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Basel III and SME bank finance in Germany

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Non-technical summary

Research Question

This paper examines how Basel III capital reforms affected bank lending to non-financial firms in Germany, with a focus on small and medium-sized enterprises (SMEs). Basel III may have particularly hampered the financing of SMEs, since bank lending is their most important source of external finance.

We focus on the increase of minimum risk-based capital requirements (RBC) and on the introduction of the leverage ratio (LR), which -in simple terms- corresponds to the unweighted capital ratio. We measure the impact on lending volumes, maturity and on collateralization. The analysis builds on the German component of a Financial Stability Board (FSB) evaluation project. The project investigated the impact of the Basel III reforms on SME finance and was published in 2019.

Contribution

We contribute to the literature on capital regulation impact studies. This is the first study assessing the impact of Basel III on SME lending in Germany using granular bank level data as well as data from the Bundesbank's credit registry. Since both regulations under consideration universally apply to all banks, we focus on the relative impact of the regulations by differentiating between the most affected banks and banks that had been affected only to a minor degree or not at all. Our definition of affectedness depends on banks' reform-specific capital strength in the year prior to the regulatory change. In the analysis, we exploit two supervisory datasets capturing two complementary segments of SMEs: first, a dataset at the bank level covering mostly very small enterprises, and second, a dataset at the bank-firm level covering small and particularly medium-sized enterprises.

The observed estimates can only be interpreted as a relative effect between both defined groups of banks. Hence, the empirical approach does not allow us to draw conclusions on aggregate lending.

Results

The results provide robust evidence that the announcement of RBC in 2011 significantly affected lending and collateralization of low capitalized banks. In contrast, the introduction of the LR exerted a rather limited impact on bank lending and collateralization.

The reaction to the RBC announcement depends on the bank's approach to determining risk weights - either the standardized approach (SA) or the internal ratings-based approach (IRBA). Low capitalized banks using the standardized approach significantly cut lending to non-financial firms, particularly to SMEs. By contrast, low capitalized IRBA banks did not adjust lending volumes, but significantly increased collateralization, particularly for loans to large companies. The reason why IRBA banks adjust collateral instead of lending volumes is probably the fact that there is a broader range of eligible collateral.

Nichttechnische Zusammenfassung

Fragestellung

Dieser Beitrag untersucht, wie die Basel-III-Eigenkapitalreformen die Kreditvergabe an nichtfinanzielle Unternehmen in Deutschland beeinflusst haben, und legt dabei einen Schwerpunkt auf kleine und mittelständische Unternehmen (KMU). Basel III kann insbesondere die Finanzierung von KMUs beeinträchtigt haben, da Bankkredite deren wichtigste Außenfinanzierungsquelle sind.

Wir fokussieren uns auf die Anhebung der risikogewichteten Mindesteigenkapitalanforderungen (RBC) sowie auf die Einführung der Verschuldungsquote (Leverage Ratio), die vereinfacht einer nicht gewichteten Eigenkapitalquote entspricht. Wir messen den Einfluss auf die Höhe der Kreditvergabe, Laufzeiten und Besicherung. Die Analyse baut auf dem deutschen Teil eines Evaluationsprojekts auf, das für den Finanzstabilitätsrat (Financial Stability Board, FSB) durchgeführt wurde. Es untersuchte den Einfluss der Basel III Reformen auf die Finanzierung von KMUs und wurde 2019 veröffentlicht.

Beitrag

Dieses Papier leistet einen Beitrag zur Literatur über Auswirkungsstudien zur Eigenkapitalregulierung. Es ist die erste Studie, die die Auswirkungen von Basel III auf die Kreditvergabe an KMUs in Deutschland untersucht. Da beide betrachteten Regulierungsmaßnahmen einheitlich für alle Banken gelten, betrachten wir den relativen Einfluss der Regeln, indem wir zwischen sehr stark betroffenen Banken und Banken, die kaum oder überhaupt nicht betroffen waren, unterscheiden. Dabei hängt die Einteilung in betroffene und nicht betroffene Banken davon ab, wie hoch die reformspezifische Kapitalisierung der Bank im Jahr vor der regulatorischen Änderung war. In unserer Analyse nutzen wir zwei Datensätze, die sich in ihrer Abdeckung in Bezug auf KMUs ergänzen: erstens einen Datensatz auf Bankebene, der hauptsächlich sehr kleine KMUs beinhaltet, und zweitens einen Datensatz auf Bank-Firmen-Ebene aus dem Kreditregister, der kleine und vor allem mittelgroße KMUs enthält.

Die Schätzergebnisse können als relativer Einfluss zwischen den definierten Bankengruppen interpretiert werden. Daher erlaubt der empirische Ansatz keine Rückschlüsse auf die aggregierte Kreditvergabe.

Ergebnisse

Die Ergebnisse zeigen robust, dass die Ankündigung der risikogewichteten Eigenkapitalmaßnahmen (RBC) im Jahr 2011 signifikant die Kreditvergabe und die Besicherung von Krediten gering kapitalisierter Banken beeinflusste. Demgegenüber wirkte sich die Einführung der Verschuldungsquote (LR) eher geringfügig auf Kreditvergabe und die Besicherung aus.

Wir finden, dass die Reaktion auf die Ankündigung der RBC von dem Ansatz der Bank zur Bestimmung der Risikogewichte abhängt, d.h. ob die Bank den Standardansatz (SA) oder einen internen rating-basierten Ansatz (IRBA) verwendet. Gering kapitalisierte Banken, die den Standardansatz nutzen, kürzten signifikant ihre Kreditvergabe an nicht finanzielle Unternehmen, insbesondere an KMUs. Hingegen passten schwach kapitalisierte IRBA-Banken die Höhe der Kreditvergabe nicht an, aber erhöhten signifikant die Besicherung, vor allem bei Krediten an große Unternehmen. Der Grund, warum IRBA Banken die Besicherung anstelle der Kreditmengen anpassen, dürfte wahrscheinlich die breitere Palette an anrechenbaren Sicherheiten sein.

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Basel III and SME Bank Finance in Germany *

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Abstract

This paper examines how Basel III capital reforms affected bank lending in Germany. We focus on the increase of minimum risk-based capital requirements and the introduction of the leverage ratio. The announcement of stricter risk-based capital regulation significantly affected low capitalized banks. The impact depends on a bank's credit risk model, i.e. whether a bank applies the standardized approach (SA) or an internal ratings-based approach (IRBA) to determine risk weights. Low capitalized SA banks significantly cut lending whereas IRBA banks did not adjust lending volumes. By contrast, low capitalized IRBA banks significantly increased collateralization while low capitalized SA banks adjusted collateralization only marginally.

Moreover, the impact on SMEs and large companies also differs. In terms of lending, SMEs were affected more strongly, whilst in terms of collateralization the impact on large companies was bigger. The announcement of the leverage ratio had, however, a rather limited impact. We find some evidence that low capitalized banks reduced lending. Furthermore, low capitalized banks somewhat tightened collateral requirements, especially for large companies.

Keywords: Basel III, bank lending, financial regulation, small and medium-sized enterprises (SMEs).

JEL classification: D22, E58, G21.

*Any views expressed are only those of the authors and do not necessarily represent the views of Deutsche Bundesbank or the Eurosystem. We would like to thank members of the FSB working group on "Evaluation of the effects of financial regulatory reforms on small and medium-sized enterprise (SME) financing", in particular Maddalena Galardo and Catherine Koch.

1 Introduction

The financial crisis of 2008 led to tremendous economic losses worldwide. As a reaction, the Basel III regulatory framework was approved some years later, with the aim of making banks more resilient and rendering future crises less likely and less costly. A key element of the Basel III reforms were stricter capital requirements. However, concerns have been raised that Basel III capital rules could lead to credit constraints for companies and thereby hinder economic growth. In the event that a bank has to react to increased capital requirements, they can improve their capital ratio either by raising equity or decreasing their assets, e.g. by reducing loan supply. Basel III may have particularly hampered the financing of small and medium-sized enterprises (SMEs) since bank lending is the most important source of external financing for SMEs (see FSB, 2019, p. 10). These issues are highly relevant from an economic perspective as SMEs usually generate a large fraction of value added and account for the majority of employees in the labour force (OECD, 2019; FSB, 2019).

This paper examines how Basel III capital rules affected bank lending in Germany. We investigate two components of Basel III capital rules: stricter risk-based capital regulation (RBC), i.e. equity over risk-weighted assets, as well as the introduction of the leverage ratio (LR) which is, simply speaking, equity over (non-risk-weighted) total assets. We measure the impact on lending growth, loan maturities and collateralization and distinguish between small and large companies.

We face several challenges in quantifying the impact of the Basel III rules. First, the rules were announced shortly after or amid fundamental economic changes, in particular the global financial crisis and the policy responses to it (e.g. unconventional monetary policy). These macroeconomic events may have a confounding effect. Second, the regulations under consideration universally apply to all banks. This setting does not allow a typical impact analysis between a treatment and a control group. To work around this, we focus on the relative impact of the regulation. We first identify the banks which had been most affected by the specific rule. Then, we analyze how the regulations affected lending of the most affected banks compared to lending of banks which had been affected only to a minor degree or not at all.

The German banking sector provides an ideal laboratory to investigate the impact of Basel III on bank lending to SMEs. The banking sector is very heterogenous. There are more than 1,600 banks differing in their business models and in the extent to which they have been affected by Basel III. Moreover, SMEs play an important role for overall economic growth and employment in Germany. In the analysis, we make use of two supervisory datasets: one dataset at the bank level and one at the bank-firm level. As shown in section 3, both datasets are complementary and reflect different SME size classes.

We find that the announcement of RBC significantly affected low capitalized banks. The reaction depends on a bank's credit risk model, i.e. whether a bank applies the standardized approach (SA) or an internal ratings based approach (IRBA) to determine risk weights. Low capitalized SA banks significantly cut lending whereas IRBA banks did not adjust lending volumes. By contrast, low capitalized IRBA banks significantly increased collateralization while low capitalized SA banks adjusted collateralization only marginally. Moreover, the impact on SMEs and large companies also differs. In terms of lending, SMEs were affected somewhat more strongly, whilst in terms of collateralization

the impact on large companies was bigger.

The announcement of the leverage ratio had, however, a rather limited impact. We find some evidence that low capitalized banks reduced lending, in particular long-term lending. Furthermore, low capitalized banks tightened collateral requirements somewhat, especially for large companies.

This paper builds on the German component for a FSB evaluation project looking into the impact of Basel III reforms on SME finance, which was carried out in the G20 countries (FSB, 2019). Only aggregate results were published. The evaluation provides "some evidence that the more stringent risk-based capital requirements slowed the pace and in some jurisdictions tightened the conditions of SME lending at those banks that were least capitalized". The impact varies across jurisdictions and is found to be of a rather temporary nature. Furthermore, the evaluation does not find robust effects of other capital and liqudity reforms on SME lending. The findings for Germany are mostly in line with the international evidence.

The paper is structured as follows. In section 2, we provide a literature review on SME financing in general and the impact of capital regulation on lending. In section 3, we discuss data and the empirical approach. Section 4 contains the empirical output, and section 5 concludes.

2 Literature Review

Access to finance is considered the major constraint on enterprises' ability to grow (Ayyagari, Demirgüç-Kunt, and Maksimovic, 2008). For SMEs, bank lending is particularly important as bank loans are the main source of external finance for small firms (Beck, Demirgüç-Kunt, Laeven, and Levine, 2008). In this context, Ayyagari, Demirgüç-Kunt, and Maksimovic (2017) show that smaller firms face higher barriers to accessing external finance than larger and established firms. As outlined by Rostamkalaei and Freel (2016), these barriers are based on several obstacles such as information asymmetries, scarcity of collateralizable assets, or high monitoring costs translating into credit rationing or higher risk premiums for the borrower.

According to Berger and Udell (1998), the access to finance for an enterprise may be characterized by a financial growth cycle. In early years, young firms face financial constraints (see Angelini and Generale, 2008). Thus, these firms rely more strongly on internal sources such as private wealth. With increasing age and size, a firm may build up experience or expand in its base of collateralizable assets, leading to an improved access to finance (see e.g. Beck and Demirgüç-Kunt, 2006; Ferrando and Griesshaber, 2011). Furthermore, long-lasting relationships between firms and credit institutions may facilitate SMEs' access to finance. As outlined by Uzzi and Lancaster (2003), the credit eligibility process relies on two complementary channels. On the one hand, there is "hard", public, and verifiable information such as balance sheet information or audited financial statements. Banks relying more on hard information may either grant less credit to smaller and opaque firms (Ferri and Murro, 2015; Berger, Miller, Petersen, Rajan, and Stein, 2005) or may apply stricter contract features such as demand for collateral or shorter maturities (Beck, Ioannidou, and Schäfer, 2017). On the other hand, "soft" and private information may not be objectively verified by third parties. The consideration of soft information also rests on trust and, thus, on the relationship between both contract parties. Bartoli,

Ferri, Murro, and Rotondi (2013) empirically show that long relationships may facilitate the availability of financial funding for SME, while Petersen and Rajan (1994) do not find any evidence for price effect.

Credit access of firms also depends on the credit supply of banks. Theoretically, banks can react to higher capital requirements either by raising capital or by reducing the asset side of their balance sheet. The latter may be achieved by scaling back loan origination to firms and/or households. On the one hand, the empirical literature provides strong evidence that higher capital requirements are likely to lead to a reduction in short-term loan issuance (see e.g. Peek and Rosengren, 1995; Behn, Haselmann, and Wachtel, 2016; Gropp, Mosk, Ongena, and Wix, 2018). On the other hand, long-term effects of increased capital requirements on firm lending are much more difficult to assess.

Many studies are based on structural models, which provide ambiguous evidence. In a DSGE framework with a banking sector, Gerali, Neri, Sessa, and Signoretti (2010) show that loans to firms experience a persistent decline when banks increase their capital position. In contrast, the model by Hristov and Hülsewig (2017) reveals that firm lending is not affected in the long run under the same scenario. Among the empirical studies assessing the long-run effects on aggregate lending, Eickmeier, Kolb, and Prieto (2018) find that higher capital requirements in the United States do not induce a long-run reduction of bank lending. The key mechanism behind this result might be that better capitalized banks tend to be more robust, which in turn has a positive impact on the real economy (see Gambacorta and Shin, 2018). Further, Jiménez, Ongena, Peydró, and Saurina (2017) also show that procyclical capital requirements strengthen the non-financial sector in crises by mitigating credit supply cycles, with strong effects in terms of employment, credit, and firm survival. A contrary position is taken by Calomiris (2013) who argues that higher capital requirements would permanently reduce loan supply.

There are also some papers investigating the impact of macroprudential regulation on lending and collateralization. Ayyagari, Beck, and Peria (2018) show that smaller firms as well as smaller banks experience lower credit growth as a reaction to macroprudential policies. Fišera, Horvath, and Meleckỳ (2019) obtain similar results when assessing the impact of the implementation of Basel III on SME lending. Degryse, Karapetyan, and Karmakar (2021) find that banks facing stricter capital requirements require loans to be collateralized more often. Similarly, Mayordomo, Moreno, Ongena, and Rodriguez-Moreno (2021) document that stricter capital requirements increased the usuage of loan guarantees.

3 Data & Empirical Strategy

3.1 SME Definition and Data

There is significant heterogeneity across countries in terms of SME definitions. We refer to a widely used definition stemming from the European Commission (European Commission, 2003). Accordingly, an enterprise is classified as being an SME, if it fulfils the following criteria: first, it does not have more than 249 employees. Second, its annual turnover does not exceed EUR 50 million. And third, its balance sheet total is less than EUR 43 million.

In order to analyze the impact of the Basel III reforms on SME lending, a combination

of different types of information is necessary, in particular data on bank lending by firm size classes, regulatory information and bank balance sheet information. We employ various data sources of the Deutsche Bundesbank but, unfortunately, none of the sources contains explicit information on the size of corporate borrowers for the period since the introduction of Basel III. Instead, we use different proxies for SME lending depending on the data source. We conduct the analysis on two aggregation levels, at bank level as well at bank-firm level.

i) *Bank level analysis*

For the analysis of the Basel III reforms on bank lending, we combine information from three bank level datasets: firstly the monthly balance sheet statistics (BISTA) including the loan portfolio of banks operating in Germany (see Beier, Krüger, and Schäfer, 2017), secondly the profit and loss statistics (GuV) capturing the profitability of banks (see Stahl and Rauth, 2021) and, thirdly information from the Bundesbank's prudential database (BAKIS) covering supervisory information (see Memmel and Stein, 2008). The final dataset includes private banks, the small regional savings and cooperative banks as well as their central institutions (overall 1,600 banks).

As mentioned above, the Bundesbank's data do not allow us to identify SME lending explicitly. We proxy SME lending by the amount of outstanding loans to self-employed individuals provided by the BISTA database. Thus, the proxy for SME lending captures micro firms, a particular segment of SMEs.

ii) *Bank-firm level analysis*

The second part of the analysis is based on bank-firm level data obtained from the Bundesbank's credit register called MiMiK. This database contains single exposures of banks located in Germany. Banks are required to report if their exposures to an individual borrower or the sum of exposures to a borrower unit (e.g. group) exceed the threshold of EUR 1 million[1] once in the respective quarter (see Schmieder, 2006, p. 656). However, a large portion of exposures in the database is below EUR 1 million, due, for example, to the fact that the threshold is applied at the group level of enterprises.

The MiMiK database contains various kinds of information on the borrower, e.g. its location and sector, but no information on firm size in terms of employment, sales or total assets. Therefore, loans to SMEs are approximated by the total exposure of banks. According to aggregate firm balance sheet information for non-financial SMEs (Deutsche Bundesbank, 2019), total bank loans amount on average to 15.7% of annual sales.[2] The European Commission threshold for total sales of EUR 50 million thus corresponds to a total bank loan exposure of EUR 7.9 million. Therefore, we will consider firms below this loan threshold as SMEs.

As table 1 shows, the bank-firm level dataset contains a large number of firms from all size classes. However, due to the high reporting threshold, small firms and in particular micro firms may not be representative for the universe of German firms. Hence, the two datasets - the bank level data and the bank-firm level data - complement each other. SME loans obtained from bank level data are biased towards smaller SMEs, whereas larger SMEs are overrepresented in the MiMiK database.

We augment the MiMiK database by incorporating information on banks' balance sheets (BISTA), profit and loss statistics (GuV) and banks' supervisory information

[1] Before 2014, the threshold for total loans exposure was EUR 1.5 million.

[2] Average calculated for SMEs from 2010 to 2017.

Table 1: **Composition of MiMiK Sample by Firms Size**

Firm Size	SME			Large
	Micro	Small	Medium-sized	
Turnover (EUR million)	≤ 2	> 2 and ≤ 10	> 10 and ≤ 50	> 50
Equivalent total bank loans (EUR million)	≤ 0.316	> 0.316 and ≤ 1.58	> 1.58 and ≤ 7.9	> 7.9
Number of firms	62,290	64,274	61,909	23,006
Number of bank-firm-year observations	289,520	349,567	499,762	486,963
Median of total bank loans (EUR million)	0.05	0.89	2.91	15.68

(BAKIS).

3.2 Empirical Strategy

We use a difference-in-difference approach to estimate the impact of the Basel III reforms. In a standard difference-in-difference framework, banks would be allocated to two groups, one group of banks affected by the reforms (treatment group) and one group of not affected ones (control group). In our setting, there is no clear-cut definition of treatment and control group of banks since the regulatory reforms considered in this analysis apply to all banks in Germany. However, banks are likely to be affected by the reforms to a different extent depending on their capital strength before the reform. This means, credit supply from less capitalized banks is more likely to be constrained by increased capital requirements than the credit supply from high capitalized banks. Our identification strategy is thus based on the relative capital position of banks.

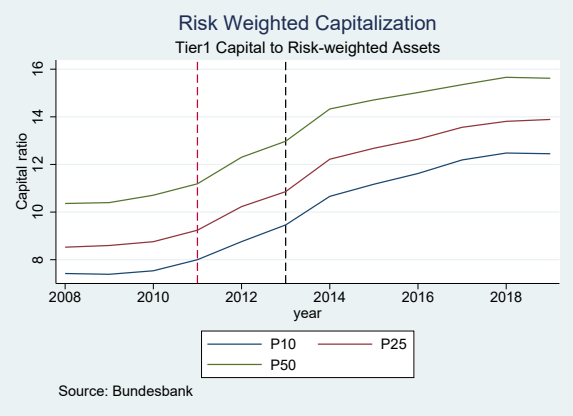
We derive a bank's exposure to a regulatory change from its reform-specific regulatory position. The exposure to risk-based capital requirements (RBC) is based on a bank's Tier 1 risk-weighted capital ratio. The exposure to the leverage ratio is based on a bank's leverage ratio (fully phased-in definition). Since information on individual leverage ratios has only been available since 2014, we proxy the leverage ratio by the ratio of Tier 1 capital over total assets as well.

We transform each exposure measure into a dummy variable, $ExpReg_b$. This dummy variable takes the value of one if the corresponding regulatory position of bank b is located in the lowest decile ($x<P10$) of the sample of all banks. In order to avoid endogeneity issues, the exposure measure is determined one year prior to the regulatory change. The exposure measure for bank b is time-invariant and does not change over the entire sample period. We carry out robustness tests where we vary the threshold and classify banks belonging to the lowest quartile ($x<P25$) as being exposed.

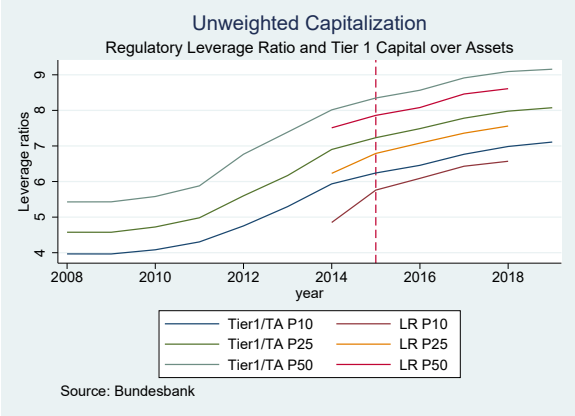
Banks may adjust to reforms at different implementation stages of the reforms, for instance, when reforms are announced, or when details on the legal framework are published, or after the phase-in period expires. Our post-reform period starts with the national announcement as an early implementation stage. We observe the effect on banks until the end of the sample to capture later reactions as well. The introduction of RBC was an-

nounced in Germany in the first quarter of 2011 and legally implemented in the second quarter of 2013. The introduction of the leverage ratio was announced and legally implemented in the second quarter of 2015. We limit the period of the effect to a maximum of six years.

Figure 1: Distribution of capital ratios over time



Risk-based Capital



Leverage Ratio

Figure 1 illustrates how the capitalization of banks at the lower half of the distribution developed over time, namely the 10th and 25th percentile as well as the median value. The left graph captures the development of the Tier 1 capital to risk-weighted asset ratio, whereas the right graph represents the development of the ratio of Tier 1 capital to total assets. Both measures show a similar trend, that banks have substantially improved risk-weighted and unweighted capital ratios since 2010. This development is not only restricted to low capitalized banks, but also to banks with a capital ratio in the middle of the corresponding distribution.

In the analysis, we assess the impact of the capital regulation reforms on bank lending to non-financial firms with a focus on SMEs. We investigate, in both samples, how capital regulation affected lending growth and, depending on the sample, different lending conditions.

We also control for a bank's credit risk model by looking at subsamples of banks defined by their model choice. The risk weight underlying the minimum capital requirements depends on the type of credit risk model, i.e. whether a bank applies the standardized approach (SA) or an internal ratings based model (IRBA) to measure credit risk. Moreover, IRBA gives banks more room to reduce credit risk by using collateral. While SA banks can only use collateral in the form of financial assets and guarantees to mitigate credit risk, the range of eligible collateral is much broader for IRBA banks. In addition to financial assets and guarantees, IRBA banks can also use real estate claims or physical collateral (see Arbeitskreis Basel II, 2005). Finally, SA banks are often small banks whereas IRBA banks are typically large and international active institutes.

i) *Bank level analysis*

We look at the growth rate of outstanding loans to the non-financial sector as well as to SMEs. Further, we also examine how the maturity of outstanding SME loans developed by investigating the impact on short-term and long-term loans. We classify short-term loans as loans with a maturity of up to one year, while long-term loans are defined as

those with a maturity of more than one year.

We use the following baseline specification:

$$\Delta y_{b,r,t} = \alpha_b + \alpha_{r*t} + \sum_{t=\tau}^{T} \beta_t Ann_t * ExpReg_b + \gamma CBank_{b,t-1} + \epsilon_{b,r,t} \quad (1)$$

where $\Delta y_{b,t}$ is the outcome variable of bank b, the growth rate of outstanding corporate loans. As described earlier, we consider loans to the entire non-financial sector, loans to SMEs, and the maturity-based distinction of SME loans. The regression measures the impact of the reform on bank lending for each period after the regulatory change, ranging from the date of the regulatory change τ until the end of the sample T (or a maximum period of six years, namely τ+6). The time indicator is represented by a dummy variable, Ann_t, defined by the time since annoucement of the corresponding reform. Each time indicator is interacted with the bank-specific exposure measure, $ExpReg_b$, indicating whether bank b is exposed to the corresponding regulatory change.

Moreover, we control for the characteristics of bank b by means of bank fixed effects, α_b, and a set of covariates $CBank_{b,t-1}$ measured in period $t-1$. This set includes bank size measured by log total assets and the loan-to-asset ratio as well as the deposit-to-asset ratio to capture a bank's business model. Further, we include return on equity (ROE) and the ratio of total costs to revenue to measure profitability. A bank's risk profile and capitalization are measured by the share of non-performing loans, its liquidity ratio and the Tier 1 capital ratio (see table A1 for the descriptive statistics of the variables included in the analysis). In order to control for changes in regional demand, the model is enriched by fixed effects for year-by-NUTS-3-region, α_{r*t}, with respect to the banks' headquarters. Due to the bank fixed effects and region-times-year fixed effects, the specification can include neither isolated time dummies, Ann_t, nor the standalone exposure dummy, $ExpReg_b$.

In specification (1), the impact of the regulatory change on the growth rate of outstanding loans is estimated for each period, ranging from the date of the regulatory change τ until the end of the sample T. The cumulative effect of the regulation is obtained by the sum of coefficients between period τ and t. The corresponding standard error is calculated by means of the delta method, accounting for the variance-covariance-matrix of the corresponding covariates (see e.g. Greene, 2012). Such a specification allows us to analyze whether exposed banks adjusted their portfolio, and whether the observed effect is either temporary or permanent.

ii) *Bank-firm level analysis*

When turning to the bank-firm level analysis, we look at three different loan growth rates: the growth rate of loans to all non-financial companies, of loans to SMEs and thirdly of loans to large (non-SME) firms.

We apply the following specification which is very close to specification (1):

$$\Delta y_{b,f,t} = \alpha_{b*f} + \alpha_{t*sector} + \sum_{t=\tau}^{T} \beta_t Ann_t * ExpReg_b + \gamma CBank_{b,t-1} + \epsilon_{b,f,t} \quad (2)$$

where $\Delta y_{b,f,t}$ is the growth rate of bank b's outstanding loans to firm f at time t.

Furthermore, we also investigate the impact of capital regulation on the share of

collateralization. The corresponding equation is estimated in levels:

$$y_{b,f,t} = \alpha_{b*f} + \alpha_{t*sector} + \sum_{t=\tau}^{T} \beta_t Ann_t * ExpReg_b + \gamma CBank_{b,t-1} + \epsilon_{b,f,t} \quad (3)$$

The dependent variable is, here, the share of collateralization of bank b's outstanding loans to firm f at time t. In equations (2) and (3), the key variable of interest, the interaction between the time span since the year of the announcement, Ann_t, and the exposure measure of bank b, $ExpReg_b$, as well as the set of bank controls are defined and calculated as in specification (1). Given the dimensional difference, equations (2) and (3) contain fixed effects at the bank-firm level, α_{b*f}, in order to account for unobservable bank-firm heterogeneity. We do consider neither bank-time nor firm-time fixed effects. This procedure enables us to include firms with only one bank relationship, which is highly common among SMEs. Without this approach, our sample size would be significantly smaller. In order to account for demand effects with barely any loss of observation, both equations contain sector-times-year fixed effects, $\alpha_{t*sector}$.

4 Results

4.1 Risk-based capital ratio (RBC)

The stricter minimum RBC requirements were announced in Germany in 2011. We therefore use the risk-weighted capital ratio one year prior, i.e. in 2010, to measure whether a bank was affected by the regulatory change.

Bank level results

In our baseline specification, banks whose risk-weighted capital ratio is in the lowest decile (P10) in 2010 are classified as affected (see table 2). In table A2, we ease this restriction and the exposure measure is then defined by the lowest quartile (P25) of the risk-weighted capital ratio in 2010. Each table captures the regressions for the entire sample in the left panel and the results for the sample of banks using the standardized approach in the right panel.

For each sample, we run regressions on the annual growth rate of outstanding loans to the non-financial corporate sector with respect to four specficiations. In the first specification, we report the estimates for the entire non-financial sector, whereas the second specification captures lending to SMEs, given by outstanding loans to self-employed individuals. The maturity of outstanding loans to SMEs is considered in the third and fourth specification, with the former capturing loans with a maturity up to one year, while the latter contains the growth rate of loans to SMEs with a maturity of more than one year.

As outlined in equation (1), the key explanatory variables are the interaction terms between the dummy variable, whether bank b is exposed to a regulatory change, ExpReg_b, and time indicators for each period, ranging from the date of announcement τ up to six years after the regulatory change, Ann_t. Since the impact of a regulatory change may span the period of investigation, we report the cumulative effects described above in the lower part of the regression output.

Table 2: **Impact of Higher Minimum Risk-based Capital Requirements (RBC) on Outstanding Loans to SMEs and Non-financial firms (Bank Level Data)**
Banks exposed to RBC are defined as banks with a risk-weighted capital ratio below P10 in the period prior to the announcement

Banks (credit risk model)	All Banks				Standardized Approach			
Firms	CORP	SME	SME	SME	CORP	SME	SME	SME
Maturity	All	All	Short-term	Long-term	All	All	Short-term	Long-term
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ExpReg_b * Ann_τ	0.087	-1.421	-4.676*	-1.427	0.417	-1.196	-4.817*	-1.271
	(1.140)	(1.189)	(2.727)	(1.236)	(1.104)	(1.158)	(2.795)	(1.215)
ExpReg_b * $Ann_{\tau+1}$	-1.586	-1.000	-2.827	-0.543	-2.148**	-1.781	-3.721	-1.602
	(1.086)	(1.216)	(2.292)	(1.255)	(1.016)	(1.109)	(2.280)	(1.131)
ExpReg_b * $Ann_{\tau+2}$	-0.495	-1.242	0.586	-1.076	-0.694	-1.347	0.185	-1.036
	(0.876)	(1.021)	(2.336)	(1.099)	(0.898)	(1.063)	(2.374)	(1.139)
ExpReg_b * $Ann_{\tau+3}$	0.043	-1.674	-1.147	-2.524*	0.109	-1.734	-0.968	-2.913**
	(1.170)	(1.116)	(2.498)	(1.357)	(1.176)	(1.177)	(2.580)	(1.393)
ExpReg_b * $Ann_{\tau+4}$	-1.942*	-0.897	0.270	-0.737	-2.174**	-1.109	0.134	-1.062
	(0.992)	(1.532)	(2.481)	(1.581)	(1.043)	(1.585)	(2.559)	(1.619)
ExpReg_b * $Ann_{\tau+5}$	-0.265	-0.261	1.586	-0.082	-0.591	-0.310	1.358	-0.104
	(1.263)	(1.784)	(2.964)	(1.831)	(1.286)	(1.805)	(3.064)	(1.885)
ExpReg_b * $Ann_{\tau+6}$	0.763	-1.396	0.826	-0.302	0.757	-1.308	1.930	-0.492
	(1.461)	(1.679)	(3.260)	(1.802)	(1.498)	(1.719)	(3.295)	(1.871)
$\ln(\text{Total assets})_{t-1}$	-11.695***	-11.674***	-13.152***	-12.092***	-11.280***	-11.520***	-13.825***	-12.010***
	(1.894)	(2.158)	(2.467)	(2.351)	(1.931)	(2.190)	(2.538)	(2.421)
$\text{Loan-to-asset ratio}_{t-1}$	-0.179**	-0.086	-0.104	-0.043	-0.184**	-0.083	-0.101	-0.048
	(0.082)	(0.070)	(0.090)	(0.077)	(0.087)	(0.073)	(0.094)	(0.082)
$\text{Deposit-to-asset ratio}_{t-1}$	-0.123*	-0.136**	-0.127	-0.163**	-0.094	-0.138*	-0.173*	-0.161**
	(0.073)	(0.066)	(0.090)	(0.069)	(0.072)	(0.072)	(0.092)	(0.074)
TIER1 ratio_{t-1}	0.041	0.043	-0.005	0.051	0.077	0.030	0.009	0.054
	(0.110)	(0.114)	(0.114)	(0.120)	(0.114)	(0.119)	(0.120)	(0.129)
$\text{Liquidity ratio}_{t-1}$	0.053	0.022	-0.038	0.048	0.049	0.026	-0.049	0.043
	(0.048)	(0.047)	(0.069)	(0.056)	(0.049)	(0.046)	(0.069)	(0.055)
NPL ratio_{t-1}	-0.394***	-0.294**	-0.450**	-0.174	-0.411***	-0.328**	-0.506**	-0.201
	(0.133)	(0.142)	(0.204)	(0.171)	(0.136)	(0.146)	(0.211)	(0.176)
$\text{Return on equity}_{t-1}$	-0.072	-0.058	0.045	-0.117	-0.019	-0.060	0.096	-0.134
	(0.094)	(0.100)	(0.121)	(0.101)	(0.095)	(0.104)	(0.129)	(0.107)
$\text{Cost over income}_{t-1}$	-0.084	-0.167*	-0.102	-0.193**	-0.046	-0.163	-0.072	-0.197**
	(0.093)	(0.093)	(0.101)	(0.091)	(0.098)	(0.100)	(0.113)	(0.099)
Observations	16,466	16,466	16,466	16,466	16,162	16,162	16,162	16,162
R-squared	0.387	0.391	0.291	0.376	0.395	0.392	0.298	0.376
Number of banks	1660	1660	1660	1660	1632	1632	1632	1632
Cumulative effect on exposed banks since year of regulatory change in 2011								
0 years (2011)	0.087	-1.421	-4.676*	-1.427	0.417	-1.196	-4.817*	-1.271
	(1.140)	(1.189)	(2.727)	(1.236)	(1.104)	(1.158)	(2.795)	(1.215)
1 year (2012)	-1.500	-2.421	-7.504*	-1.970	-1.730	-2.977	-8.539**	-2.873
	(1.854)	(1.966)	(3.997)	(2.007)	(1.802)	(1.875)	(4.065)	(1.914)
2 years (2013)	-1.995	-3.663	-6.917	-3.046	-2.425	-4.324*	-8.354*	-3.909
	(2.451)	(2.606)	(4.916)	(2.609)	(2.410)	(2.547)	(5.038)	(2.577)
3 years (2014)	-1.952	-5.337*	-8.065	-5.570*	-2.315	-6.058*	-9.322	-6.822**
	(3.214)	(3.179)	(6.365)	(3.336)	(3.167)	(3.161)	(6.528)	(3.356)
4 years (2015)	-3.894	-6.233	-7.794	-6.308	-4.490	-7.167*	-9.188	-7.884*
	(3.863)	(4.185)	(7.526)	(4.245)	(3.829)	(4.235)	(7.763)	(4.329)
5 years (2016)	-4.159	-6.494	-6.209	-6.390	-5.081	-7.477	-7.830	-7.988
	(4.63)	(5.325)	(8.818)	(5.338)	(4.586)	(5.404)	(9.184)	(5.454)
6 years (2017)	-3.397	-7.890	-5.382	-6.691	-4.324	-8.785	-5.900	-8.480
	(5.304)	(6.310)	(10.623)	(6.243)	(5.303)	(6.437)	(11.008)	(6.426)

Notes: The table shows difference-in-difference estimates of the announcement of stricter RBC requirements. Dependent variable: annual growth rate of outstanding loans to non-financial firms (CORP) and SMEs (SME). Short-term loans are loans with a maturity up to one year. Long-term loans are loans with a maturity of more than one year. Period of investigation: 2010-2019. Key explanatory variables are the exposure dummy, ExpReg_b, multiplied by a set of time dummy variables, Ann_τ, $\text{Ann}_{\tau+1}$, ..., $\text{Ann}_{\tau+6}$ where τ represents the year of the reform (2011). ExpReg_b captures whether a bank's risk-weighted capital ratio was below P10 in the year prior to the regulatory change, namely 2010. The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the banks level and for region times year. Cumulative effect: coefficient represents the sum of the estimated coefficients between the year of regulatory change and a given year afterwards. The corresponding variance is derived by means of the delta method. Clustered standard errors at the bank level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. *Source:* BISTA and BAKIS, own calculations.

Table 2 shows the impact of the RBC announcement on the SME lending of banks with a risk-weighted capital ratio in the lowest decile (P10) in 2010. For the entire sample, the vast majority of annual estimates are insignificant. Only a few estimates are significant at a level of 10%. These comprise the coefficients on lending to the non-financial sector four years after the announcement (-1.9 percentage points - ppts), short-term lending to SME in the year of the regulatory change (-4.7 ppts) and long-term lending to SMEs three years after the announcement of RBC (-2.5 ppts). For banks using the standardized approach to measure risk weights, the results are slightly more pronounced in the magnitude. The impact on the growth rate of outstanding loans to the non-financial sector exceeds -2 ppts twice, one and four years after the announcement, at a 5% significance level. The contemporaneous effect on short-term loans rises slightly to -4.8 ppts, but the significance level remains at 10%. The effect on SME long term loans three years after the reform increases in its magnitude to -2.9 ppts at a 5% significance level. All other estimates remain insignificant.

The calculation of cumulative effects allows us to test whether effects of regulatory changes on bank lending require some time to develop a significant impact, and whether the effect is of a temporary or a permanent nature. For both samples, we do not observe any significant effect on lending to the entire non-financial sector. For SME lending, the results for the whole sample suggests, that low capitalized banks significantly reduced their lending to SMEs by more than 5 ppts three years after the announcement of the RBC reform. For the banks using the standardized approach, we observe a significant impact for the period between two (-4.3 ppts) and four (-7.2 ppts) years after the announcement. For both samples, the effects are significant at a 10% level.

Furthermore, we observe a distinction with respect to maturity. On the one hand, short-term lending to SMEs went down immediately after the announcement by almost 5 ppts. This effect is statistically significant at a 10% level for both samples. For the whole sample, the effect rises to -7.5 ppts at a 10% significance level one year after the announcement and turns insignificant afterwards. For the sample of banks using the standardized approach, the magnitude of the effect rises to -8.5 ppts in the two years after the announcement and turns insignificant afterwards. Thus, we may conclude that short-term lending to SME by low capitalized banks is reduced temporarily after the announcement of the RBC reform. On the other hand, the estimates report a significant effect on long-term lending, which requires three years to unfold. The decline reaches 6.8 ppts at a 5% significance level for banks using the standardized approach, while the estimates for the entire sample report a decline of 5.6 ppts for a significance level of 10%. For the latter the effect becomes insignificant directly afterwards. For banks using the standardized approach, the effect rises to -7.9 ppts at a significance level of 10% four years after the regulatory change. Afterwards, the effect of the RBC announcement on SME long-term lending turns insignificant. This delayed effect is not surprising, since long-term outstanding loans adjust more slowly than short-term loans.

To sum up, we may conclude that banks with a risk-weighted capital ratio in the lowest decile in 2010 reacted to the announcement of the RBC by reducing loans to SMEs, whereas lending to the entire non-financial sector remained unaffected. Furthermore, we find that short-term SME loans were reduced more strongly and in a more timely fashion than long-term lending.

In table A2, we report the regression output capturing the impact of the RBC an-

nouncement on lending of banks with a risk-weighted capital ratio in the lowest quartile (P25) in 2010. For the entire sample, as well as for the sample of banks using the standardized approach, the vast majority of annual estimates are insignificant. The only significant effect can be observed for the period six years after the regulatory change. This effect is significantly positive for each specification except for SME short-term loans for the entire bank sample.

When turning to the cumulative effects, the lower part of table A2 does not report a significant effect holding for six years or more. Thus, the significant estimates for the standalone term six years after the regulatory change do not affect the cumulative estimates. The only cumulative effect which is signficant can be observed for short-term loans one year after the reform. For the sample of all banks as well as for the sample of banks using the standardized approach, the estimate suggests that short-term lending declines by 4.8 ppts one year after the regulatory change at a significance level of 10%. Afterwards, the effect turns insignificant.

Thus, we may conclude that the definition of a bank's exposure to the RBC reform clearly matters, when assessing the impact of the reform on SME lending. Our results show that banks with a risk-weighted capital ratio in the lowest decile prior to the regulatory change reduced their lending activities to SMEs. A broader definition for the exposure does not confirm these results, suggesting that banks with a risk-based capital ratio in the lowest decile are those reacting most sensitively to the RBC announcement.

Bank-firm level results

We now turn to the results at the bank-firm level. We first carry out the regressions for all banks and then split the sample into banks using the standardized approach (SA) and banks using the IRB approach (IRBA) to determine risk weights. At the bank level, the IRBA banks account for less than 2% of the banks in the sample, whereas these banks account for more than 30% of the observations of credit relations. Thus, separate regressions for the sample of IRBA-banks at the bank-firm level clearly provide more insights than regressions at the bank level. Moreover, we show results for all firms as well as separate results for SMEs and large firms.

As table 3 shows, the announcement of RBC significantly slowed down lending growth of low capitalized SA banks (column (4)) whereas it did not affect lending of either IRBA banks (column (7)) or of all banks, i.e. IRBA and SA together (column (1)). SA banks with a risk-based capitalization below P10 prior to the announcement significantly cut lending in nearly all years of our sample period. The total impact amounts to around 8 ppts three years after the announcement and finally sums up to around 17 ppts six years after the announcement. There is also some evidence that SA banks with a risk-based capitalization below P25 decreased lending after the RBC announcement (see table 3). However, the impact is considerably smaller than for banks below P10 capitalization and only significant in some years.

Lending of SA banks to SMEs went down somewhat more strongly than for large firms. While the total impact amounts to 9 ppts for SMEs three years after the RBC announcement, the total effect is around 7 ppts for large companies. In particular, the impact for SMEs is statistically significant in most years of the sample (both for single years in the upper part of the table as well as for the cumulative impact). The impact for large companies is, however, mostly insignificant. Our results above at the bank level

also suggested that the impact on SMEs is larger than for large companies. However, the impact which we now find for SMEs is more than twice as large than the previous figures. While the bank-firm level data predominantly contain larger SMEs, the bank level data focus on the very small companies.

Table 4 shows the impact of the change in RBC on collateralization. The coefficient of each interaction term now reflects the aggregate change in collateralization up to the specific year, i.e. in contrast to the regressions on lending volumes, the results now already reflect the cumulative impact.

In contrast to the results on lending growth, it is now the IRBA banks which are strongly affected. The RBC announcement significantly increased collateralization at very low capitalized IRBA banks (with a risk-based capitalization below P10 prior to the announcement) from 2012 on (column (7)). The total impact amounts to 7 ppts in 2012 and continues to rise until six years after the announcement, accumulating to 17 ppts. IRBA banks with a capitalization in the lowest quartile prior to the announcement are somewhat less, but still considerably, affected. The change in collateralization amounts to 8 ppts six years after the announcement (see table column (7)). Affected IRBA banks seem to have tightened lending conditions more strongly with respect to large firms. The change in collateralization is somewhat more pronounced for large firms (e.g. 19 ppts five years after the announcement) than for SMEs (15 ppts).

However, with respect to SA banks, we do not find any robust evidence of the RBC announcement affecting collateralization. While the coefficients are statistically significant in some cases, the coefficients are very small and - in economic terms - not relevant (see columns (4) - (6)). Moreover, the impact for all banks is also rather modest and reaches its maximum of 2.4 ppts after 4 years (columns (1) - (3)).

To sum up, the RBC announcement had a quite different impact on SA and IRBA banks: while low capitalized SA banks cut their lending, low capitalized IRBA banks increased their collateralization. Since banks can use the collateral in the event of loan losses, a higher collateralization decreases risk weights for assets and thereby improves the Tier 1 risk-weighted capital ratio. For IRBA banks, more types of assets are recognized as collateral for credit risk reduction.

Table 3: **Impact of Higher Minimum Risk-based Capital Requirements (RBC) on Outstanding Loans to Firms (Bank-Firm Level Data)**
Banks exposed to RBC are defined as banks with a risk-weighted capital ratio below P10 in the period prior to the announcement

Banks	All			Standardized approach			IRBA		
Firms	All	SME	LARGE	All	SME	LARGE	All	SME	LARGE
Threshold		P10			P10			P10	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$ExpReg_b$*Ann_τ	-0.470	0.241	-1.820	-1.555*	-1.408	-2.415*	0.656	0.580	0.423
	(0.913)	(1.125)	(1.458)	(0.916)	(1.131)	(1.453)	(1.338)	(1.856)	(1.933)
$ExpReg_b$*$Ann_{\tau+1}$	-1.184	-1.567	0.153	-2.947***	-3.795***	-0.380	0.0815	2.036	-3.004
	(0.864)	(1.066)	(1.395)	(0.879)	(1.087)	(1.397)	(1.308)	(1.823)	(1.892)
$ExpReg_b$*$Ann_{\tau+2}$	1.891**	2.301**	0.846	-1.400	-1.118	-2.431	-1.191	-1.317	-1.596
	(0.890)	(1.093)	(1.456)	(0.910)	(1.115)	(1.498)	(1.389)	(1.940)	(2.034)
$ExpReg_b$*$Ann_{\tau+3}$	-0.727	-0.317	-1.564	-2.588***	-2.830**	-2.076	1.484	2.381	-0.241
	(0.890)	(1.086)	(1.504)	(0.914)	(1.113)	(1.553)	(1.454)	(1.926)	(2.273)
$ExpReg_b$*$Ann_{\tau+4}$	-0.122	-0.171	0.0408	-2.154**	-2.614**	-0.933	-0.263	0.208	-0.371
	(0.879)	(1.082)	(1.458)	(0.918)	(1.122)	(1.542)	(1.437)	(1.990)	(2.117)
$ExpReg_b$*$Ann_{\tau+5}$	1.213	1.407	0.190	-3.167***	-3.225***	-3.364**	-0.600	-1.003	-0.827
	(0.873)	(1.065)	(1.482)	(0.918)	(1.108)	(1.612)	(1.481)	(2.047)	(2.174)
$ExpReg_b$*$Ann_{\tau+6}$	-0.829	-0.666	-1.439	-3.439***	-3.265***	-4.293**	2.268	0.422	5.076**
	(0.894)	(1.091)	(1.512)	(0.947)	(1.142)	(1.672)	(1.523)	(2.060)	(2.306)
$\ln(\text{Total assets})_{t-1}$	3.836***	2.644***	4.799***	-2.656***	-3.413***	-1.411	4.227***	5.195***	2.446
	(0.627)	(0.795)	(1.052)	(0.959)	(1.157)	(1.758)	(1.180)	(1.599)	(1.785)
Loans-to-asset ratio_{t-1}	-0.026	-0.024	-0.056	-0.147***	-0.134***	-0.189***	0.051	0.004	0.045
	(0.027)	(0.034)	(0.045)	(0.035)	(0.043)	(0.059)	(0.063)	(0.082)	(0.101)
Deposit-to-asset ratio_{t-1}	-0.121***	-0.125***	-0.104***	-0.119***	-0.132***	-0.070	-0.234***	-0.244***	-0.255***
	(0.023)	(0.028)	(0.038)	(0.029)	(0.035)	(0.050)	(0.043)	(0.057)	(0.066)
NPL ratio_{t-1}	-0.171***	-0.120**	-0.256***	-0.086	-0.070	-0.134	0.200*	0.442***	-0.009
	(0.046)	(0.053)	(0.010)	(0.055)	(0.059)	(0.138)	(0.105)	(0.147)	(0.155)
TIER1 ratio_{t-1}	0.238***	0.240***	0.202***	0.138***	0.128***	0.143***	0.270***	0.495***	0.009
	(0.031)	(0.044)	(0.041)	(0.033)	(0.048)	(0.043)	(0.088)	(0.120)	(0.132)
Liquidity ratio_{t-1}	0.070***	0.109***	-0.040	-0.009	0.020	-0.087	0.024	0.182**	-0.235***
	(0.025)	(0.030)	(0.044)	(0.032)	(0.037)	(0.062)	(0.055)	(0.078)	(0.081)
Return on equity_{t-1}	-0.090***	-0.085***	-0.092***	-0.099***	-0.066**	-0.13***	-0.071***	-0.085**	-0.039
	(0.017)	(0.022)	(0.025)	(0.024)	(0.032)	(0.035)	(0.026)	(0.036)	(0.038)
Cost over income_{t-1}	-0.0039	-0.017	0.031*	-0.102***	-0.134***	0.032	0.025**	0.011	0.042*
	(0.009)	(0.010)	(0.018)	(0.024)	(0.027)	(0.043)	(0.011)	(0.013)	(0.023)
Observations	1,285,619	885,569	400,050	853,635	626,796	226,839	422,073	254,055	168,018
R-squared	0.210	0.211	0.205	0.217	0.215	0.224	0.200	0.205	0.194
Number of banks	1,682	1,606	1,596	1,531	1,489	1,477	39	39	39
Number of firms	175,374	153,863	21,511	135,959	120,929	15,030	64,306	48,037	16,269
Cumulative effect on loans of exposed banks since year of regulatory change									
0 years (2011)	-0.469	0.241	-1.820	-1.555*	-1.407	-2.415*	0.656	0.580	0.424
	(0.913)	(1.125)	(1.458)	(0.916)	(1.131)	(1.453)	(1.338)	(1.857)	(1.934)
1 years (2012)	-1.653	-1.326	-1.667	-4.502***	-5.203***	-2.795	0.738	2.616	-2.581
	(1.544)	(1.911)	(2.440)	(1.565)	(1.944)	(2.430)	(2.296)	(3.218)	(3.285)
2 years (2013)	0.237	0.974	-0.820	-5.902***	-6.321**	-5.226	-0.453	1.299	-4.176
	(2.216)	(2.744)	(3.517)	(2.262)	(2.803)	(3.563)	(3.285)	(4.660)	(4.648)
3 years (2014)	-0.490	0.657	-2.384	-8.490***	-9.151**	-7.301	1.031	3.680	-4.417
	(2.895)	(3.580)	(4.632)	(2.979)	(3.681)	(4.764)	(4.298)	(6.068)	(6.144)
4 years (2015)	-0.612	0.486	-2.344	-10.64***	-11.76**	-8.235	0.768	3.888	-4.789
	(3.582)	(4.431)	(5.747)	(3.714)	(4.582)	(5.995)	(5.337)	(7.570)	(7.568)
5 years (2016)	0.601	1.894	-2.154	-13.81***	-14.99***	-11.60	0.168	2.884	-5.616
	(4.282)	(5.290)	(6.911)	(4.466)	(5.491)	(7.307)	(6.436)	(9.139)	(9.097)
6 years (2017)	-0.228	1.227	-3.592	-17.25***	-18.25***	-15.89*	2.436	3.306	-0.540
	(5.003)	(6.174)	(8.102)	(5.247)	(6.431)	(8.698)	(7.567)	(10.71)	(10.73)

The table shows difference-in-difference estimates of the announcement of stricter RBC requirements. The dependent variables are the annual growth rates of outstanding loans to all non-financial firms (ALL) and to the subsamples of SMEs (SME) and large firms (LARGE). Period of investigation: 2010-2017. The key explanatory variables are the exposure dummy, $ExpReg_b$, multiplied by a set of time dummy variables, Ann_τ, $Ann_{\tau+1}$, ..., $Ann_{\tau+6}$ where τ represents the year of the reform (2011). $ExpReg_b$ captures whether a bank's risk-weighted capital ratio was in the lowest decile (P10) in the year prior to the reform (i.e. 2010). The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the bank-firm level and for sector times year. Cumulative effect: coefficient represents the sum of the estimated coefficients between the year of regulatory change and a given year afterwards. The corresponding variance is derived by means of the delta method. Clustered robust standard errors at the firm level in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 4: **Impact of Higher Minimum Risk-based Capital Requirements (RBC) on Collateralization of Non-financial Firms (Bank-Firm Level Data)**

Banks exposed to RBC are defined as banks with a risk-weighted capital ratio below P10 in period prior to the announcement

Banks (credit risk model)	All			Standardized approach			IRBA		
Firms	All	SME	LARGE	All	SME	LARGE	All	SME	LARGE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$ExpReg_b$*Ann_τ (2011)	-0.0457	0.435	-1.616***	0.569**	0.716**	-0.0908	0.780*	-0.302	2.111***
	(0.237)	(0.288)	(0.398)	(0.250)	(0.303)	(0.419)	(0.465)	(0.601)	(0.749)
$ExpReg_b$*$Ann_{\tau+1}$ (2012)	-0.0516	0.363	-1.496***	0.675**	0.848**	-0.0235	7.174***	5.913***	8.397***
	(0.271)	(0.330)	(0.445)	(0.291)	(0.354)	(0.473)	(0.473)	(0.659)	(0.685)
$ExpReg_b$*$Ann_{\tau+2}$ (2013)	0.825***	1.343***	-0.882*	0.406	0.683*	-0.757	10.49***	6.163***	15.94***
	(0.301)	(0.365)	(0.513)	(0.321)	(0.388)	(0.541)	(0.609)	(0.841)	(0.880)
$ExpReg_b$*$Ann_{\tau+3}$ (2014)	2.102***	2.939***	-0.305	0.288	1.114***	-1.771***	12.13***	9.795***	14.79***
	(0.318)	(0.383)	(0.542)	(0.359)	(0.406)	(0.653)	(0.628)	(0.872)	(0.904)
$ExpReg_b$*$Ann_{\tau+4}$ (2015)	2.367***	2.967***	0.318	0.469	0.493	-0.114	15.46***	14.16***	16.87***
	(0.324)	(0.394)	(0.542)	(0.352)	(0.426)	(0.584)	(0.648)	(0.892)	(0.934)
$ExpReg_b$*$Ann_{\tau+5}$ (2016)	2.318***	2.884***	0.418	0.0861	0.162	-0.732	14.84***	13.53***	16.13***
	(0.336)	(0.407)	(0.572)	(0.364)	(0.438)	(0.619)	(0.654)	(0.889)	(0.960)
$ExpReg_b$*$Ann_{\tau+6}$ (2017)	1.426***	1.644***	0.482	-0.512	-0.752*	-0.516	16.90***	15.17***	18.52***
	(0.346)	(0.419)	(0.587)	(0.378)	(0.453)	(0.647)	(0.662)	(0.915)	(0.957)
$\ln(\text{Total assets})_{t-1}$	-1.760***	-0.726**	-3.916***	-1.634***	-1.538***	-2.446***	-10.40***	-12.32***	-7.240***
	(0.252)	(0.307)	(0.435)	(0.333)	(0.414)	(0.549)	(0.452)	(0.635)	(0.639)
Loans-to-asset ratio_{t-1}	0.0356***	0.0661***	-0.0309*	0.0147	0.0184	-0.0168	-0.0511**	0.00559	-0.110***
	(0.0100)	(0.0122)	(0.0173)	(0.0118)	(0.0145)	(0.0200)	(0.0240)	(0.0329)	(0.0338)
Deposit-to-asset ratio_{t-1}	-0.0605***	-0.0647***	-0.0432***	0.0252***	0.0129	0.0623***	-0.361***	-0.399***	-0.296***
	(0.00780)	(0.00969)	(0.0132)	(0.00875)	(0.0106)	(0.0152)	(0.0181)	(0.0256)	(0.0248)
NPL ratio_{t-1}	0.200***	0.132***	0.327***	0.0545**	0.0280	0.147***	1.341***	1.586***	0.922***
	(0.0216)	(0.0264)	(0.0391)	(0.0277)	(0.0320)	(0.0553)	(0.0575)	(0.0826)	(0.0783)
TIER1 ratio_{t-1}	-0.281***	-0.289***	-0.266***	-0.0164	0.0212	-0.0726***	-0.964***	-1.100***	-0.756***
	(0.0134)	(0.0182)	(0.0191)	(0.0134)	(0.0192)	(0.0176)	(0.0310)	(0.0436)	(0.0437)
Liquidity ratio_{t-1}	0.0274***	0.0502***	-0.0223	0.0258**	0.0264*	0.0119	0.0344	0.0143	0.0947***
	(0.00925)	(0.0110)	(0.0166)	(0.0109)	(0.0137)	(0.0167)	(0.0213)	(0.0312)	(0.0283)
Return on equity_{t-1}	0.0384***	0.0563***	0.00650	0.0212***	0.0374***	-0.0119	0.162***	0.211***	0.0891***
	(0.00559)	(0.00748)	(0.00817)	(0.00738)	(0.0100)	(0.0106)	(0.00865)	(0.0117)	(0.0126)
Cost over income_{t-1}	0.153***	0.160***	0.126***	-0.0400***	-0.0367***	-0.0616***	0.209***	0.216***	0.178***
	(0.00511)	(0.00595)	(0.00967)	(0.00657)	(0.00714)	(0.0156)	(0.00456)	(0.00527)	(0.00927)
Constant	71.44***	56.53***	102.6***	74.44***	77.61***	74.90***	239.6***	279.6***	174.4***
	(4.576)	(5.454)	(8.212)	(5.351)	(6.682)	(8.685)	(9.061)	(12.75)	(12.71)
Observations	1,625,812	1,138,849	486,963	1,095,010	810,984	284,026	517,085	320,689	196,396
R-squared	0.826	0.805	0.862	0.839	0.808	0.897	0.774	0.754	0.808
Number of banks	1,712	1,647	1,637	1,540	1,505	1,498	40	39	40
Number of firms	211,479	188,473	23,006	166,787	150,519	16,268	75,911	58,350	17,561

The table shows difference-in-difference estimates of the announcement of stricter RBC requirements on the share of collateralization. Period of investigation: 2010-2017. The key explanatory variables are the exposure dummy, $ExpReg_b$, multiplied by a set of time dummy variables, Ann_τ, $Ann_{\tau+1}$, ..., $Ann_{\tau+6}$ where τ represents the year of the reform (2011). $ExpReg_b$ captures whether a bank's risk-weighted capital ratio was in the lowest decile (P10) in the year prior to the reform (i.e. 2010). The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the bank-firm level and for sector times year. Clustered robust standard errors at the firm level in parentheses, *** p<0.01, ** p<0.05, * p<0.1

4.2 Leverage ratio

The introduction of the leverage ratio was announced and legally implemented in Germany in the second quarter of 2015. We therefore use the 2014 figures for the leverage ratio to measure the extent to which banks were affected by the new regulation.

Bank level results
The regression results based on bank level data are reported in tables 5 and A5. The former table contains the results including the exposure measure based on the lowest decile of the unweighted capital ratio ($x <$ P10), whereas the latter refers to an exposure measures based on the lowest quartile ($x <$ P25).

Table 5: **Impact of the Announcement of the Leverage Ratio (LR) on Outstanding Loans to SMEs and Non-financial Firms (Bank Level Data)**
Banks exposed to the LR are defined as banks with a capital ratio below P10 in the period prior to the regulatory change

Banks (credit risk model)	All Banks				Standardized Approach			
Firms	CORP	SME	SME	SME	CORP	SME	SME	SME
Maturity	All	All	Short-term	Long-term	All	All	Short-term	Long-term
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ExpReg_b * Ann_τ	-0.440	1.873	1.912	0.153	-1.029	0.551	1.222	-1.621
	(1.507)	(1.793)	(3.331)	(2.032)	(1.358)	(1.595)	(2.995)	(1.938)
ExpReg_b * $Ann_{\tau+1}$	0.067	-1.693	1.034	-1.255	-0.207	-1.436	3.026	-1.806
	(1.552)	(1.814)	(2.834)	(2.365)	(1.393)	(1.813)	(2.806)	(2.471)
ExpReg_b * $Ann_{\tau+2}$	-0.746	-2.830	3.832	-5.232*	-1.105	-3.768**	2.982	-5.821**
	(1.949)	(2.168)	(3.531)	(2.719)	(1.888)	(1.888)	(3.302)	(2.654)
ExpReg_b * $Ann_{\tau+3}$	-0.342	-3.148	-2.114	-4.611*	-0.415	-1.836	0.999	-2.789
	(1.848)	(2.354)	(3.441)	(2.679)	(1.822)	(2.302)	(3.392)	(2.737)
ExpReg_b * $Ann_{\tau+4}$	0.479	-0.205	-3.109	-1.311	0.814	-0.324	-3.737	-1.614
	(2.136)	(2.456)	(4.334)	(2.362)	(2.184)	(2.466)	(4.355)	(2.292)
$\ln(\text{Total assets})_{t-1}$	-12.737***	-12.751***	-13.382***	-13.396***	-12.167***	-12.779***	-14.173***	-13.513***
	(1.848)	(2.052)	(2.334)	(2.297)	(1.843)	(2.087)	(2.394)	(2.376)
$\text{Loan-to-asset ratio}_{t-1}$	-0.168**	-0.104	-0.111	-0.017	-0.155*	-0.086	-0.096	-0.007
	(0.080)	(0.075)	(0.093)	(0.083)	(0.084)	(0.077)	(0.096)	(0.085)
$\text{Deposit-to-asset ratio}_{t-1}$	-0.104	-0.119*	-0.088	-0.134*	-0.061	-0.114	-0.107	-0.143*
	(0.076)	(0.071)	(0.090)	(0.074)	(0.075)	(0.078)	(0.094)	(0.081)
TIER1 ratio_{t-1}	0.014	0.060	0.072	0.055	0.039	0.053	0.059	0.062
	(0.114)	(0.115)	(0.113)	(0.120)	(0.118)	(0.119)	(0.120)	(0.127)
$\text{Liquidity ratio}_{t-1}$	0.054	0.016	-0.047	0.053	0.064	0.035	-0.036	0.055
	(0.050)	(0.053)	(0.073)	(0.061)	(0.050)	(0.052)	(0.073)	(0.061)
NPL	-0.426***	-0.310*	-0.462**	-0.125	-0.432***	-0.353**	-0.521**	-0.175
	(0.139)	(0.165)	(0.219)	(0.188)	(0.142)	(0.170)	(0.228)	(0.190)
$\text{Return on equity}_{t-1}$	-0.111	-0.053	0.075	-0.098	-0.077	-0.062	0.095	-0.082
	(0.095)	(0.101)	(0.116)	(0.103)	(0.096)	(0.105)	(0.122)	(0.110)
$\text{Cost over income}_{t-1}$	-0.131	-0.177*	-0.095	-0.185**	-0.116	-0.186*	-0.098	-0.159
	(0.096)	(0.094)	(0.095)	(0.093)	(0.102)	(0.102)	(0.107)	(0.103)
Observations	16,057	16,057	16,057	16,057	15,755	15,755	15,755	15,755
R-squared	0.383	0.386	0.291	0.364	0.391	0.382	0.297	0.359
Number of banks	1548	1548	1548	1548	1520	1520	1520	1520
Cumulative effect on exposed banks since year of regulatory change in 2015								
0 years (2015)	-0.440	1.873	1.912	0.153	-1.029	0.551	1.222	-1.621
	(1.507)	(1.793)	(3.331)	(2.032)	(1.358)	(1.595)	(2.995)	(1.938)
1 year (2016)	-0.373	0.181	2.947	-1.102	-1.236	-0.886	4.248	-3.427
	(2.593)	(3.050)	(4.487)	(3.804)	(2.304)	(3.014)	(4.188)	(3.981)
2 years (2017)	-1.119	-2.649	6.779	-6.333	-2.341	-4.654	7.230	-9.248*
	(3.746)	(4.462)	(5.813)	(5.441)	(3.452)	(4.219)	(5.408)	(5.371)
3 years (2018)	-1.461	-5.798	4.665	-10.94	-2.755	-6.489	8.229	-12.04*
	(4.757)	(5.617)	(7.207)	(6.678)	(4.448)	(5.26)	(6.767)	(6.566)
4 years (2019)	-0.982	-6.002	1.556	-12.26	-1.941	-6.813	4.492	-13.65*
	(6.259)	(7.133)	(8.880)	(7.990)	(5.926)	(6.870)	(8.587)	(7.781)

Notes: Dependent variable: annual growth rate of outstanding loans to non-financial firms (CORP) and SMEs (SME). Short-term loans are loans with a maturity up to one year. Long-term loans are loans with a maturity of more than one year. Period of investigation: 2010-2019. Key explanatory variables are the exposure dummy, ExpReg_b, multiplied by a set of time dummy variables, Ann_τ, $\text{Ann}_{\tau+1}$, ..., $\text{Ann}_{\tau+4}$ where τ represents the year of the announcement of the leverage ratio (2015). ExpReg_b captures whether a bank's leverage capital ratio was below P10 in the year prior to the regulatory change, namely 2014. The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the banks level and for region times year. Cumulative effect: coefficient represents the sum of the estimated coefficients between the year of regulatory change and a given year afterwards. The corresponding variance is derived by means of the delta method. Clustered standard errors at the bank level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. *Sources:* BISTA and BAKIS, own calculation.

The estimates in table 5 are predominantly insignificant. For the entire sample, the only two significant estimates are obtained for the impact on long-term SME lending. The

coefficient suggests, that long-term SME lending declines by 5.2 ppts or 4.6 ppts two or three years after the regulatory change, respectively. Both effects are significant at a 10% level. For the sample of banks using the standardized approach, the estimates suggest that SME lending decreases by 3.8 ppts and SME long-term lending by 5.8 ppts two years after the announcement of the leverage ratio. Both effects are significant at a 5% level.

When turning to the cumulative effect of the LR reform on lending by banks with a capital ratio in the lowest decile, the regressions results are insignificant for lending to the entire non-financial sector as well as for SME lending. The same holds for short-term lending to SMEs. When turning to the cumulative effect on long-term SME lending, the estimates for banks using the standardized approach show that long-term loans to SMEs decline by 9.3 ppts two years after the regulatory change at a significance level of 10%. In the two following years, this impact increases to -13.7 ppts at the same significance level. For the whole sample, the cumulative impact on long-term lending to SMEs is insignificant.

Table A5 shows the estimates assessing the impact of the announcement of the leverage ratio in 2015 on SME lending by banks with capital ratios below P25 in the year prior the regulatory change. For both samples, all coefficient estimates, capturing the impact of the LR reform for a specific year, are insignificant. The same holds for the cumulative results reported in the bottom panel of table A5.

To sum up, we may conclude that the introduction of the leverage ratio barely exerted any impact on the reaction of low capitalized banks. We find some evidence that low capitalized banks reduced long-term loans to SMEs after the LR was introduced. However, the estimates suggest that the impact of the announcement of the risk-based capital regulation four years earlier was more pronounced.

Bank-firm level results

Results from bank-firm level data, however, suggest that the introduction of the leverage ratio had some impact (see table 6). Based on the total sample, very low capitalized banks (i.e. banks with a leverage ratio in the lowest decile prior to the announcement) significantly reduced lending after the announcement. The impact accumulates to almost 5 ppts two years after the regulatory change. However, we do not find a significant impact either for the subsample of SMEs or for large firms. Moreover, we do not find an effect for banks with a capitalization in the lowest quartile.

With respect to collateralization, the announcement of the leverage ratio significantly increased collateralization ratios observed at low capitalized banks (see table 7). The impact slightly increases over time, from 2 ppts in 2015 to 3 ppts in 2017. The impact is somewhat more pronounced for large companies than for SMEs (4 ppts for large companies versus 2.3 ppts for SMEs in 2017).

Overall, the LR announcement affected collateralization more weakly than the RBC announcement. At the first glance, it may be to some extent surprising that the LR announcement affected collateralization at all. While a higher collateralization reduces risk weights and improves risk-weighted capitalization, risk weights are irrelevant for the leverage ratio. However, if loan losses occur, collateral can be used to cover (part of the) losses and banks deplete less capital. Therefore, a high collateralization rate helps low capitalized banks to avoid slipping below the minimum leverage ratio requirements even if remarkable unexpected credit losses arise.

Table 6: **Impact of Leverage Ratio (LR) on Outstanding Loans to SMEs and Large Firms (Bank-Firm Level Data)**

Banks exposed to the LR are defined as banks with a capital ratio below P10 or P25 in the period prior to the regulatory change

Banks (credit risk model)		All			All	
Firms	All	SME	Large	All	SME	Large
Threshold		P10			P25	
	(1)	(2)	(3)	(4)	(5)	(6)
ExpReg_b*Ann_τ (2015)	-1.615**	-1.363	-1.493	-0.401	-0.695	0.316
	(0.646)	(0.907)	(0.934)	(0.477)	(0.622)	(0.762)
ExpReg_b*$\text{Ann}_{\tau+1}$ (2016)	-1.193*	-0.802	-0.853	0.0416	0.185	0.354
	(0.646)	(0.874)	(0.968)	(0.472)	(0.605)	(0.776)
ExpReg_b*$\text{Ann}_{\tau+2}$ (2017)	-1.885***	-1.561	-1.572	0.365	0.385	0.745
	(0.720)	(0.977)	(1.071)	(0.500)	(0.650)	(0.802)
$\ln(\text{Total assets})_{t-1}$	3.440***	2.350***	4.327***	3.767***	2.553***	4.857***
	(0.622)	(0.793)	(1.026)	(0.632)	(0.808)	(1.034)
Loan-to-asset ratio_{t-1}	-0.0297	-0.0298	-0.0523	-0.0267	-0.0279	-0.0449
	(0.0266)	(0.0331)	(0.0445)	(0.0270)	(0.0336)	(0.0452)
Loan-to-deposit ratio_{t-1}	-0.122***	-0.125***	-0.106***	-0.122***	-0.126***	-0.106***
	(0.0225)	(0.0282)	(0.0375)	(0.0225)	(0.0282)	(0.0374)
TIER1 ratio_{t-1}	0.222***	0.227***	0.188***	0.229***	0.233***	0.203***
	(0.0306)	(0.0438)	(0.0410)	(0.0310)	(0.0444)	(0.0419)
Liquidity ratio_{t-1}	0.0579**	0.0992***	-0.0526	0.0654***	0.102***	-0.0384
	(0.0247)	(0.0298)	(0.0441)	(0.0247)	(0.0298)	(0.0440)
NPL ratio_{t-1}	-0.166***	-0.117**	-0.257***	-0.171***	-0.121**	-0.260***
	(0.0463)	(0.0524)	(0.0976)	(0.0463)	(0.0524)	(0.0975)
Bank ROE_{t-1}	-0.0944***	-0.0897***	-0.0954***	-0.0935***	-0.0888***	-0.0927***
	(0.0167)	(0.0223)	(0.0254)	(0.0167)	(0.0223)	(0.0254)
Cost over income_{t-1}	-0.00462	-0.0171*	0.0301*	-0.00339	-0.0162	0.0331*
	(0.00897)	(0.0103)	(0.0181)	(0.00901)	(0.0103)	(0.0181)
Observations	1,284,385	885,099	399,286	1,284,385	885,099	399,286
R-squared	0.209	0.211	0.204	0.209	0.211	0.204
Number of banks	1,683	1,606	1,596	1,683	1,606	1,596
Number of firms	175,316	153,826	21,490	175,316	153,826	21,490
Cumulative effect on loans of exposed banks since year of regulatory change						
0 years (2015)	-1.615**	-1.363	-1.494	-0.401	-0.695	0.316
	(0.647)	(0.907)	(0.934)	(0.477)	(0.622)	(0.762)
(1 year) 2016	-2.808***	-2.165	-2.346	-0.359	-0.511	0.670
	(1.038)	(1.402)	(1.567)	(0.766)	(0.977)	(1.27)
2 years (2017)	-4.693***	-3.726*	-3.919*	0.006	-0.125	1.415
	(1.495)	(1.997)	(2.276)	(1.091)	(1.387)	(1.816)

The table shows difference-in-difference estimates of the announcement of the LR. The dependent variables are the annual growth rates of outstanding loans to all non-financial firms (ALL) and to the subsamples of SMEs (SME) and large firms (LARGE). Period of investigation: 2010-2017. The key explanatory variables are the exposure dummy, ExpReg_b, multiplied by a set of time dummy variables, Ann_τ, $\text{Ann}_{\tau+1}$, $\text{Ann}_{\tau+2}$ where τ represents the year of the reform (2015). ExpReg_b captures whether a bank's leverage ratio was in the lowest decile (P10) or in the lowest quartile (P25) in the year prior to the reform (i.e. 2014). The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the bank-firm level and for sector times year. Cumulative effect: coefficient represents the sum of the estimated coefficients between the year of regulatory change and a given year afterwards. The corresponding variance is derived by means of the delta method. Clustered robust standard errors at the firm level in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table 7: **Impact of Leverage Ratio (LR) on Collateralization (Bank-Firm Level Data)**

Banks exposed to the LR are defined as banks with a capital ratio below P10 or P25 in the period prior to the regulatory change

Banks (credit risk model)		All			All	
Firms	All	SME	Large	All	SME	Large
Threshold		P10			P25	
	(1)	(2)	(3)	(4)	(5)	(6)
ExpReg_b*Ann_τ (2015)	2.381***	1.784***	2.930***	1.003***	0.151	2.260***
	(0.240)	(0.289)	(0.391)	(0.221)	(0.202)	(0.435)
ExpReg_b*$\text{Ann}_{\tau+1}$ (2016)	2.238***	1.964***	2.452***	1.448***	1.166***	1.892***
	(0.256)	(0.321)	(0.401)	(0.233)	(0.228)	(0.444)
ExpReg_b*$\text{Ann}_{\tau+2}$ (2017)	3.178***	2.300***	4.109***	1.749***	1.529***	2.095***
	(0.290)	(0.367)	(0.446)	(0.250)	(0.256)	(0.465)
$\ln(\text{Total assets})_{t-1}$	-1.101***	-0.303	-2.897***	-0.952***	-0.117	-2.838***
	(0.246)	(0.308)	(0.399)	(0.240)	(0.311)	(0.375)
Loan-to-asset ratio_{t-1}	0.0243**	0.0522***	-0.0375**	0.0353***	0.0585***	-0.0158
	(0.00984)	(0.0119)	(0.0172)	(0.00962)	(0.0121)	(0.0155)
Loan-to-deposit ratio_{t-1}	-0.0523***	-0.0560***	-0.0364***	-0.0542***	-0.0577***	-0.0375***
	(0.00762)	(0.00952)	(0.0126)	(0.00764)	(0.00952)	(0.0126)
TIER1 ratio_{t-1}	-0.284***	-0.303***	-0.252***	-0.271***	-0.293***	-0.231***
	(0.0131)	(0.0182)	(0.0180)	(0.0129)	(0.0183)	(0.0167)
Liquidity ratio_{t-1}	0.0420***	0.0575***	0.00430	0.0413***	0.0570***	0.00252
	(0.00901)	(0.0110)	(0.0152)	(0.00875)	(0.0110)	(0.0139)
NPL ratio_{t-1}	0.193***	0.125***	0.323***	0.200***	0.128***	0.339***
	(0.0215)	(0.0264)	(0.0386)	(0.0215)	(0.0263)	(0.0390)
Bank ROE_{t-1}	0.0381***	0.0539***	0.00968	0.0396***	0.0554***	0.0132*
	(0.00560)	(0.00747)	(0.00816)	(0.00555)	(0.00745)	(0.00803)
Cost over income_{t-1}	0.153***	0.159***	0.127***	0.155***	0.161***	0.131***
	(0.00508)	(0.00590)	(0.00959)	(0.00510)	(0.00596)	(0.00937)
Constant	60.64***	50.18***	84.55***	57.49***	46.75***	82.20***
	(4.455)	(5.489)	(7.450)	(4.323)	(5.571)	(6.838)
Observations	1,624,444	1,138,311	486,133	1,624,444	1,138,311	486,133
R-squared	0.826	0.804	0.862	0.825	0.804	0.862
banks	all	all	all	all	all	all
firms	all	SME	Large	all	SME	Large

The table shows difference-in-difference estimates of the announcement of the LR on the share of collateralization. Our key explanatory variables are the exposure dummy, ExpReg_b, multiplied by a set of time dummy variables, Ann_τ, $\text{Ann}_{\tau+1}$, $\text{Ann}_{\tau+2}$, where τ indicates the year of the announcement of LR (2015). ExpReg_b measures whether a bank was affected by the change in regulation. It captures whether a bank's leverage ratio was in the lowest decile (P10) or in the lowest quartile (P25) in the year prior to the announcement, i.e. 2014. The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the bank-firm level and for sector times year. Clustered robust standard errors at the firm level in parentheses, *** p<0.01, ** p<0.05, * p<0.1

5 Conclusion

This paper examines how Basel III capital rules affected bank lending in Germany. We investigate two elements of Basel III rules: i) stricter risk-based capital regulation (RBC), i.e. equity over risk weighted assets and ii) the introduction of the leverage ratio (LR) which is, simply speaking, equity over (non-risk-weighted) total assets. We measure the impact on lending growth, loan maturities and collateralization and distinguish between small and large companies. Moreover, we use two different datasets, one at the bank level and one at the bank-firm level, which complement each other.

We use a difference-in-difference approach to quantify the impact of Basel III. Since Basel III applies to all banks, we focus on the relative capital strength of banks prior to the announcement to measure whether a bank is affected or not. We classify banks in the lowest decile (or quartile) as affected banks.

The results provide robust evidence that the announcement of RBC in 2011 significantly affected corporate lending and collateralization of low capitalized banks. The reaction depends on the bank's approach to determining risk weights, namely the standardized approach (SA) or an internal ratings based approach (IRBA). Low capitalized banks using the standardized approach significantly cut lending to non-financial firms. Thereby, lending to SMEs declined more strongly than lending to non-SMEs. In contrast to SA banks, low capitalized IRBA banks did not adjust lending volumes, but significantly increased collateralization. The impact on collateralization differs between SMEs and large companies, where the impact on larger firms is more substantial. However, SA banks adjusted collateralization only slightly.

The reason why IRBA banks adjust collateral instead of lending volumes is probably the broader range of eligible collateral. While SA banks can only use collateral in the form of financial assets or guarantees to reduce risk weights of loans, more types of assets are recognized for IRBA banks, in particular physical assets too. Hence, IRBA banks can more easily improve risk-weighted capitalization by requiring more collateral. From a supervisory perspective, it is primarily important that banks have a buffer against unexpected credit losses, either in the form of capital or by selling collateral. However, from an economic and financial stability perspective, requiring more collateral seems less detrimental than cutting loans (under the assumption that lenders are creditworthy). In this respect, the IRB approach may offer an advantage.

In contrast to the observed impact of the RBC reform, the introduction of the leverage ratio affected lending and collateralization to only a minor extent. We find some evidence that low capitalized banks reduced lending to SMEs, in particular long-term lending. Furthermore, low capitalized banks somewhat tightened collateral requirements, especially for large companies. However, the effects of the leverage ratio on SME lending are much smaller in magnitude than the effects observed for the announcement of the RBC reform.

Generally, the results show that the RBC reform in 2011 affected non-financial corporate lending more than the introduction of the leverage ratio in 2015. The difference in when these reforms occurred could be the reason why low capitalized banks tended to react to the adjustment of risk-weighted capital requirements rather than to the introduction of the leverage ratio. This assumption could be tied to the aim of increasing banks' capital basis in response to the global financial crisis.

Moreover, we compare lending activities of banks with a capitalization below a chosen

threshold, i.e. low capitalized banks, to banks with capitalization above this threshold. Thus, the observed effects can only be interpreted as a relative effect between both groups of banks. Hence, the empirical approach does not allow us to draw conclusions on aggregate lending. Our finding that low capitalized banks reduced SME lending, can be interpreted in two different ways with respect to aggregate bank lending. On the one hand, the decline of SME lending by low capitalized banks could be absorbed by better capitalized banks without affecting aggregate credit supply. Such a shift to better capitalized banks may even be beneficial from a financial stability perspective. On the other hand, the decline in SME lending of low capitalized banks could not be substituted by well-capitalized banks. In such a case, the results would indicate that higher capital requirements would lead to an aggregate drop in SME lending. As shown above, the empirical and theoretical literature predominantly shows that stricter capital requirements reduce lending, at least temporarily. In this context, we may assume that the latter assumption - that aggregate SME lending is negatively affected - might hold for the RBC reform.

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A Tables

Table A1: Descriptive statistics

Variables	Source	Mean	Sd	Median	Observations	Banks
Dependent variables						
Annual growth rate of loans to non-financial sector in % (bank level)						
All	BISTA	5.378	12.27	4.352	16,466	1,660
SME	BISTA	3.627	13.06	2.404	16,466	1,660
SME Short-term	BISTA	-2.198	24.12	-3.393	16,466	1,660
SME Long-term	BISTA	4.043	14.22	2.894	16,466	1,660
Annual growth rate of loans to non-financial sector in % (bank-firm level)						
All	MiMiK	-6.61	64.08	-4.06	1,285,619	1,238
SME	MiMiK	-7.79	65.97	-5.11	885,569	824
large	MiMiK	-4.00	59.61	-2.51	400,050	414
Share of Collateralization in % (bank-firm level)						
All	MiMiK	44.92	43.26	41.12	1,625,812	1,712
SME	MiMiK	49.14	42.67	53.03	1,138,849	1,147
large	MiMiK	35.04	43.02	0.00	486,963	565
Bank control variables						
ln(total assets in EUR)	BISTA	20.23	1.482	20.18	16,466	1,660
Loan-to-asset ratio in %	BISTA	59.42	14.10	60.54	16,466	1,660
Deposit-to-asset ratio in %	BISTA	71.76	11.85	73.91	16,466	1,660
Tier 1 capital ratio in %	BAKIS	14.02	7.424	12.79	16,466	1,660
Liquidity ratio	BISTA	27.84	12.51	26.93	16,466	1,660
Non-performing loans in %	BAKIS	4.601	4.736	2.912	16,466	1,660
Return on equity in %	GuV	16.04	8.874	15.49	16,466	1,660
Total costs to revenue in %	GuV	80.39	14.83	78.67	16,466	1,660

Table A2: **Impact of the Announcement of Risk-based Capital Requirements (RBC) on Outstanding Loans to SMEs and Non-financial Firms (Bank Level data)**

Banks exposed to RBC are defined as banks with a risk-weighted capital ratio below P25 in the period prior to regulatory change

Banks (credit risk model)	All Banks				Standardized Approach			
Firms	CORP	SME	SME	SME	CORP	SME	SME	SME
Maturity	All	All	Short-term	Long-term	All	All	Short-term	Long-term
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ExpReg_b * Ann_τ	0.275	-0.261	-3.164	-0.485	0.468	-0.249	-2.909	-0.578
	(0.763)	(0.799)	(1.939)	(0.850)	(0.733)	(0.788)	(1.942)	(0.845)
ExpReg_b * $Ann_{\tau+1}$	0.179	0.109	-1.589	0.357	0.171	-0.038	-1.839	0.177
	(0.714)	(0.821)	(1.643)	(0.880)	(0.718)	(0.835)	(1.660)	(0.889)
ExpReg_b * $Ann_{\tau+2}$	-0.057	-0.380	2.383	-0.330	0.213	-0.485	2.008	-0.053
	(0.746)	(0.769)	(1.763)	(0.830)	(0.700)	(0.791)	(1.759)	(0.844)
ExpReg_b * $Ann_{\tau+3}$	0.081	-0.428	-0.915	-1.065	0.379	-0.671	-1.280	-1.292
	(0.814)	(0.820)	(1.818)	(0.944)	(0.804)	(0.836)	(1.833)	(0.963)
ExpReg_b * $Ann_{\tau+4}$	-0.418	0.198	1.195	0.180	-0.621	0.155	1.488	0.281
	(0.769)	(0.927)	(1.823)	(0.977)	(0.770)	(0.953)	(1.819)	(0.998)
ExpReg_b * $Ann_{\tau+5}$	0.695	0.576	1.128	0.895	0.575	0.552	0.822	0.818
	(0.823)	(0.974)	(1.883)	(1.053)	(0.826)	(0.974)	(1.912)	(1.078)
ExpReg_b * $Ann_{\tau+6}$	2.967***	1.926*	2.960	2.671**	3.145***	2.159*	4.147*	2.722**
	(1.082)	(1.153)	(2.221)	(1.209)	(1.091)	(1.156)	(2.182)	(1.218)
$\ln(\text{Total assets})_{t-1}$	-11.730***	-11.716***	-13.194***	-12.138***	-11.316***	-11.567***	-13.903***	-12.062***
	(1.894)	(2.159)	(2.469)	(2.353)	(1.930)	(2.191)	(2.543)	(2.423)
$\text{Loan-to-asset ratio}_{t-1}$	-0.178**	-0.084	-0.100	-0.041	-0.182**	-0.081	-0.095	-0.045
	(0.082)	(0.070)	(0.090)	(0.077)	(0.087)	(0.073)	(0.094)	(0.082)
$\text{Deposit-to-asset ratio}_{t-1}$	-0.124*	-0.137**	-0.128	-0.164**	-0.094	-0.139*	-0.175*	-0.162**
	(0.073)	(0.066)	(0.090)	(0.068)	(0.072)	(0.072)	(0.092)	(0.074)
TIER1 ratio_{t-1}	0.040	0.041	-0.008	0.049	0.076	0.028	0.005	0.052
	(0.110)	(0.114)	(0.114)	(0.120)	(0.114)	(0.120)	(0.120)	(0.129)
$\text{Liquidity ratio}_{t-1}$	0.054	0.024	-0.032	0.049	0.051	0.029	-0.041	0.045
	(0.048)	(0.047)	(0.069)	(0.056)	(0.049)	(0.046)	(0.069)	(0.055)
NPL ratio_{t-1}	-0.392***	-0.293**	-0.445**	-0.172	-0.410***	-0.326**	-0.500**	-0.200
	(0.133)	(0.142)	(0.203)	(0.171)	(0.136)	(0.146)	(0.210)	(0.176)
$\text{Return on equity}_{t-1}$	-0.072	-0.058	0.050	-0.116	-0.020	-0.060	0.099	-0.133
	(0.095)	(0.100)	(0.122)	(0.101)	(0.095)	(0.105)	(0.129)	(0.107)
$\text{Cost over income}_{t-1}$	-0.083	-0.165*	-0.097	-0.191**	-0.046	-0.162	-0.069	-0.195**
	(0.094)	(0.093)	(0.101)	(0.091)	(0.099)	(0.100)	(0.114)	(0.099)
Observations	16,466	16,466	16,466	16,466	16,162	16,162	16,162	16,162
R-squared	0.387	0.392	0.291	0.376	0.395	0.392	0.298	0.376
Number of banks	1660	1660	1660	1660	1632	1632	1632	1632
Cumulative effect on exposed banks since regulatory change in 2011								
0 years (2011)	0.275	-0.261	-3.164	-0.485	0.468	-0.249	-2.909	-0.578
	(0.763)	(0.799)	(1.939)	(0.850)	(0.733)	(0.790)	(1.943)	(0.844)
1 year (2012)	0.454	-0.153	-4.753*	-0.127	0.639	-0.287	-4.748*	-0.401
	(1.169)	(1.315)	(2.797)	(1.399)	(1.170)	(1.315)	(2.839)	(1.411)
2 years (2013)	0.398	-0.533	-2.370	-0.458	0.852	-0.772	-2.740	-0.455
	(1.577)	(1.822)	(3.524)	(1.863)	(1.574)	(1.831)	(3.570)	(1.895)
3 years (2014)	0.478	-0.961	-3.285	-1.522	1.231	-1.443	-4.020	-1.747
	(2.066)	(2.262)	(4.503)	(2.433)	(2.052)	(2.271)	(4.556)	(2.491)
4 years (2015)	0.060	-0.763	-2.091	-1.342	0.610	-1.288	-2.532	-1.466
	(2.519)	(2.846)	(5.435)	(3.014)	(2.513)	(2.878)	(5.475)	(3.098)
5 years (2016)	0.755	-0.186	-0.962	-0.447	1.184	-0.735	-1.710	-0.648
	(2.986)	(3.417)	(6.218)	(3.635)	(2.978)	(3.454)	(6.296)	(3.740)
6 years (2017)	3.722	1.739	1.998	2.225	4.329	1.423	2.437	2.074
	(3.483)	(4.008)	(7.323)	(4.171)	(3.485)	(4.049)	(7.358)	(4.288)

Notes: The table shows difference-in-difference estimates of the announcement of stricter RBC requirements. Dependent variable: annual growth rate of outstanding loans to non-financial firms (CORP) and SMEs (SME). Short-term loans are loans with a maturity up to one year. Long-term loans are loans with a maturity of more than one year. Period of investigation: 2010-2019. Key explanatory variables are the exposure dummy, ExpReg_b, multiplied by a set of time dummy variables, Ann_τ, $\text{Ann}_{\tau+1}$, ..., $\text{Ann}_{\tau+6}$ where τ represents the year of the reform (2011). ExpReg_b captures whether a bank's risk-weighted capital ratio was below P25 in the year prior to the regulatory change, namely 2010. The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the bank level and region-times-year level. Cumulative effect: coefficient represents the sum of the estimated coefficients between the year of regulatory change and a given year afterwards. The corresponding variance is derived by means of the delta method. Clustered standard errors at the bank level, *** p<0.01, ** p<0.05, * p<0.1. *Sources:* BISTA and BAKIS, own calculations.

Table A3: **Impact of Higher Minimum Risk-based Capital Requirements (RBC) on Outstanding Loans to Firms - (Bank-Firm Level Data)**
Banks exposed to RBC are defined as banks with a risk-weighted capital ratio below P25 in the period prior to the regulatory change

Banks (credit risk model)	All			Standardized approach			IRBA		
Firms	All	SME	LARGE	All	SME	LARGE	All	SME	LARGE
Threshold		P25			P25			P25	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$ExpReg_b$*Ann_τ	-0.134	0.174	-0.467	-0.202	-0.308	-0.0440	-0.522	0.661	-2.427*
	(0.624)	(0.762)	(1.052)	(0.785)	(0.934)	(1.411)	(1.043)	(1.494)	(1.460)
$ExpReg_b$*$Ann_{\tau+1}$	0.193	0.366	-0.169	-1.605**	-1.785**	-0.716	0.616	1.078	-0.290
	(0.600)	(0.736)	(1.006)	(0.754)	(0.897)	(1.357)	(1.000)	(1.432)	(1.413)
$ExpReg_b$*$Ann_{\tau+2}$	1.165*	1.604**	-0.00140	0.0259	0.568	-1.710	-0.652	-1.189	-0.274
	(0.615)	(0.751)	(1.050)	(0.771)	(0.910)	(1.413)	(1.094)	(1.595)	(1.515)
$ExpReg_b$*$Ann_{\tau+3}$	0.345	0.827	-0.671	-0.912	-0.501	-2.183	-0.343	0.913	-2.417
	(0.621)	(0.753)	(1.088)	(0.776)	(0.911)	(1.461)	(1.117)	(1.571)	(1.617)
$ExpReg_b$*$Ann_{\tau+4}$	0.144	0.167	0.249	-1.923**	-1.900**	-1.636	-0.471	1.015	-1.725
	(0.613)	(0.748)	(1.057)	(0.771)	(0.910)	(1.425)	(1.104)	(1.619)	(1.530)
$ExpReg_b$*$Ann_{\tau+5}$	0.927	0.990	0.463	-1.487*	-1.649*	-1.159	-2.549**	-2.441	-3.150*
	(0.609)	(0.740)	(1.058)	(0.763)	(0.897)	(1.431)	(1.184)	(1.716)	(1.671)
$ExpReg_b$*$Ann_{\tau+6}$	0.0791	-0.218	0.891	-2.228***	-1.959**	-3.088**	-0.348	-0.821	0.0104
	(0.623)	(0.756)	(1.083)	(0.772)	(0.910)	(1.432)	(1.251)	(1.762)	(1.805)
$\ln(\text{Total assets})_{t-1}$	3.765***	2.593***	4.551***	-2.795***	-3.633***	-1.351	4.334***	5.248***	2.456
	(0.625)	(0.796)	(1.034)	(0.953)	(1.150)	(1.744)	(1.201)	(1.645)	(1.799)
Loan-to-asset ratio_{t-1}	-0.0293	-0.0343	-0.0454	-0.145***	-0.133***	-0.189***	0.0633	0.0244	0.0423
	(0.0268)	(0.0333)	(0.0449)	(0.0333)	(0.0411)	(0.0562)	(0.0651)	(0.0845)	(0.104)
Deposit-to-asset ratio_{t-1}	-0.122***	-0.125***	-0.113***	-0.124***	-0.133***	-0.0831*	-0.251***	-0.262***	-0.261***
	(0.0226)	(0.0282)	(0.0378)	(0.0278)	(0.0338)	(0.0485)	(0.0437)	(0.0584)	(0.0660)
NPL ratio_{t-1}	-0.167***	-0.115**	-0.267***	-0.0856	-0.0666	-0.146	0.282**	0.516***	0.0839
	(0.0463)	(0.0524)	(0.0976)	(0.0544)	(0.0586)	(0.137)	(0.111)	(0.158)	(0.161)
TIER1 ratio_{t-1}	0.237***	0.242***	0.199***	0.142***	0.133***	0.144***	0.278***	0.512***	-0.0292
	(0.0305)	(0.0437)	(0.0411)	(0.0326)	(0.0476)	(0.0428)	(0.0896)	(0.122)	(0.136)
Liquidity ratio_{t-1}	0.0674***	0.104***	-0.0402	-0.00434	0.0266	-0.0883	0.00185	0.152*	-0.235***
	(0.0247)	(0.0298)	(0.0441)	(0.0314)	(0.0364)	(0.0618)	(0.0581)	(0.0809)	(0.0847)
Return on equity_{t-1}	-0.0908***	-0.0866***	-0.0902***	-0.0961***	-0.0625**	-0.128***	-0.0825***	-0.0905**	-0.0683*
	(0.0167)	(0.0223)	(0.0252)	(0.0236)	(0.0316)	(0.0352)	(0.0272)	(0.0377)	(0.0395)
Cost over income_{t-1}	-0.00387	-0.0176*	0.0334*	-0.104***	-0.136***	0.0320	0.0208*	0.00979	0.0303
	(0.00900)	(0.0103)	(0.0181)	(0.0235)	(0.0268)	(0.0432)	(0.0110)	(0.0128)	(0.0236)
Observations	1,285,619	885,569	400,050	853,635	626,796	226,839	422,073	254,055	168,018
R-squared	0.210	0.211	0.205	0.217	0.215	0.223	0.200	0.205	0.194
Number of banks	1,682	1,606	1,596	1,531	1,489	1,477	39	39	39
Number of firms	175,374	153,863	21,511	135,959	120,929	15,030	64,306	48,037	16,269
Cumulative effect on loans of exposed banks since year of regulatory change									
0 years (2011)	-0.134	0.174	-0.467	-0.202	-0.308	-0.044	-0.522	0.661	-2.427*
	(0.624)	(0.762)	(1.052)	(0.785)	(0.934)	(1.411)	(1.043)	(1.494)	(1.460)
1 year (2012)	0.059	0.540	-0.637	-1.806	-2.093	-0.760	0.094	1.739	-2.717
	(1.065)	(1.305)	(1.788)	(1.341)	(1.596)	(2.411)	(1.800)	(2.594)	(2.514)
2 years (2013)	1.224	2.144	-0.638	-1.781	-1.525	-2.469	-0.558	0.549	-2.991
	(1.525)	(1.870)	(2.565)	(1.922)	(2.284)	(3.475)	(2.634)	(3.837)	(3.637)
3 years (2014)	1.569	2.971	-1.309	-2.693	-2.027	-4.652	-0.901	1.462	-5.408
	(1.991)	(2.440)	(3.360)	(2.517)	(2.983)	(4.603)	(3.435)	(4.996)	(4.766)
4 years (2015)	1.712	3.139	-1.060	-4.616	-3.926	-6.288	-1.371	2.477	-7.133
	(2.462)	(3.018)	(4.160)	(3.119)	(3.693)	(5.724)	(4.231)	(6.206)	(5.818)
5 years (2016)	2.639	4.129	-0.598	-6.103	-5.575	-7.446	-3.920	0.036	-10.28
	(2.946)	(3.607)	(500)	(3.732)	(4.412)	(6.882)	(5.103)	(7.496)	(7.020)
6 years (2017)	2.718	3.911	0.294	-8.331*	-7.534	-10.53	-4.268	-0.785	-10.27
	(3.444)	(4.212)	(5.857)	(4.358)	(5.148)	(8.051)	(5.981)	(8.761)	(8.266)

The table shows difference-in-difference estimates of the announcement of stricter RBC requirements. The dependent variables are the annual growth rates of outstanding loans to all non-financial firms (ALL) and to the subsamples of SMEs (SME) and large firms (LARGE). Period of investigation: 2010-2017. The key explanatory variables are the exposure dummy, $ExpReg_b$, multiplied by a set of time dummy variables, Ann_τ, $Ann_{\tau+1}$, ..., $Ann_{\tau+6}$ where τ represents the year of the reform (2011). $ExpReg_b$ captures whether a bank's risk-weighted capital ratio was in the lowest quartile (P25) in the year prior to the reform (i.e. 2010). The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the bank-firm level and sector-times-year level. Cumulative effect: coefficient represents the sum of the estimated coefficients between the year of regulatory change and a given year afterwards. The corresponding variance is derived by means of the delta method. Clustered robust standard errors at the firm level in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A4: **Impact of Higher Minimum Risk-based Capital Requirements (RBC) on Collateralization of non-financial firms (Bank-firm Level Data)**

Banks exposed to RBC are defined as banks with a risk-weighted capital ratio below P25 in the period prior to the regulatory change

Banks (credit risk model)	All			Standardized approach			IRBA		
Firms	All	SME	LARGE	All	SME	LARGE	All	SME	LARGE
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$ExpReg_b$*Ann_τ (2011)	0.307*	0.282	0.227	0.319	0.358	-0.0362	2.200***	2.576***	1.381***
	(0.167)	(0.200)	(0.304)	(0.196)	(0.233)	(0.347)	(0.318)	(0.442)	(0.459)
$ExpReg_b$*$Ann_{\tau+1}$ (2012)	1.225***	0.878***	1.891***	0.445**	0.484*	0.134	4.546***	5.108***	3.293***
	(0.189)	(0.230)	(0.324)	(0.226)	(0.269)	(0.394)	(0.345)	(0.493)	(0.486)
$ExpReg_b$*$Ann_{\tau+2}$ (2013)	2.306***	1.672***	3.790***	0.832***	0.923***	0.241	6.895***	5.400***	8.101***
	(0.214)	(0.257)	(0.388)	(0.252)	(0.298)	(0.454)	(0.433)	(0.625)	(0.614)
$ExpReg_b$*$Ann_{\tau+3}$ (2014)	3.604***	3.307***	4.201***	1.022***	1.317***	0.116	7.222***	5.931***	7.881***
	(0.228)	(0.272)	(0.416)	(0.277)	(0.315)	(0.523)	(0.447)	(0.656)	(0.623)
$ExpReg_b$*$Ann_{\tau+4}$ (2015)	4.480***	4.057***	5.224***	1.432***	1.299***	1.248**	9.486***	9.310***	8.635***
	(0.234)	(0.280)	(0.422)	(0.277)	(0.327)	(0.494)	(0.461)	(0.676)	(0.637)
$ExpReg_b$*$Ann_{\tau+5}$ (2016)	4.413***	3.950***	5.229***	1.182***	1.091***	0.796	9.399***	9.311***	8.256***
	(0.240)	(0.288)	(0.433)	(0.286)	(0.336)	(0.514)	(0.493)	(0.724)	(0.676)
$ExpReg_b$*$Ann_{\tau+6}$ (2017)	4.090***	3.395***	5.426***	1.040***	0.769**	1.120**	8.312***	9.225***	6.316***
	(0.250)	(0.300)	(0.444)	(0.298)	(0.351)	(0.532)	(0.510)	(0.753)	(0.696)
$\ln(\text{Total assets})_{t-1}$	-2.271***	-1.144***	-4.587***	-1.724***	-1.594***	-2.670***	-9.306***	-10.62***	-7.376***
	(0.252)	(0.307)	(0.432)	(0.334)	(0.415)	(0.554)	(0.463)	(0.652)	(0.652)
Loan-to-asset ratio_{t-1}	0.033***	0.061***	-0.023	0.029**	0.029**	0.002	-0.047*	0.019	-0.120***
	(0.010)	(0.012)	(0.017)	(0.012)	(0.015)	(0.020)	(0.025)	(0.034)	(0.035)
Deposit-to-asset ratio_{t-1}	-0.070***	-0.069***	-0.063***	0.014*	0.001	0.052***	-0.280***	-0.327***	-0.216***
	(0.008)	(0.010)	(0.013)	(0.009)	(0.011)	(0.015)	(0.018)	(0.026)	(0.025)
NPL ratio_{t-1}	0.200***	0.130***	0.335***	0.0433	0.0191	0.130**	1.163***	1.350***	0.837***
	(0.021)	(0.026)	(0.039)	(0.028)	(0.032)	(0.055)	(0.059)	(0.086)	(0.080)
TIER1 ratio_{t-1}	-0.282***	-0.300***	-0.250***	-0.006	0.030	-0.059***	-0.956***	-1.090***	-0.737***
	(0.014)	(0.018)	(0.019)	(0.013)	(0.019)	(0.018)	(0.033)	(0.045)	(0.047)
Liquidity ratio_{t-1}	0.021**	0.044***	-0.028*	0.026**	0.025*	0.015	0.030	0.021	0.038
	(0.009)	(0.011)	(0.017)	(0.011)	(0.014)	(0.017)	(0.022)	(0.032)	(0.029)
Return on equity_{t-1}	0.045***	0.062***	0.015*	0.022***	0.038***	-0.011	0.169***	0.214***	0.099***
	(0.006)	(0.007)	(0.008)	(0.007)	(0.010)	(0.011)	(0.009)	(0.012)	(0.013)
Cost over income_{t-1}	0.156***	0.163***	0.132***	-0.0343***	-0.032***	-0.054***	0.208***	0.216***	0.177***
	(0.005)	(0.006)	(0.0010)	(0.006)	(0.007)	(0.015)	(0.005)	(0.005)	(0.009)
Observations	1,625,812	1,138,849	486,963	1,095,010	810,984	284,026	517,118	320,705	196,413
R-squared	0.826	0.805	0.862	0.839	0.808	0.897	0.773	0.754	0.807
Number of banks	1,712	1,647	1,637	1,540	1,505	1,498	40	39	40
Number of firms	211,479	188,473	23,006	166,787	150,519	16,268	75,912	58,351	17,561

The table shows difference-in-difference estimates of the announcement of stricter RBC requirements. The dependent variables represent the share of collateralized loans over outstanding loans to all non-financial firms (ALL) and to the subsamples of SMEs (SME) and large firms (LARGE). Period of investigation: 2010-2017. The key explanatory variables are the exposure dummy, $ExpReg_b$, multiplied by a set of time dummy variables, Ann_τ, $Ann_{\tau+1}$, ..., $Ann_{\tau+6}$ where τ represents the year of the reform (2011). $ExpReg_b$ captures whether a bank's risk-weighted capital ratio was in the lowest quartile (P25) in the year prior to the reform (i.e. 2010). The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the bank-firm level and sector-times-year level. Clustered robust standard errors at the firm level in parentheses, *** p<0.01, ** p<0.05, * p<0.1

Table A5: **Impact of the Announcement of the Leverage Ratio (LR) on Outstanding Loans to SME and Non-financial Firms (Bank Level Data)**
Banks exposed to the LR are defined as banks with a capital ratio below P25 in the period prior to the regulatory change

Banks (credit risk model)	All Banks				Standardized Approach			
Firms	CORP	SME	SME	SME	CORP	SME	SME	SME
Maturity	All	All	Short-term	Long-term	All	All	Short-term	Long-term
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
ExpReg_b * Ann_τ	-0.110	0.884	0.910	0.885	-0.380	0.185	0.379	-0.060
	(0.992)	(1.115)	(2.052)	(1.199)	(0.936)	(1.032)	(1.970)	(1.174)
ExpReg_b * $Ann_{\tau+1}$	-0.074	-0.862	-0.486	-0.194	-0.495	-0.974	0.622	-0.497
	(0.991)	(1.084)	(1.980)	(1.261)	(0.939)	(1.064)	(1.965)	(1.279)
ExpReg_b * $Ann_{\tau+2}$	-0.065	0.005	0.897	-0.845	-0.181	-0.432	-0.151	-1.045
	(1.249)	(1.349)	(2.196)	(1.571)	(1.198)	(1.222)	(2.129)	(1.510)
ExpReg_b * $Ann_{\tau+3}$	-0.819	-1.124	0.102	-0.787	-1.363	-1.583	0.767	-0.992
	(1.191)	(1.417)	(2.320)	(1.560)	(1.118)	(1.353)	(2.263)	(1.575)
ExpReg_b * $Ann_{\tau+4}$	0.631	0.081	-1.265	-0.625	0.507	-0.072	-1.721	-0.627
	(1.304)	(1.407)	(2.549)	(1.394)	(1.260)	(1.370)	(2.493)	(1.350)
$\ln(\text{Total assets})_{t-1}$	-12.735***	-12.733***	-13.364***	-13.368***	-12.176***	-12.827***	-14.154***	-13.595***
	(1.848)	(2.052)	(2.332)	(2.299)	(1.841)	(2.082)	(2.389)	(2.376)
$\text{Loan-to-asset ratio}_{t-1}$	-0.168**	-0.104	-0.111	-0.017	-0.155*	-0.087	-0.096	-0.007
	(0.080)	(0.075)	(0.094)	(0.083)	(0.084)	(0.077)	(0.097)	(0.085)
$\text{Deposit-to-asset ratio}_{t-1}$	-0.104	-0.120*	-0.089	-0.136*	-0.060	-0.115	-0.107	-0.144*
	(0.076)	(0.071)	(0.090)	(0.074)	(0.075)	(0.078)	(0.094)	(0.081)
TIER1 ratio_{t-1}	0.014	0.060	0.066	0.059	0.040	0.054	0.052	0.069
	(0.115)	(0.116)	(0.114)	(0.121)	(0.118)	(0.119)	(0.120)	(0.127)
$\text{Liquidity ratio}_{t-1}$	0.054	0.017	-0.048	0.055	0.064	0.035	-0.036	0.057
	(0.050)	(0.053)	(0.073)	(0.061)	(0.050)	(0.052)	(0.073)	(0.061)
NPL ratio_{t-1}	-0.426***	-0.314*	-0.460**	-0.133	-0.433***	-0.357**	-0.519**	-0.184
	(0.138)	(0.165)	(0.219)	(0.187)	(0.142)	(0.169)	(0.228)	(0.189)
$\text{Return on equity}_{t-1}$	-0.111	-0.053	0.073	-0.098	-0.077	-0.061	0.095	-0.081
	(0.095)	(0.101)	(0.116)	(0.103)	(0.096)	(0.105)	(0.122)	(0.111)
$\text{Cost over income}_{t-1}$	-0.131	-0.177*	-0.098	-0.183*	-0.116	-0.186*	-0.100	-0.157
	(0.096)	(0.094)	(0.095)	(0.094)	(0.102)	(0.102)	(0.107)	(0.103)
Observations	16,057	16,057	16,057	16,057	15,755	15,755	15,755	15,755
R-squared	0.383	0.386	0.290	0.363	0.391	0.382	0.297	0.359
Number of banks	1548	1548	1548	1548	1520	1520	1520	1520
Cumulative effect on exposed banks since year of regulatory change in 2015								
0 years (2015)	-0.110	0.884	0.910	0.885	-0.380	0.185	0.379	-0.060
	(0.992)	(1.115)	(2.052)	(1.199)	(0.936)	(1.032)	(1.970)	(1.174)
1 year (2016)	-0.184	0.022	0.424	0.691	-0.874	-0.788	1.001	-0.557
	(1.713)	(1.757)	(2.996)	(2.013)	(1.598)	(1.708)	(2.929)	(2.070)
2 years (2017)	-0.249	0.027	1.321	-0.154	-1.055	-1.220	0.850	-1.602
	(2.473)	(2.586)	(3.730)	(2.952)	(2.315)	(2.429)	(3.604)	(2.881)
3 years (2018)	-1.068	-1.097	1.423	-0.941	-2.418	-2.803	1.618	-2.594
	(3.109)	(3.249)	(4.688)	(3.665)	(2.901)	(3.035)	(4.546)	(3.635)
4 years (2019)	-0.437	-1.016	0.158	-1.566	-1.911	-2.875	-0.104	-3.221
	(3.941)	(4.113)	(5.613)	(4.474)	(3.702)	(3.906)	(5.443)	(4.397)

Notes: Dependent variable: annual growth rate of outstanding loans to non-financial firms (CORP) and SMEs (SME). Short-term loans are loans with a maturity up to one year. Long-term loans are loans with a maturity of more than one year. Period of investigation: 2010-2019. Key explanatory variables are the exposure dummy, ExpReg_b, multiplied by a set of time dummy variables, Ann_τ, $\text{Ann}_{\tau+1}$, ..., $\text{Ann}_{\tau+4}$ where τ represents the year of the announcement of the Leverage Ratio (2015). ExpReg_b captures whether a bank's leverage ratio was below P25 in the year prior to the regulatory change, namely 2014. The regression includes bank control variables, lagged by one year (for a description of the variables, see table A1) as well as fixed effects at the banks level and region-times-year level. Clustered standard errors at the bank level in parentheses, *** p<0.01, ** p<0.05, * p<0.1. *Sources:* BISTA and BAKIS, own calculations.