, 50th and 68th percentiles of the distribution reported. (a), (b) and (c) belong to different models estimated using the same methodology (see section 3.1).

Comparing the specifications with different proxy variables for banks' profitability or leverage reveals that the effect of a lower capital surplus on banks' profitability (as measured by ROA) is not statistically significant, while the effect on banks' retained earnings and regulatory capital (both in relation to total assets) is positive and significant. This indicates that banks react to a decrease in the capital surplus not only by changing the risk composition of their balance sheets, but also by increasing the share of net profit redirected to regulatory capital in the form of retained earnings.

Ordering the variables differently or controlling for additional variables (the real monetary conditions index, RMCI, or the bank lending rate) does not change the results (see Figure B1 in Appendix B). The response of both the RMCI and the lending rate is very close to zero, indicating that there is no significant effect.

The presented results provide an aggregate macro view of the relationship between banks' capital surplus and loan growth. However, the response might be expected to differ at the micro-level when heterogeneity among banks is taken into account. For example, the responses will most likely differ with respect to individual banks' capitalisation, as discussed in section 3.2. These effects cannot be analysed at the macro-level, so they are addressed in the next subsections.

5.2 Micro-level Analysis

In this subsection, we provide a wide range of estimation results for the possible effects of higher additional capital requirements using supervisory bank-level data. First, we estimate the direct effect of higher additional capital requirements on various bank-specific variables in order to distinguish between the different transmission channels described in section 2 and formalised in subsection 3.2. Second, we focus our attention more on the relationship between the capital requirements, the capital surplus and credit growth to gain a deeper understanding of their interlinkages. In order to do so, we analyse the direct effect of higher additional capital requirements on bank loan growth with respect to banks' capital surplus and a different lag-lead structure; then we estimate a system of equations describing the indirect effect of higher additional capital requirements on bank loan growth via the capital surplus; and finally, we distinguish between intentionally and unintentionally formed capital surpluses and analyse the transmission via these two variables.

All these model specifications are estimated using the LSDV technique and the bootstrap-based bias-corrected fixed-effect technique; in addition, the systems of equations are estimated using the 3SLS procedure (for more details, see section 3.2). We estimate all specifications using a shorter data sample from 2013 Q1 to 2017 Q4, i.e. covering only the period of changing capital requirements plus four quarters before; the four additional quarters are considered because higher additional capital requirements are announced at least one year before they become effective. The two- and three-equation specifications are also estimated using a longer data sample running from 2004 Q1 to 2017 Q4. The longer data sample serves a few purposes; it can be used as a sensitivity analysis; it can be used to analyse the relationship between the capital surplus and loan growth (similarly to the macro-level analysis); and the results can be more easily compared with those from the macro-level analysis.

For the sake of brevity, we present selected estimation results in the next few subsections; the rest of the results are presented in Appendix C. However, where there are any important differences between the model specifications or estimation techniques, we disclose them transparently and refer to the relevant tables for comparison.

5.2.1 Direct Effect of Higher Additional Capital Requirements

As discussed in section 2, banks may react to higher additional capital requirements in different ways. Therefore, in this subsection we analyse the effect of higher additional capital requirements on different bank-specific variables describing possible transmission channels (see equations (1)–(6)). The estimation results from the bootstrap-based bias-corrected method are summarised in Table 1.

The effect of additional capital requirements on equity and regulatory capital, both in relation to total assets, is not statistically significant (see columns 1 and 3). The effect on retained earnings is, however, positive and statistically significant at the 10% level, indicating that a bank increases its retained earnings in response to higher additional capital requirements (column 2). This is in line with the results obtained using the Bayesian VAR model (see subsection 5.1). The effect of additional capital requirements on banks' implicit risk weights is not statistically significant (see columns 6–7). More importantly, the effect on the total capital surplus and credit growth is negative and both statistically and economically significant, regardless of the model specification and estimation technique. This is in line with the results of the macro-level analysis. Specifically, in response to a 1 pp increase in the additional capital requirements, the total capital surplus decreases by approximately 0.64 pp and the year-on-year growth of bank credit to the private sector (excluding interbank loans) falls by around 0.74 pp. Given the autocorrelation coefficients, the cumulative long-run effect is approximately −5.0 pp for lending growth and −1.6 pp for the total capital surplus.[32] It takes about 5 to 6 years for the initial effect on lending growth to disappear and about 3 to 4 years for the initial effect on the total capital surplus to vanish. The cumulative effects after 1 and 2 years are about 2.7 pp and 3.8 pp for loan growth and around 1.5 pp and 1.6 pp for the total capital surplus respectively.

Table 1: Estimation Results for Higher Additional Capital Requirements

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent var.:	EA	REA	CA	CS	CS	RW	RW	%Δ*loans*
Dependent variable (t-1)	0.956***	0.994***	0.895***	0.641***	0.600***	0.809***	0.793***	0.852***
	(0.058)	(0.059)	(0.054)	(0.046)	(0.046)	(0.059)	(0.053)	(0.057)
ORCR	0.0208	0.564*	−0.052	−0.609***	−0.636***	−0.056	0.046	−0.737**
	(0.046)	(0.032)	(0.032)	(0.073)	(0.076)	(0.171)	(0.176)	(0.354)
ROA (t-1)	0.004	0.083	−0.013	−0.147	−0.066			
	(0.156)	(0.073)	(0.138)	(0.259)	(0.259)			
LLPA (t-1)	0.241	0.154	0.166	−0.386***	−0.445***	1.007***	1.121***	0.437
	(0.210)	(0.170)	(0.123)	(0.120)	(0.121)	(0.366)	(0.379)	(0.575)
CA (t-1)								1.593***
								(0.493)
Interbank loans/A (t-1)					0.006		0.133	
					(0.038)		(0.157)	
Loans to CB&CG/A (t-1)					−0.002		0.012	
					(0.010)		(0.027)	
Loans to PS excl. IL/A (t-1)					−0.049**		0.007	
					(0.022)		(0.053)	
Bonds/A (t-1)					0.016		0.080	
					(0.016)		(0.049)	
Lending rate (t-1)								−1.269*
								(0.669)
Real GDP growth	−0.0170	−0.068**	0.010	0.087	0.092	−0.122	−0.161	−0.121
	(0.041)	(0.030)	(0.031)	(0.062)	(0.063)	(0.166)	(0.169)	(0.329)
PX growth	−0.003	0.002	0.003	0.031***	0.028**	−0.024	−0.013	
	(0.008)	(0.005)	(0.006)	(0.011)	(0.012)	(0.027)	(0.027)	
Spread	0.0229	−0.057	−0.203*	−1.099***	−1.076***	0.293	0.0218	
	(0.159)	(0.114)	(0.112)	(0.220)	(0.231)	(0.545)	(0.570)	
Observations	276	276	276	276	276	276	276	276

Note: The specifications are estimated using the bootstrap-based bias-corrected estimator. Bootstrapped standard errors reported in parentheses; ***, ** and * denote the 1%, 5% and 10% significance levels.

In terms of the coefficients on the control variables, the lending rate is significant in explaining bank loan growth and has a negative effect on it. We also find there is a positive and significant coefficient on the capital-to-assets ratio, indicating that loan growth is higher for banks with a greater amount of regulatory capital.[33] For banks' capital surplus, there are negative and significant coefficients on the ratio of loan loss provisions to total assets and the spread between the 10-year Czech government bond yield and the 3-month Pribor, and positive and significant coefficients on PX growth and real GDP growth. Risk weights rise with a higher ratio of loan loss provisions to total assets as a proxy for credit risk.

Bank capitalisation. In what follows, we focus our attention solely on the relationship between the capital requirements, the capital surplus and credit growth, as this is the main aim of this paper.

[32] The long-run effect is calculated as $\beta/(1-\alpha)$, where β is the coefficient on the overall capital requirements and α is the autocorrelation coefficient.

[33] The intuition is the following: a higher capital-to-assets ratio provides more space for balance sheet expansion, while a higher additional capital requirement, holding the capital-to-assets ratio constant, reduces the capital surplus and thus reduces the space for balance sheet expansion. Moreover, changing the capital requirements while holding capital-to-assets constant is not an unreasonable condition, as we have seen that the effect of the ORCR on the capital-to-assets ratio is almost zero and not statistically significant.

As discussed in subsection 2, the effect of higher additional capital requirements may differ with respect to bank capitalisation, or, more specifically, with respect to the initial size of the capital surplus.[34,35] The relationship between the overall capital requirements and bank loan growth remains statistically significant only for banks with lower capital surpluses (see Table 2), which supports our initial intuition. In terms of size, the effect is also much stronger as compared to estimates without interaction dummies, suggesting that the effect in the baseline regression may be driven by banks with lower capital surpluses. In particular, the effect for banks with lower capital surpluses is 60% stronger than the effect for all banks.

Table 2: Estimation Results of Higher Additional Capital Requirements wrt Banks' Capital Surplus

	(1)	(2)
Estimation method:	BBBC	LSDV
Dependent var.:	$\%\Delta loans$	$\%\Delta loans$
$\%\Delta loans$ (t-1)	0.853***	0.749***
	(0.0582)	(0.0465)
ORCR*dLowCS	-1.147*	-1.751***
	(0.659)	(0.576)
ORCR*(1-dLowCS)	-0.472	-0.606
	(0.305)	(0.365)
LLPA (t-1)	0.445	0.166
	(0.496)	(0.263)
CA (t-1)	1.404**	1.794**
	(0.542)	(0.695)
Lending rate (t-1)	-1.161*	-1.501***
	(0.673)	(0.442)
Real GDP growth	-0.0859	-0.0838
	(0.377)	(0.295)
Observations	276	276

Note: The specifications are estimated using the least square dummy variable estimator (LSDV) with robust (clustered) standard errors and the bootstrap-based bias-corrected estimator (BBBC) with bootstrapped standard errors. Standard errors reported in parentheses; ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons.

Different lags and leads. Higher capital buffers (such as the countercyclical capital buffer) are usually announced well in advance of them taking effect. On the other hand, Pillar 2 capital add-ons may be announced only a few months before they become effective. However, there may be a phase-in, or transitional, period during which banks are required to fulfil the higher Pillar 2 capital add-ons only partly. Banks can therefore react to the higher additional requirements in advance. However, they may also react with some delay after evaluating their own situation, the macroeconomic situation and the outlook for the near future. We therefore estimate the relationship between the overall capital requirements and bank loan growth with up to four lags or leads. For the sake of brevity, we only report estimates of the coefficient on the interaction dummy between higher additional capital requirements and the dummy for banks with lower capital surpluses (see Table 3); the effect for banks with higher capital surpluses turns out to be not statistically significant, similarly to the previous results. The complete estimation results are presented in Table C2 in the Appendix. Allowing for lags or leads reveals that banks tend to react at the time when the higher additional

[34] Even though we cover only a relatively small sample of banks located in one country, there is still noticeable heterogeneity with respect to the capital surplus held (see Figure 4).

[35] In addition, we introduce an interaction variable between the overall capital requirements and a dummy variable for four large banks accounting for about 75% of total consolidated banking sector assets as of 2017 Q4; the estimation results, however, remain similar for both groups, i.e. they do not yield any additional information, so we do not report them.

capital requirements become effective, or with a slight delay. The effect tends to be weaker with more lags and turns out to be not statistically significant for leads. The immediate effect, i.e. the reaction in the same quarter, remains the strongest. We therefore conclude that a richer lag or lead structure is not necessary and does not help to explain the variation, as it does not capture the nature of the data.

Table 3: Effect of Higher Additional Capital Requirements on Loan Growth of Banks with Relatively Low Capital Surpluses – Coefficient Estimates

No. of lags	Coeff. on ORCR*dLowCS BBBC	LSDV
-4	not statistically significant	not statistically significant
-3	not statistically significant	not statistically significant
-2	not statistically significant	not statistically significant
-1	not statistically significant	−1.07*
0	**−1.19***	**−1.78*****
1	−1.13**	−1.61**
2	−0.91**	−1.37**
3	not statistically significant	−1.10*
4	not statistically significant	not statistically significant

Note: The table presents estimates of the coefficient on the interaction variable between ORCR and dLowCS (the dummy for banks with low capital surpluses). The interaction variable enters the estimation equation with up to four lags or leads. Negative lags in the table correspond to leads; for example, −1 corresponds to one lead. The model also includes the interaction variable between ORCR and (1-dLowCS), which is not statistically significant in either specification. Complete results are given in Table C2 in the Appendix. BBBC – bootstrap-based bias-corrected estimator; LSDV – least square dummy variable estimator with robust (clustered) standard errors.

5.2.2 Indirect Effect of Higher Additional Capital Requirements on Banks' Lending Via the Capital Surplus

In this subsection, we estimate the effect of higher additional capital requirements on bank loan growth indirectly via their effect on the capital surplus (see equations 8–9). This exercise helps us to gain more information on possible transmission channels. The importance of the capital surplus in the transmission of higher additional capital requirements was demonstrated in the previous subsection, which showed that the effect is much stronger for banks with lower capital surpluses.

The results obtained using the system of equations confirm those obtained using individual equations (see Table 4). Specifically, a 1 pp increase in the additional capital requirements depresses the total capital surplus by approximately 0.7 pp (regardless of the initial capital surplus) and the loan growth of banks with lower capital surpluses by around 1.5 pp (−0.67 times 2.2). Similarly to the direct effects, the response of loan growth is not statistically significant for better-capitalised banks. The long-run indirect effect of a 1 pp increase in the additional capital requirements is an approximately 6.2 pp decrease in loan growth for relatively low-capitalised banks.[36]

[36] We calculate the long-term impact in this system of equations assuming only first-round effects: $\beta_{CSEq} * \beta_{LoanEq} / (1\text{-}\alpha_{LoanEq})$.

Table 4: Estimation Results for Higher Additional Capital Requirements – System of Two Equations

	(1)	(2)	(3)	(4)
Dependent var.:	CS	$\%\Delta loans$	CS	$\%\Delta loans$
Dependent var. (t-1)	0.516***	0.769***	0.519***	0.765***
	(0.040)	(0.0334)	(0.040)	(0.0319)
ORCR	−0.702***			
	(0.063)			
CS (t-1)		0.197		
		(0.248)		
ORCR*dLowCS			−0.668***	
			(0.084)	
ORCR*(1-dLowCS)			−0.711***	
			(0.066)	
CS (t-1)*dLowCS				2.188***
				(0.445)
CS (t-1)*(1-dLowCS)				−0.236
				(0.251)
ROA (t-1)	−0.035		−0.037	
	(0.170)		(0.172)	
LLPA (t-1)	−0.531***	0.380	−0.532***	−0.053
	(0.106)	(0.654)	(0.106)	(0.629)
Interbank loans/A (t-1)	0.002		0.010	
	(0.036)		(0.037)	
Loans to CB&CG/A (t-1)	−0.008		−0.008	
	(0.011)		(0.011)	
Loans to PS excl. IL/A (t-1)	−0.064***		−0.061***	
	(0.019)		(0.019)	
Bonds/A (t-1)	0.015		0.016	
	(0.017)		(0.017)	
Lending rate (t-1)		−0.853		−0.973*
		(0.526)		(0.505)
CA (t-1)		1.901***		1.674***
		(0.500)		(0.479)
Real GDP growth	0.100*	−0.681***	0.095*	−0.390
	(0.056)	(0.262)	(0.056)	(0.256)
PX growth	0.028***		0.029***	
	(0.0107)		(0.0108)	
Spread	−1.058***		−1.077***	
	(0.212)		(0.212)	
IRB dummy	−0.891		−1.373	
	(0.556)		(1.008)	
Observations	276		276	

Note: Specifications are estimated using the three-stage least squares estimator. Standard errors reported in parentheses; ***, ** and * denote the 1%, 5% and 10% significance levels.

The effect via intentional and unintentional capital surpluses. As discussed in section 3.2, the transmission of higher additional capital requirements via intentional and unintentional capital surpluses may differ, as they are of different nature. We thus provide estimates for a three-equation structure, dividing the total capital surplus into intentional and unintentional (see equations 10–12). Again, we estimate the specification with and without the dummy for banks with relatively low capital surpluses. The results are provided in Tables C5–C6 in Appendix C.

The results show that higher additional capital requirements reduce the intentional capital surplus (ICS) and have no statistically significant effect on the unintentional capital surplus (UCS). In particular, a 1 pp increase in the additional capital requirements leads to a 0.8 pp decrease in the ICS; this effect is similar to that estimated by Malovaná (2017) and is in line with the intuition presented in section 2. While the intentional capital surplus is formed deliberately with respect to asset structure and riskiness, the unintentional capital surplus is a result of temporary fluctuations in banks' profitability[37]; this is supported by the fact that that UCS takes both positive and negative values and is much closer to zero (with a mean of 0.5, as compared to 5 for the ICS).

The results also show that the impact on bank loan growth differs for banks with relatively high and relatively low capital surpluses. In particular, an increase in the additional capital requirements of 1 pp leads to a decrease in loan growth via the ICS of −1.8 pp (−0.76*2.39; see Table C5); the effect is slightly more negative than the effect via the total capital surplus (−1.5 pp; see Table 4). The effect via the UCS is not statistically significant, but the link between the UCS and bank loan growth is. These results, however, should be interpreted with caution, because the two measures – the intentional and unintentional capital surpluses – are not observable variables.

5.3 Summary of Results, Their Robustness and Discussion

So far, we have used different estimation approaches (macro-level vs micro-level analysis), different model specifications, different estimation techniques and different data sample lengths to identify the effect of additional capital requirements on bank loan growth. Table 5 provides a summary of selected estimation results. Overall, we consider the estimated effects to be robust.

Table 5: Summary of Selected Estimation Results of Effect of Higher Additional Capital Requirements on Bank Loan Growth

Table	Specification	Data sample	Estimation technique	ST effect	LT effect
2	**direct effect**	**short**	**BBBC**	**−0.74****	**−4.98**
3	**direct effect, low-cap**	**short**	**BBBC**	**−1.19***	**−7.85**
3	**direct effect, better-cap**	**short**	**BBBC**	**not statistically significant**	
C2	direct effect	short	LSDV	−1.03**	−4.21
C2	direct effect, low-cap	short	LSDV	−1.75***	−6.98
C2	direct effect, better-cap	short	LSDV	not statistically significant	
4	**indirect effect**	**short**	**3SLS**	**not statistically significant**	
4	**indirect effect, low-cap**	**short**	**3SLS**	**−1.47*****	**−6.22**
4	**indirect effect, better-cap**	**short**	**3SLS**	**not statistically significant**	
C4	indirect effect	short	LSDV	not statistically significant	
C4	indirect effect, low-cap	short	LSDV	−1.48***	−6.18
C4	indirect effect, better-cap	short	LSDV	not statistically significant	
C4	indirect effect	short	BBBC	not statistically significant	
C4	indirect effect, low-cap	short	BBBC	−1.09**	−6.51
C4	indirect effect, better-cap	short	BBBC	not statistically significant	

Note: Baseline results are in bold. BBBC – bootstrap-based bias-corrected LSDV estimator with bootstrapped standard errors; LSDV – least squares dummy variable; 3SLS – three-stage least squares. ST (short-term) effect – effect in t for direct estimation and in t+1 for indirect estimation; LT (long-term) effect calculated as $\beta/(1-\alpha)$, where β is coefficient on ORCR and α is autocorrelation coefficient.

The effect of higher additional capital requirements is negative across different model specifications. Differentiating between banks with relatively low capital surpluses and other banks indicates that the negative relationship primarily applies to low-capitalised banks; the impact on better-capitalised banks is not statistically significant. Quantitatively, the short-term effect of a 1 pp increase in the additional capital requirements is a decrease in loan growth of banks with relatively low capital

[37] The results show that the unintentional surplus is slightly higher with higher retained earnings and a higher ratio of interest income to assets, although the effect is not significantly different from zero. However, the UCS is significantly lower for IRB banks than for non-IRB banks.

surpluses of about 1.2–1.8 pp; the long-term effect lies between −6.2 and −7 pp.[38] These numbers are very much in line with those estimated by Aiyar et al. (2014) and Bridges et al. (2015) for the UK banking sector. Similarly to us, the authors of both papers study the effect of higher *capital requirements* rather than higher *capital adequacy ratios*; they estimate the effect to be between −1 and −8 pp in the short run (depending on the type of loan) and between −6 and −8 pp in the long run. Studies analysing the effect of changes in capital ratios on bank loan growth usually report a weaker relationship, i.e. lower coefficient estimates. This is not surprising as they lack the link between capital requirements and the capital surplus (see section 2) and are not able to isolate periods of increasing capital requirements.

The results using a longer sample are comparable in terms of direction and statistical significance, but weaker (see Appendix C); this is because the true variation in the overall regulatory capital requirements takes place only after 2014. The relationship between the capital surplus and loan growth, however, remains positive and statistically significant in the period before 2013, as indicated by the estimation results with an additional interaction dummy controlling for the pre- and post-2013 periods (see Table 6). In particular, a 1 pp increase in the capital surplus leads to about a 0.6–0.7 pp increase in the loan growth of banks with lower capital surpluses in the period before 2013. This suggests that the relationship between the capital surplus and loan growth plays an important role in banks' behaviour and does not serve only as an intermediate channel for the transmission of higher additional capital requirements. These results are in line with the macro-level analysis, which points to a statistically significant positive relationship between the aggregated bank capital surplus and loan growth. Specifically, in response to a 1 pp negative shock to banks' capital surplus, loan growth drops by about 0.2 pp after one quarter. Cumulatively, the capital surplus drops by 3 pp after one year and 5.5 pp after three years, which leads respectively to a 1.5 pp and 6.5 pp drop in bank loan growth.

In addition, we test the robustness of the micro-level results by controlling for additional demand-side factors in the equation for loan growth (the unemployment rate, wage growth and the real monetary conditions index).[39] The results remain robust.

Next, we provide a very simple simulation exercise using the coefficient estimates from a two-equation model (the coefficients on the capital requirements and an autocorrelation coefficient) and calculate the hypothetical bank loan growth if no increase in the combined capital buffer requirement had occurred, all else being equal.[40] Figure 15 shows a significant difference in the effect between banks with relatively low capital surpluses and the remaining banks; the simulations indicate that the loan growth of the former group of banks might have been higher at the end of 2017. This, however, does not apply to the sector as a whole (see Figure 14), which remains well capitalised and absorbs the higher additional capital requirements without any substantial trouble; the estimations with a three-equation model indicate that banks can even benefit from higher requirements, as they increase the resilience of the sector as perceived by financial markets and investors.

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[38] The long-term relationship between higher additional requirements and the capital surplus or loan growth should be taken with caution because of the relatively short time span used in our estimation. The long-term relationship between the capital surplus and loan growth, however, is also estimated using a longer data sample, so these effects are more reliable.

[39] The robustness estimation results are not reported but are available upon request.

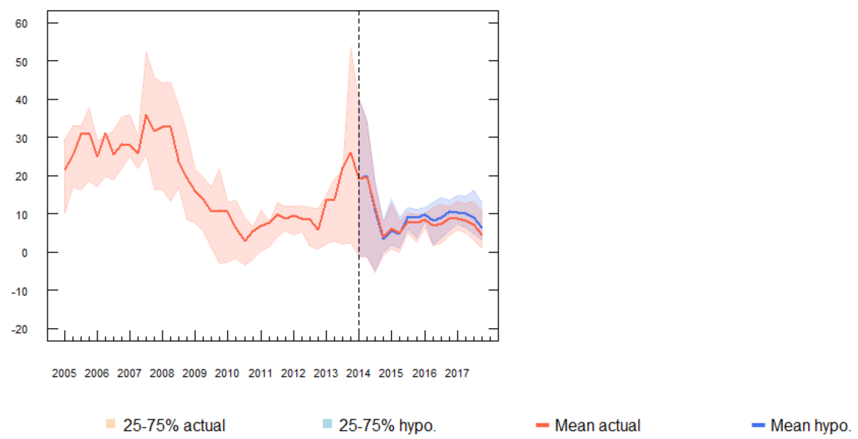
[40] The capital surplus proved to be an important factor in the transmission of higher additional capital requirements, so we only report simulations using indirect effects and divide them by banks' capitalisation. In addition, we do not consider Pillar 2 add-ons in these simulations, as the phase-in period may differ across banks and may be prolonged beyond the horizon of our analysis.

Table 6: Sensitivity Regression Results

	(1)	(2)
Estimation technique:	BBBC	LSDV
Dependent var.:	%Δ*loans*	%Δ*loans*
%Δ*loans* (t-1)	0.798***	0.849***
	(0.0355)	(0.0357)
CS (t-1)*dPostCR*dLowCS	1.633**	1.483**
	(0.585)	(0.580)
CS (t-1)*dPostCR*(1-dLowCS)	−0.0730	−0.0595
	(0.174)	(0.143)
CS (t-1)*(1-dPostCR)*dLowCS	0.663***	0.565*
	(0.201)	(0.303)
CS (t-1)*(1-dPostCR)*(1-dLowCS)	−0.00311	−0.0181
	(0.177)	(0.124)
LLPA (t-1)	−0.556	−0.428
	(0.519)	(0.391)
Real GDP growth	0.412**	0.336***
	(0.144)	(0.117)
Lending rate (t-1)	0.647	0.478
	(0.389)	(0.305)
CA (t-1)	−0.270	−0.180
	(0.277)	(0.271)
Observations	630	630

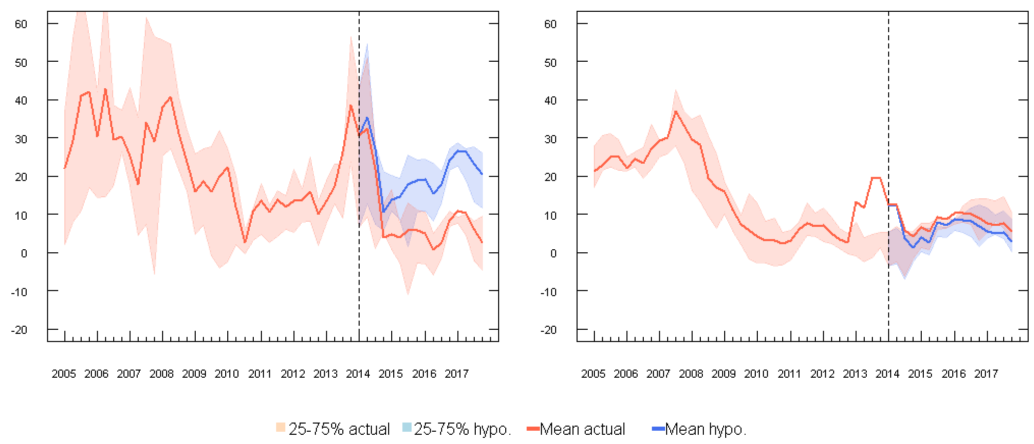
Note: The specifications are estimated using the bootstrap-based bias-corrected estimator (BBBC) with bootstrapped standard errors and the least square dummy variable (LSDV) estimator with robust (clustered) standard errors. ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons; dPostCR – a dummy variable which equals 1 for the period after 2013.

Figure 14: Actual vs. Simulated Bank Loan Growth – Indirect Effect



Note: Coefficient estimates taken from Table 4.

Figure 15: Actual vs. Simulated Bank Loan Growth, Indirect Effect – Banks with Relatively Low (Left) and High (Right) Capital Surpluses



Note: Coefficient estimates taken from Table 4.

6. Conclusions

This paper studies the impact of higher additional capital requirements on growth in loans to the private sector of banks in the Czech Republic. The analysis draws on a unique supervisory panel dataset and uses two estimation approaches – a Bayesian VAR model at the aggregate level and a dynamic panel data model at the bank-specific level.

The estimation results show that the effect is negative across various model specifications. Differentiating between banks with relatively low capital surpluses and other banks indicates that the negative relationship applies primarily to low-capitalised banks. Quantitatively, a 1 pp increase in the additional capital requirements depresses bank loan growth by about 1.2–1.8 pp. These results should be interpreted with respect to the specifics of the sample period used in the estimation exercise. The sample period covers mostly a growing phase of the financial cycle; future changes in additional capital requirements may be concentrated in a more favourable phase of the financial cycle, which may have some implications for the estimated relationship. Moreover, the increase in the additional capital requirements at the beginning of our sample relates to the introduction of the capital conservation buffer and the systemic risk buffer, which are most likely one-off policy interventions. Changes in the overall regulatory capital requirements in the near future would probably to a large extent reflect changes in the countercyclical capital buffer and Pillar 2 capital add-ons.

Furthermore, our results confirm the importance of the relationship between the capital surplus and loan growth in banks' behaviour and in the transmission of higher additional capital requirements; this relationship is positive and statistically significant not only in the period of increasing additional capital requirements, but also in the period before such changes. The importance of the relationship between banks' capital surplus is confirmed using different methodological approaches and time spans and can therefore be considered robust.

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Appendix A: Data

Figure A1: Bank-Level Regulatory Capital Requirements (%)

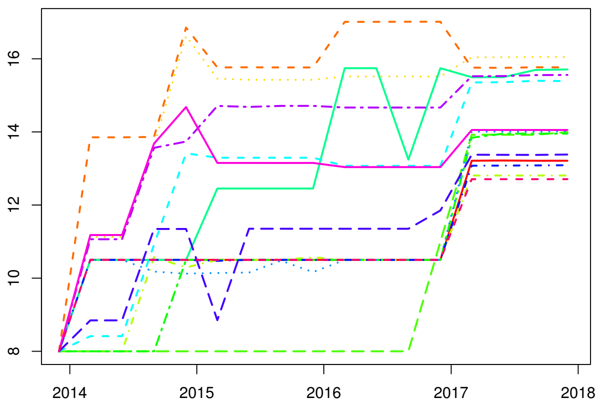


Table A1: Explained and Explanatory Variables: Summary Statistics

	Long sample					Short sample				
	Mean	SD	Min	Max	Median	Mean	SD	Min	Max	Median
EA	10.13	5.26	1.47	30.33	9.13	10.10	4.78	1.47	30.33	9.95
REA	3.85	4.93	-4.26	24.03	2.37	3.50	4.65	-4.26	24.03	2.70
CA	9.18	5.09	1.47	30.05	7.52	9.20	5.47	1.47	30.05	8.06
CS	5.61	4.57	-1.47	28.03	4.39	5.56	5.38	-1.47	28.03	3.81
ICS	5.38	4.20	-3.15	19.17	4.77	4.96	4.50	-3.15	19.12	3.87
UCS	0.28	2.64	-8.68	15.51	0.17	0.57	2.28	-4.94	9.22	0.27
RW	59.58	21.73	11.45	140.60	53.48	52.07	18.66	11.45	112.56	47.91
%Δ loans (yoy)*	15.17	20.49	-21.72	87.44	9.54	10.85	20.25	-21.72	87.44	7.04
ORCR	9.49	2.49	8.00	17.01	8.00	11.46	2.74	8.00	17.01	10.50
ROA	1.07	1.15	-4.40	10.86	0.95	0.80	1.01	-4.40	3.39	0.80
LLP/A	1.87	2.00	0.00	10.75	1.32	1.67	1.84	0.08	10.75	1.23
Lending rate	5.00	2.09	-0.20	13.96	4.69	4.18	2.18	0.56	12.23	3.63
Interbank loans/A	5.13	5.50	0.00	44.85	3.64	2.68	3.27	0.00	26.59	2.04
Loans to CB&CG/A	3.72	8.25	0.00	76.99	0.62	7.24	11.54	0.00	76.99	1.87
Loans to PS excl. IL/A	56.75	17.32	12.02	89.23	55.99	56.24	17.58	12.02	86.47	56.07
Bonds/A	16.25	11.55	0.00	52.12	15.83	16.74	11.21	0.01	49.44	14.96
IRB	0.29	0.46	0.00	1.00	0.00	0.36	0.48	0.00	1.00	0.00
Real GDP growth	2.75	3.18	-5.58	7.34	2.85	2.95	2.16	-1.75	5.80	3.40
PX growth	5.19	25.01	-53.46	67.39	2.88	1.63	9.54	-15.21	19.06	-0.11
Spread	1.37	0.91	-0.04	3.68	1.46	0.77	0.68	-0.04	2.24	0.51
N	644					278				

Note: The variables are ordered based on their order of appearance in the text. The dependent variables are located in the upper part of the summary table. Different statistics are provide for the long and short samples.
* Data on %Δ loans (yoy) are winsorised at the 2nd and 98th percentiles.

Appendix B: Bayesian VAR Model

B.1 BVAR Methodology

The VAR model can be written as

$$y_t = \alpha_0 + A_t(L)y_{t-1} + e_t \tag{B1}$$

where y_i is a $G \times 1$ vector of dependent variables at time $t = 1, \ldots, T$, a_0 is a constant and $e_t \sim N(0, \Sigma)$ is a vector of random errors, where Σ is a full $G \times G$ covariance matrix.

Let $X = I_G \otimes \mathbf{X}'$; $x_t = (1, 1 : T, y_{t-1}`, y_{t-2}`, \ldots, y_{t-p}`)$ with p lags and $\mathbf{X} = (x_1, x_2, \ldots, x_T)$; X is a $T \times K$ matrix, where $K = 1 + Gp$. Define $\alpha = vec(A)$; $A = (\alpha_0, tr, A_1, A_2, \ldots, A_p)'$; α is a $KG \times 1$ vector. Define $Y = (y_1, y_2, \ldots, y_T)$ and $E = (e_1, e_2, \ldots, e_T)$; $E \sim N(0, \Sigma \otimes I_T)$. We can then rewrite (B1) as

$$Y = XA + E \tag{B2}$$

We take a Bayesian approach to estimating the model, which requires a prior distribution for α and Σ. We let $p(\alpha, \Sigma^{-1}) = p(\alpha)p(\Sigma^{-1})$, where

$$p(\alpha) = N(a, S) \tag{B3}$$
$$p(\Sigma) = iW(V, n) \tag{B4}$$

iW stands for inverse Wishart distributions; the hyperparameters a, S, V and n are treated as fixed. This prior distribution is known as the independent Normal-Wishart distribution. As the analytical distribution is unfeasible, a Gibbs sample is used to obtain the posterior quantities.

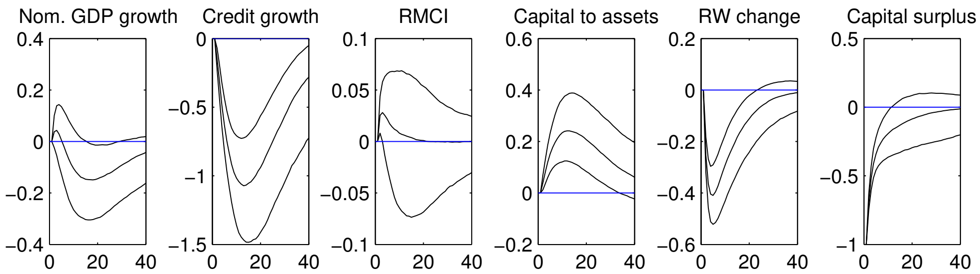
Prior distribution. Due to the short sample size, we are not able to tune our prior choice using a training sample. In order to minimise its influence, we select relatively loose and less informative priors.

$$p(\alpha) = N(0, 10 * I_{K*G}) \tag{B5}$$
$$p(\Sigma) = iW(I_G, G+1) \tag{B6}$$

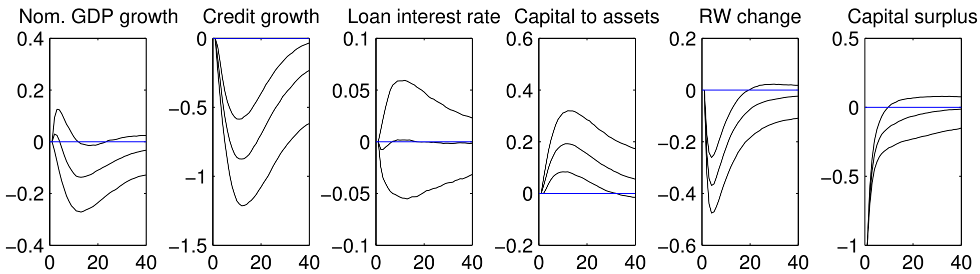
B.2 Additional Estimation Results on Macro-Level

Figure B1: Impulse Response Functions – Negative Shock to Capital Surplus (2)

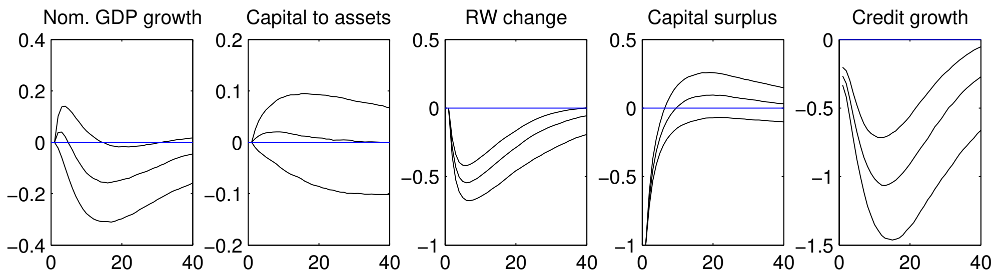
(a)



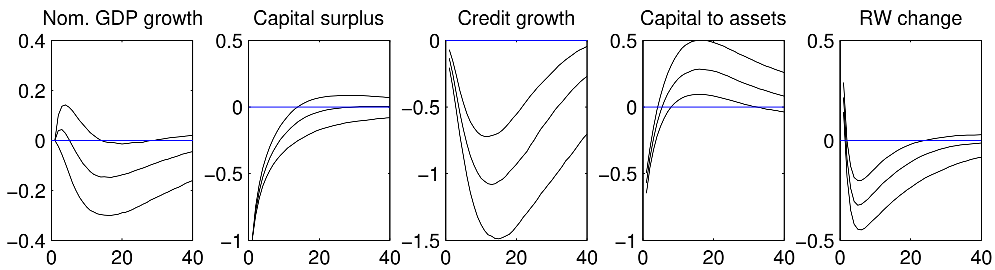
(b)



(c)



(d)



Note: 32nd, 50th and 68th percentiles of the distribution reported.

Appendix C: Additional Estimation Results on Micro-Level

Table C1: Estimation Results of Direct Effect, Short Sample, LSDV Estimator

	(1) EA	(2) REA	(3) CA	(4) CS	(5) CS	(6) RW	(7) RW	(8) $\%\Delta loans$
Dependent variable (t-1)	0.788***	0.839***	0.753***	0.569***	0.524***	0.689***	0.657***	0.756***
	(0.042)	(0.019)	(0.068)	(0.048)	(0.044)	(0.081)	(0.092)	(0.037)
ORCR	0.018	0.050	−0.058**	−0.659***	−0.685***	−0.105	−0.006	−1.027**
	(0.050)	(0.044)	(0.026)	(0.083)	(0.073)	(0.125)	(0.132)	(0.409)
ROA (t-1)	−0.015	0.119	−0.004	−0.144	−0.050			
	(0.063)	(0.111)	(0.106)	(0.351)	(0.294)			
LLPA (t-1)	0.387***	0.266***	0.221***	−0.451***	−0.514***	1.355***	1.472***	−0.022
	(0.089)	(0.052)	(0.026)	(0.085)	(0.083)	(0.289)	(0.315)	(0.270)
CA (t-1)								1.926**
								(0.754)
Lending rate (t−1)								−1.521**
								(0.534)
Interbank loans/A (t-1)					0.006		0.137**	
					(0.025)		(0.063)	
Loans to CB&CG/A (t-1)					−0.005		0.008	
					(0.009)		(0.028)	
Loans to PS excl. IL/A (t-1)					−0.058**		0.012	
					(0.022)		(0.031)	
Bonds/A (t-1)					0.017		0.102*	
					(0.013)		(0.052)	
Real GDP growth	−0.014	−0.077	0.007	0.085	0.089	−0.106	−0.160	−0.120
	(0.063)	(0.064)	(0.031)	(0.058)	(0.056)	(0.167)	(0.205)	(0.257)
PX growth	−0.003	0.003	0.003	0.031*	0.027*	−0.028	−0.012	
	(0.004)	(0.003)	(0.007)	(0.015)	(0.015)	(0.024)	(0.028)	
Spread	−0.018	−0.017	−0.228	−1.103***	−1.076***	0.460	0.153	
	(0.124)	(0.101)	(0.134)	(0.241)	(0.275)	(0.468)	(0.521)	
Observations	276	276	276	276	276	276	276	276

Note: The specifications are estimated using the least square dummy variable (LSDV) estimator with robust (clustered) standard errors. Standard errors reported in parentheses; ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons.

Table C2: Estimation Results of Direct Effect, Short Sample – Different Lags and Leads

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Dependent var.:					%Δ*loans*								%Δ*loans*			
Estimation technique:					LSDV								BBBC			
Dependent variable (t-1)	0.740***	0.736***	0.738***	0.747***	0.760***	0.755***	0.747***	0.734***	0.842***	0.841***	0.846***	0.854***	0.871***	0.872***	0.864***	0.864***
	(0.0528)	(0.0575)	(0.0553)	(0.0523)	(0.0437)	(0.0427)	(0.0446)	(0.0495)	(0.0438)	(0.0437)	(0.0419)	(0.0420)	(0.0444)	(0.0445)	(0.0463)	(0.0525)
ORCR (t-1)*dLowCS	-1.611**								-1.053*							
	(0.710)								(0.539)							
ORCR (t-1)*(1-dLowCS)	-0.184								-0.146							
	(0.320)								(0.422)							
ORCR (t-2)*dLowCS		-1.367**								-0.830						
		(0.631)								(0.520)						
ORCR (t-2)*(1-dLowCS)		0.0274								0.0513						
		(0.226)								(0.429)						
ORCR (t-3)*dLowCS			-1.097*								-0.563					
			(0.591)								(0.509)					
ORCR (t-3)*(1-dLowCS)			0.139								0.187					
			(0.204)								(0.430)					
ORCR (t-4)*dLowCS				-0.726								-0.290				
				(0.518)								(0.504)				
ORCR (t-4)*(1-dLowCS)				0.274								0.308				
				(0.162)								(0.435)				
ORCR (t+1)*dLowCS					-1.071*								-0.528			
					(0.522)								(0.572)			
ORCR (t+1)*(1-dLowCS)					-0.266								-0.123			
					(0.336)								(0.448)			
ORCR (t+2)*dLowCS						-0.819								-0.255		
						(0.483)								(0.596)		
ORCR (t+2)*(1-dLowCS)						-0.323								-0.141		
						(0.348)								(0.457)		
ORCR (t+3)*dLowCS							-0.536								-0.0829	
							(0.722)								(0.729)	
ORCR (t+3)*(1-dLowCS)							-0.0981								0.0426	
							(0.365)								(0.524)	
ORCR (t+4)*dLowCS								-0.717								0.0697
								(0.862)								(0.825)
ORCR (t+4)*(1-dLowCS)								0.411								0.468
								(0.416)								(0.709)
LLPA (t-1)	0.199	0.180	0.181	0.153	0.536*	0.649*	1.033*	1.330**	0.403	0.392	0.554	0.559	0.922	1.011	1.314	1.652
	(0.237)	(0.238)	(0.231)	(0.232)	(0.286)	(0.365)	(0.510)	(0.607)	(0.746)	(0.750)	(0.787)	(0.801)	(0.887)	(0.982)	(1.189)	(1.135)
Real GDP growth	-0.270	-0.452	-0.596**	-0.702**	-0.392	-0.502	-0.687*	-0.764**	-0.267	-0.420	-0.495*	-0.553*	-0.332	-0.462	-0.598*	-0.670*
	(0.293)	(0.262)	(0.258)	(0.250)	(0.254)	(0.295)	(0.340)	(0.279)	(0.378)	(0.371)	(0.299)	(0.284)	(0.361)	(0.335)	(0.356)	(0.356)
Lending rate (t-1)	-1.225**	-1.068**	-0.979*	-0.782*	-1.474**	-1.311**	-1.017	-0.853	-0.943	-0.794	-0.724	-0.572	-1.063	-0.959	-0.855	-0.529
	(0.444)	(0.407)	(0.468)	(0.427)	(0.520)	(0.593)	(0.768)	(0.714)	(0.628)	(0.637)	(0.673)	(0.651)	(0.837)	(0.852)	(0.859)	(1.017)
CA (t-1)	1.757**	1.786**	1.848**	1.866**	1.923***	2.077***	2.221***	2.171***	1.404***	1.424***	1.450***	1.461***	1.552***	1.661***	1.800***	1.732**
	(0.669)	(0.656)	(0.669)	(0.668)	(0.633)	(0.652)	(0.661)	(0.615)	(0.509)	(0.508)	(0.521)	(0.524)	(0.528)	(0.569)	(0.584)	(0.683)
Observations	276	276	276	276	262	248	234	220	276	276	276	276	262	248	234	220

Note: The specifications are estimated using the bootstrap-based bias-corrected estimator (BBBC) and the least square dummy variable (LSDV) estimator with robust (clustered) standard errors. ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons; dPostCR – a dummy variable which equals 1 for the period after 2013.

Table C3: Estimation Results of Indirect Effect, Short Sample

Estimation technique:	LSDV				BBBC			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Dependent var.:	CS	%Δ*loans*	CS	%Δ*loans*	CS	%Δ*loans*	CS	%Δ*loans*
Dependent variable (t-1)	0.524***	0.764***	0.525***	0.760***	0.595***	0.863***	0.599***	0.837***
	(0.0441)	(0.0365)	(0.0448)	(0.0526)	(0.0480)	(0.0619)	(0.0483)	(0.0535)
ORCR	-0.685***				-0.633***			
	(0.0732)				(0.0696)			
CS (t-1)		0.266				0.128		
		(0.294)				(0.262)		
ORCR*dLowCS			-0.653***				-0.609***	
			(0.0773)				(0.0907)	
ORCR*(1-dLowCS)			-0.696***				-0.638***	
			(0.0764)				(0.0737)	
CS (t-1)*dLowCS				2.273***				1.806**
				(0.432)				(0.747)
CS (t-1)*(1-dLowCS)				-0.190				-0.155
				(0.126)				(0.213)
ROA (t-1)	-0.0505		-0.0390		-0.0574		-0.0508	
	(0.294)		(0.288)		(0.281)		(0.281)	
LLPA (t-1)	-0.514***	0.389	-0.520***	-0.0535	-0.450***	0.600	-0.452***	0.183
	(0.0830)	(0.471)	(0.0866)	(0.350)	(0.113)	(0.596)	(0.115)	(0.486)
CA (t-1)		1.637*		1.468**		1.378**		1.207**
		(0.759)		(0.523)		(0.604)		(0.505)
Lending rate (t-1)		-0.831		-0.956**		-0.670		-0.898
		(0.531)		(0.367)		(0.617)		(0.599)
Interbank loans/A (t-1)	0.0060		0.0117		0.0065		0.0108	
	(0.0246)		(0.0293)		(0.0411)		(0.0425)	
Loans to CB&CG/A (t-1)	-0.0050		-0.0059		-0.0034		-0.0042	
	(0.0086)		(0.0096)		(0.0100)		(0.0100)	
Loans to PS excl. IL/A (t-1)	-0.0585**		-0.0574**		-0.0486**		-0.0474*	
	(0.0224)		(0.0217)		(0.0237)		(0.0241)	
Bonds/A (t-1)	0.0170		0.0178		0.0157		0.0162	
	(0.0133)		(0.0137)		(0.0162)		(0.0165)	
Real GDP growth	0.0893	-0.656**	0.0876	-0.366	0.0890	-0.519*	0.0877	-0.308
	(0.0555)	(0.260)	(0.0559)	(0.227)	(0.0673)	(0.312)	(0.0676)	(0.273)
PX growth	0.0275*		0.0282*		0.0285**		0.0291***	
	(0.0151)		(0.0154)		(0.0111)		(0.0111)	
Spread	-1.076***		-1.080***		-1.075***		-1.078***	
	(0.275)		(0.275)		(0.227)		(0.228)	
Observations	276	276	276	276	276	276	276	276

Note: The specifications are estimated using the bootstrap-based bias-corrected estimator (BBBC) with bootstrapped standard errors and the least square dummy variable (LSDV) estimator with robust (clustered) standard errors. ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons; dPostCR – a dummy variable which equals 1 for the period after 2013.

Table C4: Estimation Results of Indirect Effect, Long Sample

	LSDV				BBBC				3SLS			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent var.:	CS	%Δ*loans*	CS	%Δ*loans*	CS	%Δ*loans*	CS	%Δ*loans*	CS	%Δ*loans*	CS	%Δ*loans*
Dependent var. (t-1)	0.841***	0.804***	0.835***	0.794***	0.904***	0.852***	0.896***	0.844***	0.841***	0.803***	0.835***	0.793***
	(0.0325)	(0.0369)	(0.0300)	(0.0392)	(0.0277)	(0.0370)	(0.0297)	(0.0372)	(0.0203)	(0.022)	(0.0210)	(0.023)
ORCR	-0.181***				-0.164***				−0.182***			
	(0.0323)				(0.0463)				(0.037)			
CS (t-1)		0.237				0.195				0.231		
		(0.187)				(0.158)				(0.164)		
ORCR*dLowCS			-0.227***				-0.193***				−0.228***	
			(0.0512)				(0.0642)				(0.055)	
ORCR*(1-dLowCS)			-0.166***				-0.152***				−0.167***	
			(0.0319)				(0.0518)				(0.040)	
CS (t-1)*dLowCS				0.713**				0.583*				0.704***
				(0.264)				(0.313)				(0.236)
CS (t-1)*(1-dLowCS)				-0.0536				-0.0461				−0.056
				(0.180)				(0.135)				(0.193)
ROA (t-1)	0.0554		0.0468		0.046		0.0435		0.053		0.045	
	(0.0615)		(0.0630)		(0.107)		(0.106)		(0.076)		(0.076)	
LLPA (t-1)	-0.025	-0.261	-0.0235	-0.468	-0.0279	-0.174	-0.0131	-0.357	−0.026	−0.266	−0.024	−0.470
	(0.0419)	(0.511)	(0.0431)	(0.461)	(0.108)	(0.405)	(0.108)	(0.385)	(0.0733)	(0.477)	(0.073)	(0.480)
CA (t-1)		-0.339*		-0.353		-0.247		-0.25		−0.324		−0.342
		(0.189)		(0.291)		(0.248)		(0.243)		(0.254)		(0.252)
Lending rate (t-1)		0.693		0.519		0.522*		0.36		0.695**		0.522*
		(0.431)		(0.422)		(0.314)		(0.303)		(0.274)		(0.279)
Interbank loans/A (t-1)	-0.0137		-0.0174		-0.0119		-0.0148		−0.014		−0.018	
	(0.0288)		(0.0305)		(0.0181)		(0.0174)		(0.016)		(0.017)	
Loans to CB	0.00879		0.0105		0.00797		0.00968		0.009		0.01	
	(0.0137)		(0.0141)		(0.0122)		(0.0113)		(0.010)		(0.010)	
Loans to PS excl. IL/A (t-1)	0.00535		0.00289		0.00408		0.00248		0.005		0.003	
	(0.0102)		(0.0107)		(0.0117)		(0.0116)		(0.010)		(0.010)	
Bonds/A (t-1)	0.00522		0.00558		0.00415		0.0054		0.005		0.005	
	(0.00845)		(0.00834)		(0.0110)		(0.0115)		(0.010)		(0.010)	
Real GDP growth	-0.0362*	0.376***	-0.0363**	0.380**	-0.0337	0.310**	-0.0366	0.318***	−0.036	0.378***	−0.037	0.381***
	(0.0168)	(0.121)	(0.0167)	(0.137)	(0.0330)	(0.123)	(0.0337)	(0.118)	(0.028)	(0.129)	(0.028)	(0.128)
PX growth	0.00301		0.00287		0.00266		0.00271		0.003		0.003	
	(0.00226)		(0.00229)		(0.00311)		(0.00317)		(0.003)		(0.003)	
Spread	-0.227*		-0.230*		-0.224**		-0.224*		−0.228**		−0.231**	
	(0.117)		(0.118)		(0.110)		(0.115)		(0.0987)		(0.0987)	
IRB dummy	0.586**		0.610***		0.39		0.423		0.589**		0.612**	
	(0.206)		(0.191)		(0.315)		(0.360)		(0.263)		(0.264)	
Observations	630	630	630	630	630	630	630	630	630	630	630	630

Note: The specifications are estimated using the bootstrap-based bias-corrected estimator (BBBC) with bootstrapped standard errors, the least square dummy variable (LSDV) estimator with robust (clustered) standard errors and three-stage least squares (3SLS). ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons; dPostCR – a dummy variable which equals 1 for the period after 2013.

Table C5: Regression Results – Indirect Effect of Higher Additional Capital Requirements on Credit Growth via ICS and UCS (1), Short Sample

	3SLS						BBBC					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent var.:	ICS	UCS	%Δ*loans*	ICS	UCS	%Δ*loans*	ICS	UCS	%Δ*loans*	ICS	UCS	%Δ*loans*
Dependent var. (t-1)	0.313***	0.627***	0.749***	0.314***	0.630***	0.740***	0.357***	0.799***	0.870***	0.357***	0.803***	0.824***
	(0.028)	(0.047)	(0.034)	(0.028)	(0.047)	(0.033)	(0.034)	(0.073)	(0.065)	(0.034)	(0.074)	(0.057)
ORCR	−0.795***	0.036					−0.756***	0.026				
	(0.036)	(0.038)					(0.037)	(0.046)				
ICS (t-1)			0.383						0.092			
			(0.290)						(0.300)			
UCS (t-1)			0.077						0.080			
			(0.370)						(0.437)			
ORCR*dLowCS				−0.757***	0.053					−0.732***	0.026	
				(0.046)	(0.059)					(0.044)	(0.065)	
ORCR*(1-dLowCS)				−0.804***	0.029					−0.764***	0.026	
				(0.037)	(0.048)					(0.039)	(0.058)	
ICS (t-1)*dLowCS						2.390***						1.682**
						(0.506)						(0.802)
ICS (t-1)*(1-dLowCS)						0.0266						−0.129
						(0.299)						(0.253)
UCS (t-1)*dLowCS						2.546***						2.082**
						(0.589)						(1.019)
UCS (t-1)*(1-dLowCS)						−0.648*						−0.614*
						(0.391)						(0.357)
ROA (t-1)	0.185*			0.194**			0.370***			0.375***		
	(0.0987)			(0.0984)			(0.106)			(0.105)		
LLPA (t-1)	−0.897***	0.096	0.418	−0.905***	0.097	−0.080	−0.858***	0.132	0.573	−0.865***	0.130	−0.013
	(0.057)	(0.119)	(0.661)	(0.057)	(0.125)	(0.629)	(0.061)	(0.197)	(0.640)	(0.062)	(0.201)	(0.505)
Interbank loans/A (t-1)	−0.038**			−0.031			−0.038**			−0.034**		
	(0.019)			(0.019)			(0.017)			(0.018)		
Loans to CB&CG/A (t-1)	0.003			0.002			0.005			0.005		
	(0.006)			(0.006)			(0.006)			(0.006)		
Loans to PS excl. IL/A (t-1)	−0.010			−0.009			−0.000			0.000		
	(0.009)			(0.009)			(0.010)			(0.010)		
Bonds/A (t-1)	−0.019**			−0.017**			−0.021**			−0.020**		
	(0.009)			(0.009)			(0.010)			(0.010)		
Lending rate (t-1)			−0.788			−0.931*			−0.680			−0.900
			(0.545)			(0.517)			(0.647)			(0.603)
CA (t-1)			1.826***			1.562***			1.381**			1.419**
			(0.526)			(0.498)			(0.639)			(0.568)
Real GDP growth	0.188***		−0.532**	0.185***		−0.186	0.191***		−0.506	0.190***		−0.262
	(0.029)		(0.268)	(0.029)		(0.261)	(0.030)		(0.350)	(0.030)		(0.286)
PX growth	−0.003			−0.002			−0.004			−0.003		
	(0.006)			(0.006)			(0.006)			(0.006)		
Spread	−0.192**			−0.205***			−0.207*			−0.210*		
	(0.111)			(0.111)			(0.117)			(0.117)		
Int. income/A (t-1)		−0.006			0.007			0.027			0.027	
		(0.165)			(0.165)			(0.208)			(0.210)	
Ret. earnings/A		0.039			0.033			−0.015			−0.015	
		(0.050)			(0.054)			(0.071)			(0.077)	
Observations	276	276	276	276	276	276	276	276	276	276	276	276

Note: The specifications are estimated using the bootstrap-based bias-corrected estimator (BBBC) with bootstrapped standard errors, the least square dummy variable (LSDV) estimator with robust (clustered) standard errors and three-stage least squares (3SLS). ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons; dPostCR – a dummy variable which equals 1 for the period after 2013.

Table C6: Regression Results – Indirect Effect of Higher Additional Capital Requirements on Credit Growth via ICS and UCS (1), Long Sample

	3SLS						BBBC					
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Dependent var.:	ICS	UCS	%Δ*loans*	ICS	UCS	%Δ*loans*	ICS	UCS	%Δ*loans*	ICS	UCS	%Δ*loans*
Dependent var. (t-1)	0.634***	0.808***	0.797***	0.628***	0.805***	0.769***	0.610***	0.827***	0.855***	0.605***	0.828***	0.827***
	(0.023)	(0.022)	(0.023)	(0.023)	(0.022)	(0.023)	(0.027)	(0.039)	(0.036)	(0.027)	(0.039)	(0.038)
ORCR	−0.327***	0.029					−0.332***	0.055**				
	(0.030)	(0.030)					(0.030)	(0.025)				
ICS (t-1)			0.166						0.119			
			(0.193)						(0.179)			
UCS (t-1)			0.175						0.168			
			(0.208)						(0.226)			
ORCR*dLowCS				−0.371***	0.016					−0.379***	0.046	
				(0.043)	(0.044)					(0.035)	(0.038)	
ORCR*(1-dLowCS)				−0.314***	0.040					−0.317***	0.062*	
				(0.032)	(0.036)					(0.032)	(0.032)	
ICS (t-1)*dLowCS						1.642***						1.315**
						(0.388)						(0.553)
ICS (t-1)*(1-dLowCS)						−0.309						−0.247
						(0.218)						(0.159)
UCS (t-1)*dLowCS						0.443*						0.394
						(0.258)						(0.344)
UCS (t-1)*(1-dLowCS)						−0.018						0.031
						(0.260)						(0.197)
ROA (t-1)	0.334***			0.329***			0.518***			0.509***		
	(0.055)			(0.055)			(0.055)			(0.054)		
LLPA (t-1)	−0.435***	0.186**	−0.312	−0.435***	0.193**	−0.615	−0.444***	0.129	−0.150	−0.442***	0.131	−0.406
	(0.060)	(0.075)	(0.482)	(0.060)	(0.075)	(0.480)	(0.066)	(0.117)	(0.428)	(0.065)	(0.117)	(0.418)
Interbank loans/A (t-1)	−0.037***			−0.040***			−0.039***			−0.042***		
	(0.011)			(0.011)			(0.010)			(0.009)		
Loans to CB&CG/A (t-1)	0.005			0.007			0.007			0.009		
	(0.007)			(0.007)			(0.008)			(0.008)		
Loans to PS excl. IL/A (t-1)	0.000			−0.002			0.001			−0.001		
	(0.007)			(0.007)			(0.008)			(0.008)		
Bonds/A (t-1)	0.004			0.005			0.008			0.008		
	(0.007)			(0.007)			(0.007)			(0.007)		
Lending rate (t-1)			0.738***			0.463*			0.535*			0.298
			(0.276)			(0.279)			(0.313)			(0.303)
CA (t-1)			−0.292			−0.382			−0.243			−0.325
			(0.266)			(0.266)			(0.292)			(0.292)
Real GDP growth	0.001		0.395***	0.001		0.381***	0.008		0.322**	0.007		0.325***
	(0.019)		(0.132)	(0.019)		(0.131)	(0.018)		(0.130)	(0.018)		(0.121)
PX growth	0.005**			0.005**			0.006***			0.006***		
	(0.002)			(0.002)			(0.002)			(0.002)		
Spread	−0.225***			−0.231***			−0.234***			−0.241***		
	(0.070)			(0.070)			(0.073)			(0.072)		
IRB dummy	1.811***	−0.479**		1.858***	−0.476**		2.172***	−0.347*		2.197***	−0.347*	
	(0.207)	(0.223)		(0.208)	(0.224)		(0.195)	(0.178)		(0.194)	(0.180)	
Int. income/A (t-1)		−0.034			−0.029			0.147			0.146	
		(0.158)			(0.159)			(0.103)			(0.103)	
Ret. earnings/A		0.036*			0.030			0.041*			0.039	
		(0.022)			(0.023)			(0.024)			(0.025)	
Observations	630	630	630	630	630	630	630	630	630	630	630	630

Note: The specifications are estimated using the bootstrap-based bias-corrected estimator (BBBC) with bootstrapped standard errors, the least square dummy variable (LSDV) estimator with robust (clustered) standard errors and three-stage least squares (3SLS). ***, ** and * denote the 1%, 5% and 10% significance levels. dLowCS – a dummy variable which equals 1 for the five banks with the lowest total capital surpluses in the period after 2014, i.e. after the introduction of capital buffers and Pillar 2 add-ons; dPostCR – a dummy variable which equals 1 for the period after 2013.

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