Journal of Regulatory Economics (2022) 61:135–167
https://doi.org/10.1007/s11149-022-09448-5

ORIGINAL ARTICLE

Does capital-based regulation affect bank pricing policy?

Dominika Ehrenbergerová[1] · Martin Hodula[2,4] · Zuzana Gric[3]

Accepted: 21 March 2022 / Published online: 9 April 2022

Abstract
This paper tests whether a series of changes to capital requirements transmitted to a change to banks' pricing policy. We compile a rich bank-level supervisory dataset covering the banking sector in the Czech Republic over the period 2004–2019. We estimate that the changes to the overall capital requirements did not force banks to alter their pricing policy. The impact on bank interest margins and loan rates is found to lie in a narrow range around zero irrespective of loan category. Our estimates allow us to rule out effects even for less-capitalised banks and small banks. The results obtained contradict estimates from other studies reporting significant transmission of capital regulation to lending rates and interest margins. We therefore engage in a deeper discussion of why this might be the case. Our estimates may be used in the ongoing discussion of the benefits and costs of capital-based regulation in banking.

Keywords Bank pricing policy · Capital requirements · Interest margins · Loan rates

JEL Classfication E58 · G21 · G28

The authors note that the paper represents their own views and not necessarily those of the Czech National Bank. We would like to thank Václav Brož, Magda Pečená, Simona Malovaná, Jan Frait and Lukáš Pfeifer for valuable comments. All errors and omissions remain the fault of the authors.

✉ Martin Hodula
martin.hodula@cnb.cz

Dominika Ehrenbergerová
dominika.ehrenbergerova@cnb.cz

Zuzana Gric
zuzana.gric@cnb.cz

1 Czech National Bank and Charles University, Prague 1, Czech Republic

2 Czech National Bank and Technical University of Ostrava, Ostrava, Prague, Czech Republic

3 Czech National Bank and Masaryk University, Brno, Czech Republic

4 Financial Stability Department, Czech National Bank, Na Prikope 28, 115 03 Prague 1, Czech Republic

1 Introduction

In December 2010, the Basel Committee on Banking Supervision (BCBS) announced extensive reforms to strengthen the resilience of the financial system, reforms known as Basel III (BCBS 2010). Following the implementation of Basel III, the minimum capital requirements effectively rose from 8% to 10.5%, but with all the additional buffers the capital requirements could reach as much as 20%. Over time, the debate surrounding the gradual implementation of Basel III became focused on the question of the costs associated with increasing stringency of bank (capital) regulation.[1]

In this paper, we examine the impact of imposing higher capital requirements on banks and on their pricing policies towards their customers. Specifically, we study how changes to the overall capital requirements affect banks' lending rates, deposit rates and interest margins using bank-level data. We track the impact across different loan categories and, for this purpose, we use rich supervisory bank-level data from the Czech National Bank (CNB) non-public database. The data spans the period 2004–2019, during which the CNB as macroprudential authority maintained the resilience of the Czech financial system by making several adjustments to the regulatory capital requirements. At the end of 2019, it was applying three capital buffers and an additional Pillar 2 requirement. As a result, our dataset covers numerous changes to the capital requirements on the bank level, with the requirements ranging from 8% of risk-weighted exposures before 2014 to more than 17% in 2019 for some banks. Such a dynamic environment of the macroprudential policy serves as an ideal ground for analyzing its effects on banks' pricing policy. Moreover, the outcomes of this study might be applicable to a wider extent to small open economies with attributes of the banking sector that are similar to the Czech Republic, such as the Central and Eastern Europe (CEE) but also other economies with a relatively high degree of capitalization and foreign ownership of banks.

Unlike many of the existing studies, we find no evidence that changes to the overall capital requirements affect bank interest margins or lending rates. The effects on rates for different loan categories lie overwhelmingly in a narrow range around zero. Our finding of no significant change to bank interest margins and lending rates following regulatory adjustment is robust across alternative specifications: across short and long samples, less- and better-capitalised banks, small and large banks, and weighted and unweighted estimates.

Our findings complement the existing literature in two important aspects. First, our estimates stand in contrast to multiple studies reporting mostly statistically significant and positive responses of bank lending rates to more stringent capital regulation. However, the point estimates reported in related studies are often small and inconclusive, ranging from 0 to 25 basis points, as evidenced by surveys conducted in Martynova (2015), Boissay et al. (2019) and Birn et al. (2020) and by the updated literature review in our paper. The point estimates in the literature seem to differ based on the characteristics of the banking sector under review and the researchers' choice of variables (e.g. capital ratio vs capital requirements). Our findings are in line with the assertions

[1] On the other side of the cost-benefit equation, multiple authors argue that well-designed capital regulation should increase the stability of banks (Myers 1977; Admati et al. 2010; Beltratti and Stulz 2012; Berger and Bouwman 2013; Thakor 2014).

of Kashyap et al. (2010), according to whom carefully phased-in new requirements prompt banks to generate the necessary additional capital out of retained earnings instead of slowing the growth of their assets.

Second, we complement the ever-growing empirical literature analysing the real effects of changes to capital-based regulation. Fidrmuc and Lind (2020) perform a meta-analysis using estimates from 48 studies and show that a one percentage point increase in the target capital ratio is associated with a negligible decline in real economic activity. This supports the Basel Committee's original assessment of the long-term economic impact of stronger capital and liquidity requirements (BCBS 2010) showing that in the short run the costs of the new regulation are low to zero and in the long run they disappear altogether. Similar results can be found in Angelini et al. (2015). The impact on bank lending is rather ambiguous, with the reported estimates ranging from negative (Aiyar et al. 2014; Bridges et al. 2014), to mixed (Kolcunova and Malovana 2019) and positive (Gale et al. 2010; Kim and Sohn 2017). Our paper contributes to this literature by documenting that changes to the overall capital requirements—after carefully accounting for other determinants of bank pricing policy—have no detectable near-term impact on bank interest rates and margins. Being aware of the fact that our data are from a single country, we engage in a detailed discussion of why we obtained these null results in contrast to some other country-level studies (e.g. di Patti et al. 2020; Glancy and Kurtzman 2018).

The remainder of this paper is organised as follows. Section 2 describes the background to the capital requirements applied in the Czech Republic and provides the theoretical motivation for our hypotheses for the relationship between the capital requirements and banks' interest margin and its components. Section 3 describes the data and methodology used, and in Sect. 4 we provide the main estimation results and describe the uncovered determinants of banks' pricing policies. Section 5 offers a discussion of potential explanations of our null results, and Sect. 6 concludes.

2 Background to the overall capital requirements in the Czech Republic

The Czech National Bank (CNB), holding a mandate to maintain both price stability and financial stability, ranks among the most active macroprudential authorities in the EU (ESRB 2019). It currently applies three macroprudential capital buffers—a capital conservation buffer, a systemic risk buffer and a countercyclical capital buffer—along with additional Pillar 2 requirements. The capital in the Czech banking sector is predominantly composed of Tier 1 capital (95% on average—see Fig. A1 in the Online Appendix). Since Tier 1 capital is considered to be more expensive than Tier 2 capital, introducing new capital regulation might affect bank funding costs. Figure 1 shows the implementation of the individual buffers through time.

First, the capital conservation buffer, as provided for by European regulations, has been set at 2.5% of total risk-weighted exposures since July 2014. The aim of this buffer is simply to conserve banks' best-quality equity, consisting of Common Equity Tier 1 capital. The rate is not expected to change in the future, and all European countries have applied it at the same level. The CNB chose to introduce this capital

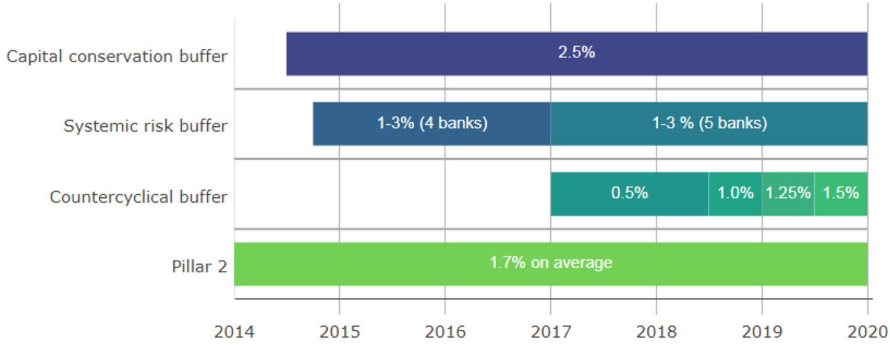

Fig. 1 Timeline of the Capital-Based Measures in the Czech Republic. *Note:* Pillar 2 represents the average across quarters and banks . *Source:* Czech National Bank

buffer immediately at the beginning of 2014 instead of implementing it gradually. This adds a unique one-off permanent increase in the overall capital requirements to our dataset.

Second, the systemic risk buffer has been set at 1–3% of total risk-weighted exposures for the four systemically most important banks with effect since October 2014 and for the five systemically most important banks since January 2017. The purpose of this buffer is to limit the systemic risk arising from potential destabilisation of the most important banks in the system. Since 2017, the systemic risk buffer has been set at 3% for three banks and 2% and 1% for the other two banks. This adds multiple bank-specific changes to the overall capital requirements time series. In order to determine the systematic importance of banks, the CNB assesses several indicators, including size, interconnectedness, substitutability and complexity.[2]

The CNB has also set a countercyclical capital buffer (CCyB), the level of which has been changed several times since its implementation. A CCyB rate of 0.5% was introduced in January 2017. The rate was then increased to 1.0% in July 2018, to 1.25% in January 2019 and to 1.5% in July 2019. The CNB was planning to increase it even further, to 1.75% in January 2020 and 2.0% in July 2020.[3] Changes to the CCyB rate are usually announced well in advance. A total of four changes to the CCyB rate are covered in our dataset. The implementation setup of the CCyB in the Czech Republic was first described in Hájek et al. (2017). Plašil (2019) describes the details of the current calibration of the CCyB—two methods for setting the CCyB rate are currently in use, one based on a financial cycle indicator and the other taking into consideration the sustainable level of credit growth. The CCyB can be fully released back to zero if the depth of the economic slowdown so requires (Holub et al. 2020).

Besides macroprudential capital buffers, the CNB has also set additional Pillar 2 requirements. These have been applied since the beginning of 2014. Pillar 2 capital

[2] Banks are assessed according to their D-SIB (domestic systemically important banks) score, calculated with respect to BCBS guidelines (BCBS 2012) and, specifically, based on the method presented in Skořepa and Seidler (2012).

[3] During 2020, the CCyB rate has been reduced in comparison to the originally planned path in response to the situation caused by the COVID-19 pandemic. However, this time period is beyond the scope of this paper.

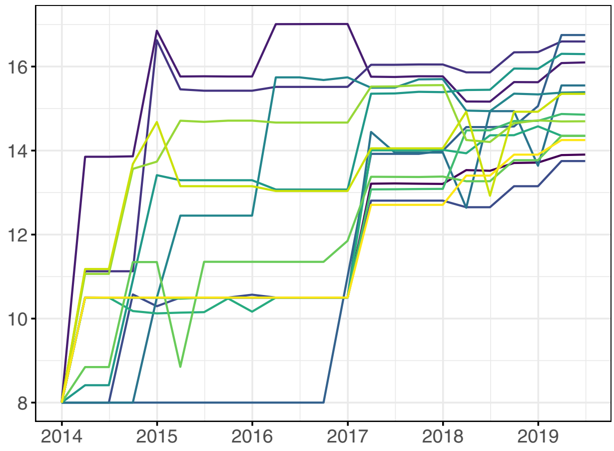

Fig. 2 Bank-Level Overall Capital Requirements (%). *Note:* Overall regulatory capital requirements for 14 banking groups operating in the Czech Republic, anonymised . *Source:* Czech National Bank

add-ons often take effect immediately or only a few months after being announced. However, phase-in (transitional) periods during which banks are allowed to fulfil higher Pillar 2 capital add-ons only partly may exist. On the aggregate level, the requirement stood at 2.0% in 2019. The average requirement across all banks since its introduction has been approximately 1.7%.

2.1 Overall regulatory capital requirements

In this paper, we measure the impact of changes to capital-based regulation by calculating the overall regulatory capital requirements. They are calculated as the sum of the minimum regulatory capital requirements together with all the relevant capital buffers specified above. Even though each of the capital buffers has a slightly different focus, their joint purpose is the same—to increase the resilience of the banking system. Thus, we can safely examine their joint effect. Since some of the buffers are bank-specific, the resulting set of overall regulatory capital requirements is quite unique and well-suited to analysing the pass-through of changes to capital regulation to bank pricing policy. Figure 2 displays the individual overall regulatory capital requirements values for the banks in our sample. Since the information is of limited public access, we do not display the names of the banks. A visual inspection of the individual time series highlights several important aspects of the overall regulatory capital requirements. First, the data display significant heterogeneity across banks, a property which can be exploited in an empirical framework. For this reason, we decided to employ a panel data analysis technique—described in the next section – that allows us to exploit the cross-sectional variability in the sample. Second, while in most cases the capital requirements grew, i.e. policy was tightened, we also document a few cases of regulatory easing in our sample.

Overall, the data at our disposal possess some unique features compared to papers that study the effects of capital regulation by considering changes to the observed capital ratio (Kashyap et al. 2010; Slovik and Cournède 2011; Sutorova and Teplý 2013; Chun et al. 2012) or by relying on a cumulative index that tracks the frequency of capital-based measures (Cerutti et al. 2017).

2.2 Theoretical motivation

We briefly introduce the theoretical underpinnings of bank pricing policy as discussed in the literature on the interest rate pass-through, which describes how changes in a reference rate (the monetary policy, money market, or T-bill rate) transmit to bank lending rates.[4] We augment the framework to also account for the pass-through from capital-based regulation.

Our departure point is a simple mark-up equation for commercial banks as shown in Rousseas (1985):

$$i^{lending} = k(u), \tag{1}$$

where $i_t^{lending}$ is the bank lending rate, k is market power (the degree of monopoly) and u are bank funding costs. As in Cottarelli and Kourelis (1994) and Gambacorta et al. (2015), we assume a constant mark-up over bank funding costs and dependence of bank funding costs on the monetary policy rate. This set-up is supported by economic theory on oligopolistic (and perfect) competition suggesting that, in the long run, the lending rate should be related to the money-market rate (Klein 1971; Freixas and Rochet 2008). Then, equation (1) can be rewritten in the following linear form:

$$i^{lending} = \alpha + \beta mpr, \tag{2}$$

where α is the mark-up, mpr is the monetary policy rate and β denotes the pass-through from the monetary policy rate to the bank lending rate. Allowing for α to have both a constant (α_1) and a time-varying ($\alpha_{2,t}$) component, equation (2) takes the form:

$$i_t^{lending} = (\alpha_1 + \alpha_{2,t}) + \beta mpr_t. \tag{3}$$

A great body of empirical literature has verified the factors that determine the time-varying component of the mark-up (Van Leuvensteijn et al. 2013; Gambacorta et al. 2015; Cifarelli and Paladino 2016). Stacking these factors in the vector X, we get:

$$\alpha_{2,t} = \gamma X_t + \epsilon_t, \tag{4}$$

where X comprises compensation for the credit risk premium (loan riskiness), bank competition, the costs of capital and its allocation, expenditure on foreign currency funds and administrative costs, and ϵ_t is the noise component. This is in line with a price-setting mechanism based on the universal RAROC formula— banks aim to attain a certain risk-adjusted return on capital, according to which the price of an asset (loan) is equal to the bank's costs of funds plus compensation for the above-mentioned factors.

[4] While the theoretical motivation is based on the pass-through to bank lending rates, a similar setup can be used to describe the deposit rate pass-through.

However, when talking about the determinants of bank lending rates, the capital-based regulation contained in the Basel accords cannot be omitted, as tighter capital regulation (increased capital requirements) can increase the costs of capital allocation and thus raise the overall funding costs. This concept can be illustrated in a stylised equation for the lending rate by adding a variable z_t which designates the capital-based regulation affecting the time-varying component of the mark-up:

$$i_t^{lending} = \alpha_1 + \beta mpr_t + \gamma X_t + \delta z_t + \epsilon_t. \tag{5}$$

This equation shows that capital-based regulation can affect the interest rate margin (mark-up) and the bank lending rate charged to borrowers. Thus, as the main aim of this paper, we will further work with this equation and examine the potential effects of capital requirements while controlling for other determinants of margins and lending rates.

2.3 The role of capital surpluses

The question of capital surpluses is rarely discussed in the literature on the effects of capital-based regulation. This is surprising, since maintaining capital in excess of the minimum regulatory requirements has been observed in US banks (Berger et al. 2008; Flannery and Rangan 2008) and in European ones (Brewer et al. 2008; Gropp and Heider 2010). Country-level data paint a similar picture (Fig. A2 in the Online Appendix).

One might assume that a shift in bank funding costs would only be transmitted to client rates for capital-constrained banks, i.e. banks whose capital ratios are very close to the minimum capital requirements and thus have no capital surplus. In this case, increasing the overall capital requirements requires action to be taken, as these banks hit the lower bound of capital-based regulation.

But what if the surpluses are sufficient and there is no need to increase the actual capital ratios when the new buffers come into effect? We can assume that the costs of capital—and, consequently, price setting—would be affected anyway. Banks face internal costs of funds, or implicit costs of funds, which are set on a consolidated basis.[5] Those can increase when capital requirements increase. As will be shown later, surpluses are in fact a characteristic feature of our dataset.

3 Methodology and data

3.1 Methodology

In order to examine the effects of capital requirements on banks' pricing policies, we employ a panel data model using detailed supervisory bank-level data. We use a fixed

[5] The Czech banking sector is largely (up to 80%) foreign owned. In this case, the internal costs of funds are likely to be set by parent banks.

effects estimator to account for bank-level heterogeneity. We evaluate the effects of capital requirements on interest margins, lending rates and deposit rates separately. When doing so, we also distinguish between two sectors, namely households and non-financial corporations. Moreover, in the case of lending rates in the household sector, we differentiate mortgages and consumer loans on top of the above mentioned listings. As a result, we end up with five baseline specifications for the household sector and three for the sector of non-financial corporations (NFCs). Our baseline empirical specification is summarised as follows:

$$Y_{i,t} = \alpha_i + \beta_1 CR_{i,t} + \gamma_1 X_{i,t-1} + \epsilon_{i,t}, \tag{6}$$

where $Y_{i,t}$ stands for any one of the following: (i) the bank interest margin, (ii) the lending rate and (iii) the deposit rate. Indices i and t stand for banks and time periods (quarters). The bank interest margin is defined as the difference between the lending rate and the deposit rate. Our main explanatory variable of interest is $CR_{i,t}$, the overall regulatory capital requirements. The term α_i stands for bank fixed effects; $\epsilon_{i,t}$ is the error term.

We include a wide range of bank pricing policy determinants as control variables in vector $X_{i,t}$. The set of control variables is the same for interest margins and for lending rates, while it differs for deposit rates. In case of lending rates and margins in the household sector, we include four bank-specific controls (the interest rate swap (IRS) rate; the ratio of non-performing loans to total loans (the NPL ratio), specific for a given loan type; a simplified leverage ratio measured as the ratio of Tier 1 capital to total assets adjusted for exposures to the central bank; and the logarithm of total assets as a proxy for bank size), two sector-specific controls (the Herfindahl index as a measure of concentration in the banking sector; and a borrower-based dummy variable, controlling for the strength of the loan-to-value, debt-service-to-income and debt-to-income measures that were in place in the relevant time period) and two macroeconomic controls (consumption and disposable income). In part of the analysis, we further distinguish between lending rates on loans for house purchase (mortgages) and consumer loans. In that case, the equation for lending rates for loans for house purchase includes house price growth in addition to the above-mentioned macroeconomic variables.

The set of control variables for the NFC segment is the same as above; however, we exclude disposable income and the borrower-based measure variable since those are not directly relevant for non-financial corporations. On the other hand, we include the real effective exchange rate as another macroeconomic control variable. The set of determinants of deposit rates is more parsimonious—we restrict the control variables to the monetary policy proxy, the competition proxy and three bank heterogeneity controls—the simplified leverage ratio, the logarithm of total assets and a proxy for liquidity (expressed as the ratio of liquid assets to total assets). More information on the variables employed is provided in the following Sect. 3.2. The set of control variables follows the theoretical model presented in Sect. 2: first, bank lending interest rates are a function of monetary policy; thus the above-mentioned interest rate swap is included. Second, rates consists of time-varying mark-up that reflects credit risk premium, which we approximate by the NPL ratio in our model. Herfindahl index variable compensates for concentration. Leverage ratio and total assets are usual bank-level variables that control for bank health and size, while consumption or disposable income control for macroeconomic conditions. The choice of variables draws on existing literature—the similar set of variables was used in related studies, for example in Fungáčová and Poghosyan (2011).

In order to estimate Eq. 6, we employ weighted fixed effects regression. Including bank fixed effects is an approach often used in empirical banking in order to capture time-invariant bank heterogeneity (in similarly oriented literature, bank fixed effects were used, for example, in Santos and Winton 2019; Basten and Koch 2015).[6] As weights, we use the share of loans granted by a bank in the total amount of loans granted by all the banks in our analysis, with the weights averaged over the time horizon.[7] We employ weighted regression to account for the large time-variant heterogeneity of banks, especially when analysing certain types of loans. For example, in the mortgage loan segment, a few banks have very small market shares, while a couple of large banks serve almost the whole market. While we do not want to exclude banks with a tiny share completely, we also find it sensible not to put the same weight on banks with a completely different business model. Thus, in each loan category—loans to households, mortgage loans, consumer loans and loans to non-financial corporations, we weight the regression by the share of new loans provided by a bank in total new loans provided. By doing that, we obtain an inference which puts more weight on more important banks in the banking sector within each loan category (importance being measured by market share).

The second important methodological aspect is the use of wild bootstrap inference. Roodman et al. (2019) and Cameron et al. (2008) recommend the wild bootstrap if the error terms are clustered but the number of clusters is small. We prefer to cluster the error terms at the bank level, as heteroscedasticity may be present. However, in our case, the number of clusters is small, as our sample covers 14 banking groups only. In such case, conventional inference methods can be unreliable because the large-sample properties do not hold (Roodman et al. 2019). A large number of bootstrap samples better imitates the true distribution. For the wild bootstrap, we employ the *boottest* command in Stata. The inference is based on bootstrap p-values and confidence intervals. The procedure does not attempt to provide standard errors, as the notion of standard error is founded on an assumption that the actual distribution is close to the normal or t-distribution; bootstrap inference does not assume that. We thus report bootstrap p-values across all tables instead of the conventional inference and standard errors.

6 Fixed effects are used as we have the same sample of banks appearing over time. Formally, we check for the adequacy of fixed effect model: first, by Breusch-Pagan Lagrange multiplier, which rejects homoscedasticity (constant variance), and, second, using Hausman test, which suggests to use fixed effects model instead of random effects, as it rejects consistency of random fixed effect estimator. While the literature studying the monetary policy pass-through typically employs error correction models estimated using the pooled mean group estimator (PMSE) (see, for example, Havranek et al. 2016; Horvath et al. 2018), we opted for a fixed effects estimator for the following reasons. First, the PMSE is designed for large samples, counting both cross-section units and time periods. Moreover, the PMSE should be employed with dynamic panels, whereas we use a static model (Blackburne III and Frank 2007). Second, the long-term effects of capital-based regulation are estimated to be virtually zero (Angelini et al. 2015).

7 The individual banks' weights are nearly constant over the sample period, with no detectable spikes.

Next to our baseline procedure, we provide a wide set of robustness checks, described in detail in Sect. 4.2. The robustness checks are run both with respect to variables and model specifications as well as econometric methods. For example, we run an alternative specification of a non-weighted regression, or we provide estimates using a fixed-b estimator by Vogelsang (2012) instead of fixed effects with wild-bootstrapped standard errors. From the point of view of variables included, we run a sensitivity analysis that focuses on the low interest rate period. This period covers a significant portion of our dataset and we suspect that it might affect the potential transmission of capital requirements to bank interest rates. Thus, we first interact a dummy variable covering the period of low interest rates with the measure of capital requirements. Second, we include a cumulative variable that captures the number of periods of low interest rates. Third, we experiment with time fixed effects, which inclusion should contain any period-specific effects, including the effects of low interest rates.

3.2 Data

In the paper, we accommodate supervisory quarterly bank-level data from the CNB's non-public databases covering the period between 2004:Q1 and 2019:Q2. We use consolidated data, since capital requirements are mostly set on the consolidated level, and capital planning often takes place on the consolidated level as well. To verify whether changes in the overall capital requirements (described in detail in Sect. 2) affect bank pricing policies, we collect data on the interest rates charged on new loans and paid on deposits from the monetary financial institutions (MFI) interest rate statistics. We use data on new loans and deposits, since changes in bank pricing policies should be directly reflected in those variables, while they are only partially reflected in the interest rates on total loans outstanding (the credit stock).[8]

We examine the interest margin and its components—the lending interest rate and the deposit interest rate. At first, we distinguish between new loans to (deposits from) households and new loans to (deposits from) non-financial corporations (NFCs). In the second stage, within the new loans to households category, we differentiate between new loans for house purchase (mortgage loans) and consumer loans. For a visual representation of the time series, please consult the Online Appendix (Figs. A3–A5). In our sample, the margin on new loans to NFCs is slightly lower on average than the margin on new loans to households. The margin on new loans to households has higher variability across banks. In both cases, there is a slight decline after 2014, which marks the introduction of several new capital requirements. In the last year of the sample, we observe an increase in both margins, most likely a consequence of monetary policy normalisation. Mortgage loans (loans for house purchase) exhibit much smaller variability than consumer loans to households. The 25–75th percentile is

[8] Nevertheless, the use of interest rate data on new loans and deposits bears also some disadvantages, which we are not able to control for in our study due to data limitations. Specifically, the rates imposed to new contracts might vary with age of customer accounts such that the more the relationship between bank and customer lasts, the less favorable rates the customer receives. This tendency is driven by the fact that old customers are less prone to switch between banks, and as a result they remain loyal even if offered with worse rates. Carbo-Valverde et al. (2011) and Anderson et al. (2014) provide empirical support for this trend in deposit market.

very narrow for mortgage loans. They also experienced a massive, continuous decline between 2009 and 2017 from a mean of 5.5% to almost 2%. Similarly, interest rates on loans to NFCs were decreasing steadily in the same period. As far as deposit rates are concerned, they attained their absolute minimum in 2017. Both household deposit rates and NFC deposit rates were continuously decreasing from the second half of 2008 onwards, similarly to lending rates. Also, the variation in deposit rates across banks decreased in the final years of our sample both for households and for the NFC sector.

As described in Sect. 3.1, we use a wide range of control variables. At first, we include the interest rate swap rate, a variable that captures the monetary policy stance and approximates the funding costs of banks better than interbank rates such as PRIBOR. Unlike interbank rates, the swap rate does not include a risk premium. The coefficient on the IRS rate then captures the strength of the monetary policy pass-through to the lending and deposit rates. In this study, IRS rates are calculated specifically for each category of loans and for each bank as a weighted average of the interest rate swaps of relevant maturities according to the maturity structure of the loans in each bank. In other words, for example, the IRS rate for households for bank i is calculated as a weighted average of the 1-year market IRS rate, the 3-year IRS rate and the 7-year IRS rate, weighted by the shares of loans to households in bank i with maturity of up to one year, between one year and five years, and above five years. Similar pairing of loan maturities and reference rates was applied in Brož and Hlaváček (2019) and Bruha (2011). As suggested in Table 1, loans to NFCs are provided for the shortest maturity on average, so the short-term IRS rate affects the costs of their funding the most. On the other hand, if we are approximating the monetary policy conditions for loans to households (both mortgage loans and consumer loans), more weight is put on longer-term interest rate swaps.

The other bank-specific control variables come mostly from the Common and Financial Reporting (COREP and FINREP) frameworks. From the theoretical motivation provided in Sect. 2 it is clear that credit risk should be priced into lending interest rates. We therefore attribute high importance to a variable capturing credit risk, which is approximated by NPL ratios. To address the bank-level heterogeneity, we include the ratio of non-performing loans to total loans, specific for a given loan type. Since the credit risk premium is an important component of lending rates, we assert that our specification with bank-level and loan-type-level NPL ratios is superior to the specifications with aggregate NPL ratios used mostly in the literature. We expect the coefficient on NPL ratios to be positive, as higher credit risk should be priced in lending rates and possibly also margins (Fungáčová and Poghosyan 2011). We calculate the NPL ratio as the ratio of non-performing loans within a given category (loans to households, mortgage loans, consumer loans, loans to NFCs) at time $t + 4$ (quarters) to the total amount of loans in that category at time t.[9] By shifting the numerator of the ratio four quarters forward, we approximate the forward-looking character of the credit-risk variable and avoid the backward-looking character of the usual NPL ratio calculated as NPLs at time t to loans at time t. By looking at NPLs for different loan

9 We winsorise the NPL ratio at the 5% level due to the number of outlying observations. The results do not change qualitatively when the series without adjustment are employed or when a different winsorisation level is chosen (e.g. 1% or 2%).

types, we also ensure that credit risk is captured as precisely as possible. That credit risk differs across loan categories (see Fig. A6 in the Online Appendix). Consumer loans of households exhibit the highest degree of credit risk as proxied by the NPL ratio, but this facet is offset by relatively low credit risk of mortgage loans in the period studied. Therefore, the credit risk of the overall household sector (Panel A) is lower than the credit risk of the NFC sector (Panel D). Across all loans, NPL ratios have been decreasing distinctly since around 2012.

Next, we include the simplified leverage ratio measured as the ratio of Tier 1 capital to total assets adjusted for exposures to the central bank. This can approximate a bank's resilience to unexpected shocks. Further, the logarithm of total assets is used as a proxy for bank size. The theory of economies of scale asserts that larger banks with a higher amount of loans on their balance sheets can profit from their size and charge lower rates and have lower margins. On the other hand, a large bank with large operations faces higher potential losses, which might be reflected in higher lending rates and margins. These bank-specific control variables are chosen in accordance with the existing literature, which suggests that they can be important pricing components (see, for example, Fungáčová and Poghosyan 2011; Claeys and Vander Vennet 2008; Martin-Oliver et al. 2013). Except for the NPL ratio, all of the bank-level variables are included in lagged form in order to deal with potential endogeneity.

We also include sector-specific (bank-invariant) variables—the Herfindahl index as a measure of concentration in the banking sector, used also in Claeys and Vander Vennet (2008), Fungáčová and Poghosyan (2011) and Horvath (2009). The higher the concentration, the higher the lending rate and margin expected. This measure is calculated for each category of loans separately. On average, there is more competition (a lower Herfindahl index) in the segment of loans to households than in the segment of loans to non-financial corporations, suggesting that tougher competition will drag down lending rates and margins in this segment. As an alternative variable to the Herfindahl index, we use a competition proxy retrieved from the Bank Lending Survey. The measure consists in the difference between two ratios that reflect how banks change their credit standards applied to the approval of loans or credit lines when faced with increased competition in the sector. Specifically, we calculate the competition proxy as the percentage of banks that report tightening of credit standards net of the percentage of banks that report easing of standards due to competition pressure, over the previous three months. Supposedly, a higher degree of competition in the banking industry is connected with less strict credit standards applied in the approval process (Heffernan 2002; Fuertes et al. 2010). Hence, the more competitive banks are, the more negative our proxy for competition is. The interpretation of this variable is thus different to the Herfindahl index. Nevertheless, we expect it to have the same, positive effect on interest rates (De Graeve et al. 2007).

Last but not least, we employ a discrete variable capturing the tightness of the borrower-based macroprudential measures—the loan-to-value ratio, the debt-service-to-income ratio and the debt-to-income ratio. A similar control variable of mortgage pricing was used, for example, by Basten and Koch (2015) and Benetton et al. (2017). We calculate this measure ourselves. It can attain five levels ranging from 0 to 4 according to the evolution of the limits on the borrower-based measures; each change of the measures is coded as a one unit increase (decrease) in the variable. In the Czech

Table 1 Reference rates and maturity structure for different loan types

Type of loan	Maturity / length of rate fixation*	Reference rate	Share of new loans of a given maturity
(1) Loans to households	< 1 year	IRS 1Y	21%
	1–5 years	IRS 3Y	42%
	5+ years	IRS 7Y	37%
(1a) Loans to households for house purchase	< 1 year	IRS 1Y	26%
	1–5 years	IRS 3Y	51%
	5+ years	IRS 7Y	23%
(1b) Consumer loans to households	< 1 year	IRS 1Y	20%
	1–5 years	IRS 3Y	38%
	5+ years	IRS 7Y	42%
(2) Loans to NFCs	< 1 year	IRS 1Y	75%
	1–5 years	IRS 3Y	13%
	5+ years	IRS 7Y	12%

*Rate fixation is used for loans to households for house purchase; otherwise loan maturity is used

Republic, the borrower-based measures take the form of a non-binding recommendation and have been in place since 2015, with four changes made between then and the end of our sample period.

Finally, we control for macroeconomic variables, in particular consumption,[10] disposable income and the house price index. Macroeconomic controls were used as predictors of lending rates or margins in Martin-Oliver et al. (2013), Dagher et al. (2016) and Sutorova and Teplý (2013), among others. Summary statistics for all the variables—dependent and independent—are provided in Table 6 in the Appendix.

4 Estimation results

We first test whether changes to the overall capital requirements caused banks to increase their interest margins, a key real behavioural response suggested by bank managers and economic theory. We begin by presenting regression evidence of the effect of changes to the overall capital requirements on the bank interest margin. We differentiate between the rates banks charge borrowers and the rates they pay to depositors. In this setup, the rates on consumer loans, mortgages and corporate loans are regressed separately. We then present extensive robustness checks: tests for the effects on low capitalised banks and tests for sample period length, lag structure and weighting.

[10] The related literature applies GDP growth. We rely on consumption to get rid of the noise associated with the use of a broad macroeconomic indicator such as GDP, which contains a significant number of records not associated with financial intermediation. Nevertheless, we ran all of our estimates with GDP growth instead of consumption growth and obtained similar results.

4.1 The effect of changes to the overall capital requirements on the bank interest margin and its components

If a bank responds to the increased overall capital requirements, this should be visible in a change of the interest margin and its components, i.e. the lending rate and the deposit rate. The bank would ideally increase its loan rates to increase its earnings and/or reduce its deposit rates to compensate for the increased funding costs.

The first row of Tables 2 and 3 reports that when one controls for a full set of carefully selected controls, a change in the overall regulatory capital requirements is estimated to have no significant effect on the interest margin or on loan rates. This null result holds when differentiating between the sectors (households vs. non-financial corporations). A one point increase in the overall capital requirements is found to be associated with a 0.019 basis point reduction in the interest margin for households, with a wide 95% confidence interval of −0.08 to 0.04; and from −0.04 to 0.05 for the margin on loans to non-financial corporations. Even more importantly, while the category of all loans to households might be too broad, the effect of capital requirements is not significant for the lending rate on mortgage loans or for the lending rate on consumer loans either.

Regarding deposit rates, we find a weak effect on the deposit rates paid to households, which are found to decrease by up to 7 basis points following a one point increase in the capital requirements. However, the effect is not significant in the case of the interest rate paid to non-financial corporations.

As suggested in our motivation in Sect. 2, the impact of a change to the capital requirements on bank pricing policies may be more pronounced for banks which have more need to adjust their equity or for which equity financing is more expensive. We therefore introduce an interaction term given by the product of the overall capital requirements and a dummy equal to one for less-capitalised banks (and equal to zero for better-capitalised banks). Two alternative distinctions between less- and better-capitalised banks are displayed in Table 4. In the first, one third of banks—the ones with the lowest average capital surpluses over the period observed—are marked as less capitalised, while the rest are marked as better capitalised (Columns 1–4). In the second distinction, less-capitalised banks are those whose capital surplus is less than two percentage points above the total capital requirement in a given quarter (Columns 5–8). We employ this distinction because a 2 pp surplus can be considered a threshold which, when surpassed, can lead to changes in banks' behaviour, including a change in dividend payouts, lending restrictions, or, finally, a change in interest rates charged.[11]

The results of the regressions with the interaction terms are reported in Table 4. As is apparent from the estimates, even if we control for the level of capitalisation, changes to the overall capital requirements have no effect, not even for low capitalised banks, which could be expected to have their funding costs increased. Again, the results hold

[11] The threshold is admittedly arbitrary. We estimated a model in which less-capitalised banks are those whose capital surpluses are less than one percentage point above the total capital requirement in a given quarter. The results remain unchanged and are available upon request.

Table 2 Effect of changes to the overall capital requirements on the pricing of bank products for households

	(1) Interest margin HHs	(2) Lending rate All loans, HHs	(3) Lending rate Mortgage loans, HHs	(4) Lending rate Consumer loans, HHs	(5) Deposit rate HHs
Cap. requirements (t)	−0.019	−0.025	−0.024	−0.040	**−0.069**
	[0.415]	[0.351]	[0.386]	[0.702]	[0.029]
IRS (t)	**0.725**	**0.904**	**0.661**	0.335	**0.067**
	[0.002]	[0.001]	[0.008]	[0.436]	[0.041]
NPL ratio (t)	**0.314**	**0.334**	**0.226**	**0.128**	
	[0.060]	[0.059]	[0.046]	[0.078]	
Leverage (t-1)	0.071	0.046	**−0.021**	0.186	−0.019
	[0.781]	[0.893]	[0.083]	[0.145]	[0.406]
Log(Assets) (t − 1)	**1.482**	**1.629**	0.335	0.549	−0.060
	[0.030]	[0.019]	[0.309]	[0.497]	[0.440]
Herfindahl (t)	**0.126**	**0.108**	**0.076**	0.010	0.011
	[0.011]	[0.011]	[0.002]	[0.881]	[0.139]
Consumption (t − 1)	**−0.115**	**−0.109**	0.008	**−0.078**	
	[0.001]	[0.040]	[0.624]	[0.045]	
Disp. income (t − 1)	0.030	0.004	−0.002	−0.117	
	[0.383]	[0.900]	[0.908]	[0.312]	
BBM dummy (t)	**−0.261**	**−0.404**	**−0.156**	**−0.886**	
	[0.071]	[0.001]	[0.003]	[0.000]	
HPI (t − 1)			**−0.016**		
			[0.001]		
Liquidity (t − 1)					−0.003
					[0.403]
N	613	613	564	534	665
Adj. R2	0.671	0.764	0.934	0.722	0.673

Wild bootstrapped *p*-values in squared brackets, clustered at the bank level

for lending rates on mortgage loans and consumer loans separately. The null result holds for the non-financial sector as well.[12]

4.2 Robustness

We conduct several robustness checks, with results presented in the Online Appendix. First, given that macroprudential authorities were equipped with more tools only after the implementation of Basel III, we re-estimate the baseline model using a short-

[12] The estimation was carried out for deposit rates as well, with a null result. To reduce visual clutter, the estimates are not reported but are available upon request.

Table 3 Effect of changes to the overall capital requirements on the pricing of bank products for non-financial corporations

	(1) Interest margin NFCs	(2) Lending rate NFCs	(3) Deposit rate NFCs
Cap. requirements (t)	0.003	−0.033	−0.014
	[0.877]	[0.149]	[0.160]
IRS (t)	**0.441**	**0.663**	**0.304**
	[0.002]	[0.001]	[0.000]
NPL ratio (t)	**0.113**	**0.100**	
	[0.008]	[0.026]	
Leverage (t − 1)	0.066	−0.016	**−0.083**
	[0.219]	[0.636]	[0.004]
Log Assets (t − 1)	0.213	0.020	**−0.136**
	[0.143]	[0.877]	[0.020]
Herfindahl (t)	−0.002	0.002	−0.001
	[0.753]	[0.746]	[0.765]
Consumption (t − 1)	−0.030	0.026	
	[0.245]	[0.251]	
REER (t − 1)	−0.007	0.003	
	[0.458]	[0.665]	
Liquidity (t − 1)			0.000
			[0.940]
N	607	611	659
Adj. R2	0.511	0.816	0.808

Wild bootstrapped *p*-values in squared brackets, clustered at the bank level

ened sample period running from 2014 to 2019. During that time period, the national macroprudential authority introduced a number of capital-based measures that effectively raised the overall capital requirements multiple times. This exercise does not come cheap, since we are effectively losing a significant proportion of the observation periods as well as entering an extremely low interest rate environment. Restricting the sample period delivers the expected positive effect on the interest margin, materialised via a change to the lending rate, both for the total household sector (Table B1 in the Online Appendix) and for NFCs (Table B2 in the Online Appendix)). However, the effect is rather small and is significant only at the 10% level. Moreover, the estimated effect is not significantly different from zero for the lending rate on mortgage loans and consumer loans when assessed separately. As for loans to non-financial corporations, the effect of the capital requirements is not different from zero when we look separately at lower-volume loans (up to CZK 30 million) and higher-volume loans (above CZK 30 million).

Next, we employed the 2014–2019 subsample in two additional frameworks. In the first one, we used an alternative specification of competition in the banking sector, measured using individual bank responses from the Bank Lending Survey (for more

Table 4 Controlling for the level of bank capitalisation

	(1) Lending rate All loans to HHs	(2) Lending rate Mortgages, HHs	(3) Lending rate Consumer loans, HHs	(4) Lending rate All loans to NFCs	(5) Lending rate All loans to HHs	(6) Lending rate Mortgages, HHs	(7) Lending rate Consumer loans, HHs	(8) Lending rate All loans to NFCs
Cap. req. (t), low-cap.	0.024	−0.025	−0.135	−0.013				
	[0.652]	[0.593]	[0.314]	[0.609]				
Cap. req. (t), high-cap.	−0.066	−0.022	−0.019	−0.044				
	[0.212]	[0.624]	[0.812]	[0.112]				
Cap. req. (t), low-cap., $< 2\%$					−0.022	−0.027	−0.100	−0.032
					[0.286]	[0.327]	[0.468]	[0.107]
Cap. req. (t), high-cap., $> 2\%$					−0.030	−.017	−0.021	−0.039
					[0.375]	[0.433]	[0.863]	[0.256]
IRS (t)	**0.908**	**0.661**	0.339	**0.661**	**0.905**	**0.659**	0.285	**0.667**
	[0.003]	[0.005]	[0.384]	[0.000]	[0.000]	[0.006]	[0.370]	[0.000]
NPL ratio (t)	**0.313**	**0.230**	**0.131**	**0.100**	**0.332**	**0.225**	**0.137**	**0.099**
	[0.062]	[0.084]	[0.085]	[0.024]	[0.048]	[0.049]	[0.091]	[0.023]
Leverage ratio (t − 1)	0.059	**−0.021**	0.183	−0.015	0.051	**−0.031**	**0.158**	−0.011
	[0.808]	[0.084]	[0.123]	[0.599]	[0.844]	[0.055]	[0.074]	[0.650]
Log Assets (t − 1)	**1.559**	0.331	0.613	0.045	**1.631**	0.293	0.364	0.021
	[0.017]	[0.288]	[0.445]	[0.667]	[0.037]	[0.347]	[0.622]	[0.853]

Table 4 continued

	(1) Lending rate All loans to HHs	(2) Lending rate Mortgages, HHs	(3) Lending rate Consumer loans, HHs	(4) Lending rate All loans to NFCs	(5) Lending rate All loans to HHs	(6) Lending rate Mortgages, HHs	(7) Lending rate Consumer loans, HHs	(8) Lending rate All loans to NFCs
Herfindahl (t)	**0.106**	**0.076**	0.011	0.002	**0.109**	**0.075**	0.019	0.003
	[0.013]	[0.000]	[0.866]	[0.752]	[0.009]	[0.001]	[0.792]	[0.694]
Consumption (t − 1)	**−0.113**	0.008	**−0.076**	0.028	**-0.112**	0.008	−0.049	0.026
	[0.034]	[0.571]	[0.055]	[0.224]	[0.025]	[0.606]	[0.177]	[0.254]
Disp. income (t − 1)	0.000	−0.001	−0.117		0.002	−0.001	−0.104	
	[0.989]	[0.950]	[0.316]		[0.912]	[0.991]	[0.331]	
BBM dummy	**−0.395**	**−0.155**	**−0.888**		**−0.404**	**−0.149**	**−0.875**	
	[0.002]	[0.004]	[0.000]		[0.000]	[0.003]	[0.000]	
HPI (t − 1)		**−0.016**				**-0.015**		
		[0.000]				[0.002]		
REER (t − 1)				0.003				0.004
				0.720				0.599
N	613	564	534	611	613	564	534	611
Adj. R2	0.770	0.933	0.726	0.817	0.764	0.935	0.740	0.817

Wild bootstrapped *p*-values in squared brackets, clustered at the bank level details, refer to Sect. 3.2). This information is only available for the shortened sample period. The results, in Tables B3 and B4 in the Online Appendix, suggest that the estimated effect of the overall capital requirements on banks' pricing policy remains robust to this alternative specification in both households and the NFC sector. In fact, the loss of significance in the case of the interest margin and interest rates in the overall sector of households compared to the results in Table B1 supports the near-zero outcome from our baseline model. In the second additional framework, we employed the shortened sample of 2014–2019 in a robustness check of Table 4. We confirm that the effect is also not significant for any of the specific categories (consumer loans, mortgage loans, loans smaller and larger than CZK 30 million) when the level of capitalisation is accounted for (Table B5 in the Online Appendix).

Second, we examine the period of low interest rates in more details. The period of very low interest rates together with its consequences on bank profitability may affect bank pricing policies and thus interact with the transmission of capital requirements to bank lending rates and margins. In order to control for this period, we generate a dummy that is equal to one if the short-term interest rate (short IRS rate) is below its bottom quartile. We then interact this dummy with the capital requirements measure to see whether the effect of capital requirements on our variables of interest differs in these two periods. In line with our baseline results, we find that the effect is insignificant in both periods (Table B6 in the Online Appendix, columns 1-5, results for households sector). Second, as an alternative check, we create a cumulative dummy capturing the number of periods in which the interest rate is low, i.e., it is below its bottom quartile. The variable is not significant either and does not affect the significance of the capital requirement measure, suggesting that the insignificance of our results before has not been caused by omitting this aspect in the regressions (Table B6, columns 5-10). Third, instead of the dummies capturing the low interest rate environment, we include time fixed effects (Table B6, columns 11-15). This does not alter our main results either. We also provide this robustness check for the NFC sector (Table B7 in the Online Appendix).

Third, we differentiate between large and small banks. The positive relationship between the overall capital requirements and the interest margin should be more pronounced for small and risky banks, given that in general the cost of capital is lower for larger and safer banks (Baker and Wurgler 2015; Gandhi and Lustig 2015). Nevertheless, the resulting estimates continue to be statistically not different from zero (Table B8 in the Online Appendix).

Fourth, since the overall capital requirements are announced in advance, we might assume that the variable has a leading effect, provided banks incorporate it into their decision-making and price setting in advance. However, the opposite might also be true, as banks may wait until the regulation comes in force and respond with a delay. This would, in turn, imply that the overall capital requirements have a lagged effect. Either way, a natural exercise to address this potential issue is to introduce a richer lead/lag structure into the regression. We test this hypothesis in separate models; the results are displayed in Table B9 in the Online Appendix. We introduce four additional lags (leads) into the regression, but they are jointly insignificant for each kind of lending rate. In accordance with our baseline results, the only case where the lags (leads) are jointly significant is that of deposit rates.

Fifth, we estimate the baseline model with fixed-b statistics for the linear panel model with fixed effects as suggested in Vogelsang (2012). Vogelsang (2012) develops the fixed-b asymptotic theory robust to heteroskedasticity, autocorrelation and/or spatial correlation, based on nonparametric heteroskedasticity autocorrelation (HAC) covariance matrix estimator. The model is estimated using *xtsccfixedb* command in Stata. The approach should alleviate the heteroscedasticity present in the sample. The results are displayed in Table B10 and B11 in the Online Appendix and confirm the previous findings.

Finally, Tables B12 and B13 in the Online Appendix replicate Tables 2 and 3 using non-weighted regression schemes. Until now, all of the models were estimated as weighted fixed effects models, weighted by the share of a bank's loans of a specific type in the total loan portfolio of a specific type. The non-weighted version, i.e. the standard fixed effects panel data model, reports similar null results.

A note on the effects of cross-border bank regulation. There is a vast literature showing that regulation of parent banks may spillover to the domestic subsidiaries (Hardy and Nieto 2011; Avdjiev et al. 2017). This could especially be the case for large international banks (Beck et al. 2013). Given the fact that the Czech banking sector is largely foreign-owned, this issue can be material, and if not treated properly, it might influence our estimates.[13] In this respect, the use of bank fixed effects should account for the presence of cross-border regulatory spillovers.

Overall, we cannot conclusively prove that the relationship between changes to the overall capital requirements affects bank pricing policy in general. We report weak effects with little statistical significance across multiple model specifications. Thus, Sect. 5 discusses in more detail why, in contrast to other studies, we fail to identify any robust effect.

4.3 What really determines bank pricing policies

The previous section discussed the results relating to our main focus, namely the effect of changes to the overall capital requirements on bank pricing policies across different bank product segments. Let us now turn to other findings of interest implied by our estimates of the control variables shown in Tables 2, 3 and 4 . In summary, we find there are other more important determinants of bank pricing policies, some of which have not yet been tested in the empirical literature. Our discussion will be focused primarily on those that have not been previously tested or that have lacked conclusive evidence.

Interest rate pass-through Compared to other studies (Gambacorta 2008; Horvath and Podpiera 2012; Hristov et al. 2014; Havranek et al. 2016; Horvath et al. 2018), we use the IRS rate instead of the inter-bank rate to estimate the strength of the pass-through mechanism. The IRS rate is superior for this exercise since it is a risk-free

[13] For instance, the capital buffer for other systemically important institutions can range from 0 to 3%, but the maximum value bestowed upon a domestic bank is directly capped by the current level of the buffer for the parent bank. Specifically, the domestic buffer cannot exceed the buffer applied to the parent bank by more than one percentage point. However, this is not relevant for the Czech banking sector since the CNB was using systemic risk buffer instead of the buffer applied to systemically important institutions during the period under scope (Pfeifer 2021).

rate, unlike the inter-bank rate, which has a non-zero risk premium. Moreover, the IRS rate is "closer" to the monetary policy rate compared to inter-bank rates.[14]

We identify a high short-term pass-through effect from the IRS rate to bank lending rates. Specifically, a 1 pp increase in the IRS is accompanied by about a 0.9 pp increase in household lending rates and about a 0.7 pp rise in corporate lending rates (Tables 2 and 3). Our point estimates are close to other studies on the interest rate pass-through in the Czech banking sector (Horvath and Podpiera 2012; Havranek et al. 2016), but ours are associated with narrower confidence bounds, which may be the outcome of applying a more precise IRS rate.

Our results point to a well-functioning transmission mechanism when the full sample period is considered. Compared to Horvath and Podpiera (2012), we report a much weaker pass-through for deposit rates, which suggests that banks that offer attractive deposit rates usually charge higher loan mark-ups. The conclusions change when we consider the interest rate pass-through in the shortened sample period B1 and B2. We record insignificant estimates of the short-term pass-through coefficients for all bank products for households with the exception of mortgages. Our estimates during the 2014–2019 period serve as updated evidence of the estimates of Havranek et al. (2016), who found the short-term pass-through to be significantly weakened in the aftermath of the global financial crisis.

Credit risk premia We take special care to approximate the credit risk premia as precisely as possible. We use the share of reported NPLs in new loans which are specific for a given loan type. This again contrasts with other studies that estimate the pricing behaviour of banks. Such studies typically employ aggregate NPL data irrespective of loan category when trying to approximate credit risk (Fungáčová and Poghosyan 2011; Islam and Nishiyama 2016). Therefore, they can only employ one measure of credit risk per bank and thus cannot differentiate between different segments of the credit market.

We find credit risk premia to play an important role in the pricing of bank products. Specifically, we find that a 1 pp increase in credit risk premia is associated with about a 0.3 pp increase in loan rates charged to households and a 0.1 pp increase in loan rates charged to corporations (Tables 2 and 3). The estimates are significant at the 5% and 1% level respectively. Therefore, banks typically charge higher rates on loans to households due to generally higher risk premia as compared to corporate loans.[15]

Bank concentration We find that a shift to a more concentrated industry is generally associated with bank loan rates that are about 0.1 pp higher in the case of loans to households, in contrast to corporate loan rates, for which we do not find any effect. This finding is closely related to the fact that we also report a positive impact of bank size—as approximated by the log of total assets—for the household loan segment only. This indicates that larger banks may charge higher rates to households owing

[14] One might wonder whether it would be best to use the repo rate as the monetary policy proxy. This was done, for example, in Gregor and Melecký (2018). In theory, this is the best way. However, the repo rate falls short on delivering reliable estimates once the economy hits the zero lower bound.

[15] We also found a positive and highly significant effect of the NPL ratio when examining interest margins (Column 1 in both Tables 2 and 3). This somewhat contradicts the empirical estimates in previous studies, which find the importance of credit risk for net interest margins to be negative or insignificant (Fungáčová and Poghosyan 2011; Islam and Nishiyama 2016).

to their dominant position in the market. In general, we find some support for the structure-performance hypothesis, which suggests that increasing market power will prompt banks to engage in rent-seeking behaviour. Our results are in line with other studies on the topic (Van Leuvensteijn et al. 2013; Brož and Hlaváček 2019).

Borrower-based measures In our model, we address the fact that apart from capital-based regulation, the national regulator employed several borrower-based measures in the period under study, which we capture with a cumulative BBM dummy. The estimated coefficient allows us to analyse how banks adjusted their pricing in response to the borrower-based measures. These measures were introduced as a non-binding recommendation, but were followed by a majority of banks (CNB 2020). We find that the borrower-based measures reduced bank household loan rates by about 0.4 pp. This implies that these measures may have spurred a price war among banks, which are trying to attract high-income and low-risk customers by cutting their loan rates. Our estimates are similar to those of Acharya et al. (2019), who estimate the impact to be around 0.46 pp for high-income households in Ireland.

5 Discussion of the reported null results

We present the following arguments for why we report largely insignificant results for our estimation of the effects of changes in capital requirements on bank pricing policy. We contrast our data sample, estimation strategy and choice of control variables with the previous empirical studies, which report positive estimates. The related studies are summarised in Table 7 in the Appendix.

We argue that our reported statistically insignificant estimates may be driven by five facts: (i) we model changes to the bank-specific overall capital requirements instead of changes to capital ratios, (ii) we incorporate other more precise determinants of bank pricing policy, some of which have not previously been employed in the literature to explain changes to bank pricing policy, and (iii) we do not make an *a priori* assumption about the well-known concept of capital-structure independence developed in Modigliani and Miller (1958). We also hypothesise that (iv) the estimates are possibly affected by the characteristics of the banking sector under review, and (v) the existing literature might be prone to publication bias, causing the existing estimates to be skewed towards positive and significant results. While the first three facts are directly observable and can be contrasted with other studies as they appear in Table 7, the latter two are not observable by our data and would require a cross-country panel dataset. We engage in detailed discussion over their relative importance but leave the empirical exploration to future research as it is outside the scope of this paper.

First, the majority of other studies examine the impact of changes to observed regulatory ratios (such as the Tier 1 ratio) instead of modelling changes to the minimum or overall regulatory requirements (Table 5). The problem with this modelling approach is that banks may change their actual regulatory ratios even when the regulatory minimum does not change, making the modelled shock not truly exogenous. As a result, the majority of the existing studies might be prone to endogeneity concerns.[16] Given that the Czech National Bank ranks among the most active macroprudential authorities, our dataset allows us to better model plausibly exogenous changes to the overall regulatory requirements.

Second, we employ detailed determinants of interest margins and lending rates. In particular, interest rate swaps weighted according to maturity, and forward-looking non-performing loan ratios specific to a given loan type, are novel contributions to the related literature. These variables were found to explain a significant part of the dynamics of interest margins and lending rates.

Third, much of the previous literature on this topic relies on calibrated models of bank funding in which one of the entry assumptions is linked to the Modigliani-Miller (M-M) theorem. Modigliani and Miller (1958) postulate that, under certain idealised conditions, a firm's capital structure is irrelevant for its operating decisions. Translated to the banking industry, this would imply that the rate a bank charges on its loans should be independent of its mix of debt and equity funding. However, as discussed in Kashyap et al. (2010), the real world (and banking in particular) may significantly deviate from the conditions set by Modigliani and Miller (1958). A common argumentation builds upon the premise that in the case of banking entities, equity is more costly than debt. This implies that banks which have to keep more equity would pass increased funding costs on to customers via increased lending rates. In other words, the prescribed independence of banks' charges on loans of the mix of debt and equity financing postulated by Modigliani and Miller (1958) would in reality not be met.[17] Alternatively, the M-M theorem might simply not work in the banking sector, because it does not assume the presence of a regulatory authority that prescribes the required portion of capital to be held. The debt-equity mix maintained by a bank under supervision is therefore "unnatural" from the point of view of the M-M theorem.

In general, studies that rely on calibrated models of bank funding report smaller estimates of the impact of increased capital ratios on loan rates than those that leave out *a priori* assumptions about the capital structure (see Table 5). Given that the banks in our sample are largely foreign-owned and the majority of them are not traded on the stock exchange, we cannot employ the framework with the funding costs calibration, simply because we lack the stock data needed for the calculation of returns on equity.[18] It is not without interest that we continuously report null results despite the fact that we did not need to tame the estimates by making assumptions about the M-M theorem. Moreover, Martynova (2015) finds the evidence on the M-M hypothesis to be mixed,

[16] Boissay et al. (2019) offer a preliminary literature review of studies focusing on the impact of financial regulations and make a similar point.

[17] A number of these studies also attempt to calculate the so-called Modigliani-Miller offset (Junge and Kugler 2013; Miles et al. 2013). This concept, simply speaking, captures the gap between two calibrated effects of the tightening of capital-based regulation on banks' funding costs (usually described by the simple weighted average cost of capital, WACC): (1) the effect which corresponds to the real-world data, and (2) the effect which would be achieved if the M-M theorem does *not* hold absolutely. A Modigliani-Miller offset of 45% therefore means that the WACC increases by 45% *less* than it would if the M-M theorem did not hold at all.

[18] Hence, we also cannot test the deviations from the Modigliani-Miller world by calculating the M-M offset.

Table 5 Summary of point estimates found in the literature

Dependent Variable	Explanatory Variable	Min-Max Δ in DV (bps)	# Studies
Panel A: Papers using M-M framework			
Funding costs/lending spread	Capital ratio	0.7–8.6	5
Lending rate	Capital ratio	7.0–12.0	1
Panel B: Papers NOT using M-M framework			
Interest income ratio	Capital ratio	2.8–18.8	2
Lending rate	Capital ratio	8.0–28.0	1
Lending spread	Capital ratio	0.1–20.0	6
Net interest margin	Capital ratio	0.7–8.7	3
Lending rate	Capital requirements	2.5–9.5	5

This table reports the min-max range of the estimated effects (in bps) of capital-based regulation (captured by changes in either the capital ratios or the capital requirements themselves) on the various variables that proxy for banks' pricing policy. Some studies provided more than one estimated effect of interest to us. Therefore, more than one estimate per study might enter the min-max sorts. More details can be found in Table 7 in the Appendix

i.e. there is little consensus on whether a change in a bank's capital structure has a material effect on the weighted average cost of its capital.

Fourth, the distinct results might be specific to our sample, which covers a relatively well-capitalised, low-risk and largely foreign-owned banking sector. The fact that, historically, more than 85% of the Czech banking sector's balance sheet assets were controlled by foreign capital cannot be taken away from the relationship studied. The degree to which foreign-owned banks operate in the Czech Republic, and also in other Central European Eastern (CEE) countries, is much higher compared to the situation in more developed regions that were subject to similar studies (see Table 7). Claessens and Van Horen (2014) provide an extensive discussion on possible benefits and costs of increased share of foreign banks and shows that also the characteristics of host and home country as well as the characteristics of banks matter. Nevertheless, the quantification of the impact of ownership structure on the interplay between capital regulation and pricing policy is not an easy task.[19] Possible explanation of the null results can be driven by the parent-daughter business model. Specifically, parent institutions might require domestic banks to perform according to a prescribed return on invested capital and equity. As a result, the ensuing setup of the bank's pricing policy might interfere with the prescribed effects of increasing capital requirements, leading to the near-zero estimates observed in our study. Strong integration of parent policy in a subsidiary's activities driven by credit allocation was demonstrated in De Haas

[19] The analysis of the implications for the monetary policy conduct received some attention. Most recently, Denderski and Paczos (2021) showed that the ownership structure of banks in CEE region negatively affects the sensitivity of supply of credit to changes in monetary policy.

and Naaborg (2006). Other authors examined the effects of parent-subsidiary linkages conditional on crisis periods and found that the lending of foreign-owned banks is more pro-cyclical and is more stable during local-country crises than that of private or government-owned banks (De Haas and Van Lelyveld 2014; Allen et al. 2017).

As the required and observed capital ratios are continuously rising, we could hypothesise that banks are getting less vulnerable to shocks and financial distress, i.e. they are getting less risky and more stable. As a result, their own risk premium is decreasing, which may mean less pressure for (aggressive) pricing policy from the parent bank. Moreover, the macro- and microprudential policy of the Czech National Bank is aimed at being transparent and predictable, which has direct implications for the degree to which banks adjust their pricing policy in reaction to the central authority's announcements. In fact, capital planning is a long-term process. If prudential policy is abrupt and unpredictable, banks will be forced to maintain a high level of capital (with high own buffers) to compensate for the unexpectedness of the regulator's decisions. If macro- and microprudential buffers are announced and discussed in advance, no abrupt reactions (including in pricing policy) are expected, as banks adjust smoothly over a longer period.

Last but not least, we hypothesise that there may be a publication bias in the literature towards larger and more significant results. According to Ioannidis et al. (2017), the reason why the average estimate in the economic literature is exaggerated is twofold. Researchers who face a large number of degrees of freedom may search for large (and consequently significant) estimates, leading to an upward bias. They liken these efforts to the Lombard effect in biology: speakers increase their effort in the presence of noise. There is no systematic meta-analysis of this topic assessing the extent of publication bias; nevertheless, the closest meta-analysis—by Fidrmuc and Lind (2020) on the macroeconomic impact of Basel III—finds that publication bias plays an important role. The authors also assert that "some studies try to support institutional views in presented publications on this topic". However, as far as estimates of the effect of capital requirements or capital ratios on lending rates are concerned, the presence and extent of publication selection remains a matter of speculation, as a formal test for publication bias is beyond the scope of this paper and is instead an opportunity for further research.

6 Conclusion

In this paper we provide new evidence on the relationship between capital-based regulation and bank pricing policy. In particular, the analysis estimates the effect of changes in capital requirements on banks' margins, lending rates on new loans, and deposit rates on new deposits of households and non-financial corporations. The paper uses a unique bank-level dataset covering various changes in the Pillar 2 capital requirements and capital buffers. We employ a fixed effects panel data model estimated by wild bootstrapped inference.

Our estimation results offer no evidence of changes in capital requirements being reflected in bank pricing policy. We estimate the effect on banks' interest margins and lending rates to be virtually zero. We provide various robustness checks and sensitivity analyses to confirm that the estimates are not statistically different from zero under any specification. We find no significant or material effect for less-capitalised banks, even though the theory could argue that more capital constrained banks are more sensitive to changes in capital requirements. We also find no differences between small and large banks or between different time periods. In addition, the capital requirements do not have a significant effect even when new loans for house purchase and consumer loans are examined separately.

The findings contrast with evidence of significant effects of changes to capital-based regulation (Basten and Koch 2015; Glancy and Kurtzman 2018; De Jonghe et al. 2020). Economically, the null result implies either that changes to the overall capital requirements have little effect on banks' cost of funding, or that banks respond to cost-of-funding changes substantially less than recent evidence would predict, or both. Overall, we show that the widely expected[20] unintended consequences of the Basel III reforms on the cost of funding and bank pricing policy are very small or not present at all. The required adjustments to bank capital were sizeable and grew over time. In addition, Czech banks operate almost exclusively with Tier 1 capital, whose average share in total capital-based funding was 95% during the period studied. The fact that despite this environment we consistently report null results may serve as a telling reminder to policymakers that new regulation should be carefully phased in and communicated up-front with banks, allowing them to meet the heightened requirements without slowing down the growth of their assets. As such, our empirical evidence echoes Kashyap et al. (2010) as well as studies claiming that the "optimal" level is much larger than what Basel III asks for (Admati et al. 2010; Miles et al. 2013). Additionally, the evidence can be used as an additional argument when discussing the benefits and costs of capital-based regulation. We assert that the costs are not borne by consumers of bank products but do not cause margins to change either.

In our paper, we elaborated on the potential explanatory factors that might drive our null results. We distinguish ourselves from a large portion of the literature by modelling exogenous changes to bank-specific capital requirements instead of modelling possibly endogenous changes to the observed capital ratio. Boissay et al. (2019) suggest that this distinction is important, because banks may change their actual regulatory ratios even when the regulatory minimum does not change. While we do not find that the capital requirements have a significant effect, we introduce several control variables and find that they explain a large portion of the variance in bank pricing.

We hypothesise that the country-level estimates might be partially driven by the relative riskiness of the banking sector under review. This constitutes a fruitful ground for future research in this area, alongside a check of whether the existing literature is prone to publication bias causing the existing estimates to be skewed towards positive and significant results.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11149-022-09448-5.

[20] Ambrocio et al. (2020) survey 149 leading academic researchers on bank capital regulation and find that the vast majority believe that an increase in capital regulation would translate to a higher cost of bank lending.

Appendix

Table 6 Summary statistics

	Mean	SD	Min	Max
Dependent variables				
Interest margin, HHs	5.14	3.41	1.06	17.66
Interest margin, NFCs	3.39	1.26	0.50	8.14
Lending rate, all loans to HHs	6.07	3.31	1.86	18.08
Lending rate, all loans to NFCs	4.11	1.52	0.44	9.60
Lending rate, mortgages to HHs	3.67	1.17	1.50	5.97
Lending rate, consumer loans to HHs	10.64	3.62	1.90	31.09
Deposit rate, HHs	0.93	0.75	0.05	3.31
Deposit rate, NFCs	0.72	0.71	−0.18	3.44
Independent variables				
Capital requirements	10.00	2.86	8.00	17.01
IRS, HHs	1.84	1.20	0.20	4.49
IRS, NFCs	1.64	1.20	0.20	4.66
IRS, mortgages to HHs	1.86	1.24	0.24	4.65
IRS, consumer loans to HHs	1.92	1.15	0.25	4.43
NPL ratio, HHs, 12M forward	5.24	3.88	1.46	17.77
NPL ratio, NFCs, 12M forward	8.33	6.85	0.00	26.50
NPL ratio, mortgages, 12M forward	2.77	1.50	0.30	5.98
NPL ratio, consumer loans, 12M forward	11.39	6.93	2.54	28.25
Leverage ratio	9.85	4.84	3.02	29.89
Logarithm of assets	18.80	1.33	16.06	21.24
Liquidity ratio	14.02	12.16	0.50	79.85
Herfindahl, HHs	20.04	1.60	15.98	23.46
Herfindahl, NFCs	21.94	8.79	6.05	36.13
Herfindahl, mortgages	24.03	2.78	17.92	31.95
Herfindahl, consumer loans	24.66	5.47	15.81	36.64
Consumption, y-o-y	4.13	2.48	−1.78	8.83
Disposable income, y-o-y	4.15	2.55	−1.75	8.45
REER	104.54	5.01	92.21	117.47
House price index, y-o-y	5.13	10.36	−17.10	35.40
BBM dummy	0.75	1.42	0.00	4.00

Table 7 Overview of the Empirical Literature

Study	Country	Period	Method[a]	Depend. var.[b]	Explanat. var.[c]	Estim. effect (bps)
Panel A: Papers using M-M framework						
Baker and Wurgler (2015)	USA	1971–2011	E + C	FC	cap. ratio	8.2−9
Barth and Miller (2018)	USA	1996–2014	E + C	FC	cap. ratio	3.1
Brooke et al. (2015)	UK	1997–2014	C	LR	cap. ratio	25
Junge and Kugler (2013)	Switzerland	1999–2010	E + C	FC	cap. ratio	0.7
Kashyap et al. (2010)	International	1976–2008	C	FC	cap. ratio	2.5−4.5
Martin-Oliver et al. (2013)	Spain	1992–2007	E	LR	cap. ratio	7−12
Miles et al. (2013)	UK	1997–2010	E + C	FC	cap. ratio	1.2
Panel B: Papers NOT using M-M framework						
Cosimano and Hakura (2011)	International	2001–2009	E	IIR	cap. ratio	12
De Nicolò (2015)	43 advanced and emerging economies	1982–2013	E	NIM	cap. ratio	1.1−4.6
Fungáčová and Poghosyan (2011)	Russia	1999–2007	E	NIM	cap. ratio	0.7−1.2
Gambacorta (2011)	USA	1994–2008	E	LS	cap. ratio	2.5−4
Rizvi et al. (2018)	India	2002–2015	E	NIM	cap. ratio	8.7
Santos and Winton (2019)	USA	1987–2007	E	LS	cap. ratio	6−20
Elliott and Santos (2012)	EA, US, Japan	2010	AA	LR	cap. ratio	8−28
Chun et al. (2012)	International	2005–2010	AA	LS	cap. ratio	0.1−9.1

Table 7 continued

Study	Country	Period	Method[a]	Depend. var.[b]	Explanat. var.[c]	Estim. effect (bps)
BCBS (2010)	International	1993–2007	AA	LS	cap. ratio	13
King (2010)	13 OECD countries	1993–2007	AA	LS	cap. ratio	15
Slovik and Cournède (2011)	US, EA, Japan	2004–2006	AA	LS	cap. ratio	14.4
Sutorova and Teplý (2013)	EU	2006–2011	E	IIR	cap. ratio	2.8−18.8
Basten and Koch (2015)	Switzerland	2012–2013	E	LR	cap. req.	2.52−5.57
Benetton et al. (2017)	UK	2005–2015	E	LR	cap. req.	6
BIS (2015)	International		E	LR	cap. req.	5−15
di Patti et al. (2020)	Italy	2012–2014	E	LR	cap. req.	9.5
Glancy and Kurtzman (2018)	US	2012–2015	E	LR	cap. req.	9.5

[a]Methodology: E—Empirical; C—Calibration; AA—Accounting approach

[b]Dependent Variable: FC—Funding costs; LR—Lending rate; LS—Lending spread; IIR—Interest income ratio; NIM—Net interest margin

[c]Explanatory Variable: Cap. ratio—Capital ratio; Cap. req.—Capital requirements

References

Acharya, V. V., Bergant, K., Crosignani, M., Eisert, T., & McCann, F. J. (2019). The anatomy of the transmission of macroprudential policies. *Available at SSRN 3388963*.

Admati, A. R., DeMarzo, P. M., Hellwig, M., Pfleiderer, P. (2010). Fallacies, irrelevant facts, and myths in the discussion of capital regulation: Why bank equity is not expensive. *Stanford gsb research paper no. 2063*, Stanford University.

Aiyar, S., Calomiris, C. W., & Wieladek, T. (2014). Does macro-prudential regulation leak? evidence from a UK policy experiment. *Journal of Money, Credit and Banking, 46*(s1), 181–214.

Allen, F., Jackowicz, K., Kowalewski, O., & Kozłowski, Ł. (2017). Bank lending, crises, and changing ownership structure in central and eastern European countries. *Journal of Corporate Finance, 42*, 494–515.

Ambrocio, G., Hasan, I., Jokivuolle, E., & Ristolainen, K. (2020). Are bank capital requirements optimally set? evidence from researchers' views. *Journal of Financial Stability, 50*, 1–15.

Anderson, R. D., Ashton, J. K., & Hudson, R. S. (2014). The influence of product age on pricing decisions: An examination of bank deposit interest rate setting. *Journal of International Financial Markets, Institutions and Money, 31*, 216–230.

Angelini, P., Clerc, L., Cúrdia, V., Gambacorta, L., Gerali, A., Locarno, A., Motto, R., Roeger, W., Van den Heuvel, S., & Vlček, J. (2015). Basel iii: Long-term impact on economic performance and fluctuations. *The Manchester School, 83*(2), 217–251.

Avdjiev, S., Koch, C., McGuire, P., von Peter, G., et al. (2017). International prudential policy spillovers: A global perspective. *International Journal of Central Banking, 13*(2), 5–33.

Baker, M., & Wurgler, J. (2015). Do strict capital requirements raise the cost of capital? bank regulation, capital structure, and the low-risk anomaly. *American Economic Review, 105*(5), 315–20.

Barth, J. R., & Miller, S. M. (2018). Benefits and costs of a higher bank leverage ratio. *Journal of Financial Stability, 38*, 37–52.

Basten, C., & Koch, C. (2015). Higher bank capital requirements and mortgage pricing: Evidence from the countercyclical capital buffer (ccb). *Bis working paper no. 511*, Bank for International Settlements.

BCBS. (2010). *An assessment of the long-term economic impact of stronger capital and liquidity requirements*. Bank of International Settlements: Basel committee on banking supervision.

BCBS. (2012). A framework for dealing with domestic systemically important banks. *Basel Committee on Banking Supervision*.

Beck, T., Todorov, R., & Wagner, W. (2013). Supervising cross-border banks: Theory, evidence and policy. *Economic Policy, 28*(73), 5–44.

Beltratti, A., & Stulz, R. M. (2012). The credit crisis around the globe: Why did some banks perform better? *Journal of Financial Economics, 105*(1), 1–17.

Benetton, M., Eckley, P., Garbarino, N., Kirwin, L., & Latsi, G. (2017). Specialisation in mortgage risk under basel ii. *Boe working papers no. 639*, Bank of England.

Berger, A. N., & Bouwman, C. H. (2013). How does capital affect bank performance during financial crises? *Journal of Financial Economics, 109*(1), 146–176.

Berger, A. N., DeYoung, R., Flannery, M. J., Lee, D., & Öztekin, Ö. (2008). How do large banking organizations manage their capital ratios? *Journal of Financial Services Research, 34*(2–3), 123–149.

Birn, M., de Bandt, O., Firestone, S., Gutiérrez Girault, M., Hancock, D., Krogh, T., Mio, H., Morgan, D. P., Palvia, A., Scalone, V., et al. (2020). The costs and benefits of bank capital-a review of the literature. *Journal of Risk and Financial Management, 13*(4), 74.

Blackburne, E. F., III., & Frank, M. W. (2007). Estimation of nonstationary heterogeneous panels. *The Stata Journal, 7*(2), 197–208.

Boissay, F., Cantú, C., Claessens, S., & Villegas, A. (2019). Impact of financial regulations: Insights from an online repository of studies. *BIS Quarterly Review, March*.

Brewer Iii, E., Kaufman, G. G., & Wall, L. D. (2008). Bank capital ratios across countries: Why do they vary? *Journal of Financial Services Research, 34*(2–3), 177–201.

Bridges, J., Gregory, D., Nielsen, M., Pezzini, S., Radia, A., & Spaltro, M. (2014). The impact of capital requirements on bank lending. *Boe working papers 486*, Bank of England.

Brooke, M., Bush, O., Edwards, R., Ellis, J., Francis, B., Harimohan, R., Neiss, K., & Siegert, C. (2015). Measuring the macroeconomic costs and benefits of higher UK bank capital requirements. *Bank of England Financial Stability Paper, 35*(35), 1–55.

Brož, V., & Hlaváček, M. (2019). What drives the distributional dynamics of client interest rates on consumer loans in the Czech Republic? *Czech Journal of Economics and Finance (Finance a Uver), 69*(3), 175–197.

Bruha, J. (2011). Retail credit premiums and macroeconomic developments. *Thematic Article, Financial Stability Report, 4*, 133–140.

Cameron, A. C., Gelbach, J. B., & Miller, D. L. (2008). Bootstrap-based improvements for inference with clustered errors. *The Review of Economics and Statistics, 90*(3), 414–427.

Carbo-Valverde, S., Hannan, T. H., & Rodriguez-Fernandez, F. (2011). Exploiting old customers and attracting new ones: The case of bank deposit pricing. *European Economic Review, 55*(7), 903–915.

Cerutti, E., Claessens, S., & Laeven, L. (2017). The use and effectiveness of macroprudential policies: New evidence. *Journal of Financial Stability, 28*, 203–224.

Chun, S. E., Kim, H., Ko, W. (2012). The impact of strengthened basel iii banking regulation on lending spreads: Comparisons across countries and business models. *Bok working paper no. 2012-15*, Bank of Korea.

Cifarelli, G., & Paladino, G. (2016). Time-varying mark-up and the ECB monetary policy transmission in a highly non linear framework. *International Review of Economics & Finance, 45*, 247–262.

Claessens, S., & Van Horen, N. (2014). Foreign banks: Trends and impact. *Journal of Money, Credit and Banking, 46*(s1), 295–326.

Claeys, S., & Vander Vennet, R. (2008). Determinants of bank interest margins in central and eastern Europe: A comparison with the west. *Economic Systems, 32*(2), 197–216.

CNB. (2020). Recommendation - limits applicable to mortgage loans. Available at https://www.cnb.cz/en/financial-stability/macroprudential-policy/recommendation-limits-applicable-to-mortgage-loans/index.html. Accessed 30 Oct 2020.

Cosimano, T. F., & Hakura, D. (2011). Bank behavior in response to basel iii: A cross-country analysis. *Imf working paper series wp/11/119*, International Monetary Fund.

Cottarelli, C., & Kourelis, A. (1994). Financial structure, bank lending rates, and the transmission mechanism of monetary policy. *IMF Staff Papers, 41*(4), 587–623.

Dagher, J., Dell'Ariccia, G., Laeven, L., Ratnovski, L., & Tong, H. (2016). Benefits and costs of bank capital. *Imf staff discussion note/16/04*, International Monetary Fund.

De Graeve, F., De Jonghe, O., & Vander Vennet, R. (2007). Competition, transmission and bank pricing policies: Evidence from Belgian loan and deposit markets. *Journal of Banking & Finance, 31*(1), 259–278.

De Haas, R., & Naaborg, I. (2006). Foreign banks in transition countries: To whom do they lend and how are they financed? *Financial Markets, Institutions & Instruments, 15*(4), 159–199.

De Haas, R., & Van Lelyveld, I. (2014). Multinational banks and the global financial crisis: Weathering the perfect storm? *Journal of Money, Credit and Banking, 46*(s1), 333–364.

De Jonghe, O., Dewachter, H., & Ongena, S. (2020). Bank capital (requirements) and credit supply: Evidence from pillar 2 decisions. *Journal of Corporate Finance, 60*, 1–28.

De Nicolò, G. (2015). Revisiting the impact of bank capital requirements on lending and real activity. *Available at SSRN 2688110*.

Denderski, P., & Paczos, W. (2021). Foreign banks and the bank lending channel. *Economic Inquiry, 59*(1), 478–493.

Elliott, D., & Santos, M. A. (2012). Assessing the cost of financial regulation. *Imf working paper no. 12/233*, International Monetary Fund.

ESRB (2019). A Review of Macroprudential Policy in the EU in 2018. *European Systemic Risk Board*.

Fidrmuc, J., & Lind, R. (2020). Macroeconomic impact of basel iii: Evidence from a meta-analysis. *Journal of Banking & Finance, 112*(2020), 1–14.

Flannery, M. J., & Rangan, K. P. (2008). What caused the bank capital build-up of the 1990s? *Review of Finance, 12*(2), 391–429.

Freixas, X., & Rochet, J. C. (2008). *Microeconomics of banking*. MIT press.

Fuertes, A.-M., Heffernan, S., & Kalotychou, E. (2010). How do UK banks react to changing central bank rates? *Journal of Financial Services Research, 37*(2–3), 99–130.

Fungáčová, Z., & Poghosyan, T. (2011). Determinants of bank interest margins in Russia: Does bank ownership matter? *Economic Systems, 35*(4), 481–495.

Gale, D., et al. (2010). The effects of bank capital on lending: What do we know, and what does it mean? *International Journal of Central Banking, 6*(34), 187–204.

Gambacorta, L. (2008). How do banks set interest rates? *European Economic Review, 52*(5), 792–819.

Gambacorta, L. (2011). Do bank capital and liquidity affect real economic activity in the long run? a VECM analysis for the US. *Economic Notes, 40*(3), 75–91.
Gambacorta, L., Illes, A., & Lombardi, M. J. (2015). Has the transmission of policy rates to lending rates changed in the wake of the global financial crisis? *International Finance, 18*(3), 263–280.
Gandhi, P., & Lustig, H. (2015). Size anomalies in us bank stock returns. *The Journal of Finance, 70*(2), 733–768.
Glancy, D., & Kurtzman, R. J. (2018). How do capital requirements affect loan rates? evidence from high volatility commercial real estate. *Finance and economics discussion series 2018-079*, Washington: Board of Governors of the Federal Reserve System.
Gregor, J., & Melecký, M. (2018). The pass-through of monetary policy rate to lending rates: The role of macro-financial factors. *Economic Modelling, 73*, 71–88.
Gropp, R., & Heider, F. (2010). The determinants of bank capital structure. *Review of Finance, 14*(4), 587–622.
Hájek, J., Frait, J., & Plašil, M. (2017). The countercyclical capital buffer in the Czech Republic. *Thematic Article in the CNB Financial Stability Report, 2016*(2017), 106–114.
Hardy, D. C., & Nieto, M. J. (2011). Cross-border coordination of prudential supervision and deposit guarantees. *Journal of Financial Stability, 7*(3), 155–164.
Havranek, T., Irsova, Z., & Lesanovska, J. (2016). Bank efficiency and interest rate pass-through: Evidence from Czech loan products. *Economic Modelling, 54*, 153–169.
Heffernan, S. A. (2002). How do UK financial institutions really price their banking products? *Journal of Banking & Finance, 26*(10), 1997–2016.
Holub, L., Konecny, T., Pfeifer, L., & Vaclav, B. (2020). The cnb's approach to setting the countercyclical capital buffer. *Thematic Article on Financial Stability 3/2020*, Czech National Bank.
Horvath, R. (2009). The determinants of the interest rate margins of Czech banks. *Czech Journal of Economics and Finance (Finance a Uver), 59*(2), 128–136.
Horvath, R., Kotlebova, J., & Siranova, M. (2018). Interest rate pass-through in the euro area: Financial fragmentation, balance sheet policies and negative rates. *Journal of Financial Stability, 36*, 12–21.
Horvath, R., & Podpiera, A. (2012). Heterogeneity in bank pricing policies: The Czech evidence. *Economic Systems, 36*(1), 87–108.
Hristov, N., Hülsewig, O., & Wollmershäuser, T. (2014). The interest rate pass-through in the euro area during the global financial crisis. *Journal of Banking & Finance, 48*, 104–119.
Ioannidis, J., Stanley, T., & Doucouliagos, H. (2017). The power of bias in economics research. *The Economic Journal, 127*(605), F236–F265.
Islam, M. S., & Nishiyama, S.-I. (2016). The determinants of bank net interest margins: A panel evidence from south Asian countries. *Research in International Business and Finance, 37*, 501–514.
Junge, G., & Kugler, P. (2013). Quantifying the impact of higher capital requirements on the swiss economy. *Swiss Journal of Economics and Statistics, 149*(3), 313–356.
Kashyap, A. K., Stein, J. C., & Hanson, S. (2010). An analysis of the impact of 'substantially heightened' capital requirements on large financial institutions. *Booth School of Business, University of Chicago, Mimeo* **2**, 1–47.
Kim, D., & Sohn, W. (2017). The effect of bank capital on lending: Does liquidity matter? *Journal of Banking & Finance, 77*, 95–107.
King, M. R. (2010). Mapping capital and liquidity requirements to bank lending spreads. *Bis working paper no. 324*, Bank of International Settlements.
Klein, M. A. (1971). A theory of the banking firm. *Journal of Money, Credit and Banking, 3*(2), 205–218.
Kolcunova, D., & Malovana, S. (2019). The effect of higher capital requirements on bank lending: The capital surplus matters. *Cnb working papers 2/2019*, Czech National Bank.
Martin-Oliver, A., Ruano, S., Salas-Fumas, V. (2013). Banks' equity capital frictions, capital ratios, and interest rates: Evidence from Spanish banks. *International Journal of Central Banking, 9*(1), 183–225.
Martynova, N. (2015). Effect of bank capital requirements on economic growth: A survey. *Dnb working paper no. 467*, De Nederlandsche Bank.
Miles, D., Yang, J., & Marcheggiano, G. (2013). Optimal bank capital. *The Economic Journal, 123*(567), 1–37.
Modigliani, F., & Miller, M. H. (1958). The cost of capital, corporation finance and the theory of investment. *The American Economic Review, 48*(3), 261–297.
Myers, S. C. (1977). Determinants of corporate borrowing. *Journal of Financial Economics, 5*(2), 147–175.

di Patti, E. B., Moscatelli, M., & Pietrosanti, S. (2020). The impact of bank regulation on the cost of credit: Evidence from a discontinuity in capital requirements. *Mimeo*.
Pfeifer, L. (2021). The cnb's approach to setting the capital buffer for other systemically important institutions: Past and present. *Thematic Article on Financial Stability 2/2021*, Czech National Bank.
Plašil, M. (2019). The countercyclical capital buffer rate for covering the usual level of cyclical risks in the czech republic. *Thematic Article on Financial Stability 2/2019*, Czech National Bank.
Rizvi, N. U., Kashiramka, S., & Singh, S. (2018). Basel i to basel iii: Impact of credit risk and interest rate risk of banks in India. *Journal of Emerging Market Finance, 17*(1S), S83–S111.
Roodman, D., Nielsen, M. Ø., MacKinnon, J. G., & Webb, M. D. (2019). Fast and wild: Bootstrap inference in Stata using boottest. *The Stata Journal, 19*(1), 4–60.
Rousseas, S. (1985). A markup theory of bank loan rates. *Journal of Post Keynesian Economics, 8*(1), 135–144.
Santos, J. A., & Winton, A. (2019). Bank capital, borrower power, and loan rates. *The Review of Financial Studies, 32*(11), 4501–4541.
Skořepa, M., & Seidler, J. (2012). An additional capital requirement based on the domestic systemic importance of a bank. *Thematic Article in the CNB Financial Stability Report, 2012*(2013), 96–102.
Slovik, P., & Cournède, B. (2011). Macroeconomic impact of basel iii. *Oecd economics department working papers no. 844*, Organisation for Economic Co-operation and Development.
Sutorova, B., & Teplý, P. (2013). The impact of basel iii on lending rates of EU banks. *Czech Journal of Economics and Finance (Finance a Uver), 63*(3), 226–243.
Thakor, A. V. (2014). Bank capital and financial stability: An economic trade-off or a Faustian bargain? *Annual Review of Financial Economics, 6*(1), 185–223.
Van Leuvensteijn, M., Sørensen, C. K., Bikker, J. A., & Van Rixtel, A. A. (2013). Impact of bank competition on the interest rate pass-through in the euro area. *Applied Economics, 45*(11), 1359–1380.
Vogelsang, T. J. (2012). Heteroskedasticity, autocorrelation, and spatial correlation robust inference in linear panel models with fixed-effects. *Journal of Econometrics, 166*(2), 303–319.