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Abstract

We study the short-term effects of both tighter and looser bank capital requirements on bank risk-taking in a crisis period. We exploit credit register data matched with firm and bank level data in conjunction with changes in capital requirements stemming from Basel III, including the introduction of a SME supporting bank capital factor in the European Union. We find that tighter capital requirements reduce the supply of bank credit to firms, while looser capital requirements mitigate the credit supply effects of increasing capital. Importantly, at the loan level (credit supply), banks more affected by capital requirements temporarily change less the supply of credit to riskier than to safer firms, and these asymmetric effects occur for both the tightening and the loosening of bank capital requirements. Finally, these effects are also important at the firm-level for total credit availability and for firm survival. Interestingly, our results suggest that those banks most impacted by the tighter Basel III capital requirements prioritize credit among ex-ante riskier firms to avoid their closure, consistent with loan evergreening.

Keywords: bank capital requirements, credit supply, bank risk-taking, Basel III, loan evergreening.

JEL classification: G21, G28.

Resumen

En este trabajo se estudia el efecto a corto plazo de aumentos y reducciones en los requerimientos de capital bancario sobre la toma de riesgo por parte de los bancos en un período de crisis. Para la identificación, se utilizaron los datos de la CIRBE vinculados con los de empresas y bancos, junto con cambios en los requerimientos de capital derivados de Basilea III, incluida la introducción en la Unión Europea de un factor de capital bancario para apoyar a las pymes. Así, se observó que los requerimientos de capital más estrictos reducen la oferta de crédito bancario a las empresas, mientras que los menores requerimientos de capital mitigan este efecto. Es importante destacar que, en cuanto al préstamo (oferta de crédito), los bancos más afectados por los cambios en los requerimientos de capital ajustan, de forma temporal, menos la oferta de crédito a las empresas más arriesgadas que a las más seguras, y estas asimetrías ocurren tanto cuando los requisitos de capital se endurecen como cuando se relajan. Por último, en cuanto a las empresas, dichos efectos son importantes tanto para su disponibilidad total de crédito como para su supervivencia. Es interesante destacar que nuestros resultados sugieren que los bancos más afectados por los requerimientos de capital más estrictos de Basilea III priorizan la oferta de crédito entre las empresas con más riesgo *ex ante* para evitar su cierre, lo que coincide con las teorías de *loan evergreening.*

Palabras clave: requerimientos de capital bancario, oferta de crédito, toma de riesgo bancario, Basilea III, *loan evergreening.*

Códigos JEL: G21, G28.

1. Introduction

Western economies suffered one of their worst banking crises following Lehman Brothers' collapse in 2008, leading to a lasting economic recession that affected all levels of the real economy (see e.g. Jiménez et al, 2017). As a response, regulatory authorities agreed at the international level on a revised prudential regulatory framework to ensure the soundness of the banking system, something key to facilitate the stability of the flow of credit to non-financial firms. The agreed reform strengthened multiple dimensions of the regulatory framework, including the level and quality of bank capital requirements.

As part of the policy cycle, it is crucial to analyze the effects of regulatory reforms and, in this case, it is key to analyze how banks react to the new capital requirements. In this respect, despite that there is ample evidence on the effects of capital requirements on credit supply, the literature on credit supply composition (bank risk-taking) associated to bank capital requirements is scarce, especially on the effects of tightening versus softening of capital requirements on bank risk-taking.

In this paper we analyze the short-term effects of bank capital requirements on banks' behavior by focusing on risk compositional changes in their credit supply (bank risk-taking), including associated firm-level real effects. Importantly, we analyze the effects of both increasing and decreasing bank capital requirements in a crisis period. This is crucial, since the results found would not necessarily have to be observed in contexts of economic prosperity. Moreover, it is important to note that increasing capital requirements offers significant long-term economic benefits that our analysis does not capture. Higher solvency can improve banks' access to market funding and reduce their costs. Additionally, higher capital requirements strengthen the banking system, reducing bank failures and crisis costs, ensuring a stable credit supply. These long-term benefits could more than offset the short-term transitory impacts found in this paper.

Our empirical identification exploits the Basel III implied increase of capital requirements, as well as its relief resulting from the introduction of a SME supporting factor in the European Union (something which was not foreseen in the revised prudential framework agreed at the international level).

Our empirical strategy includes the use of complete administrative datasets which include information on firm and bank level data. We also use the Spanish Credit Registry of loans granted to non-financials firms in Spain. The Spanish Credit Registry has rich data at loan-level for the universe of borrowing firms, including detailed data on bank-borrower credit exposures. We match this credit dataset with other databases that contain the: (i) balance sheet and income statements of banks operating in Spain (information owned by Banco de España in its role of banking supervisor), and (ii) non-financial firms' balance sheets and income statements that Spanish corporations must submit by law to the Spanish Mercantile Register.

Our identification exploits exogenous variation stemming from the introduction of the Basel III framework and, additionally, from specificities of the implementation of Basel III in the European Union. Basel III was announced in December 2010 and reviewed in June 2011. It is important to note that European authorities introduced additional ad-hoc capital requirements for SMEs in January 2014 (which, in the case of Spain, were brought forward to September 2013) with the aim of alleviating the overall regulatory capital
tightening to SMEs.[1] This announcement came as an unexpected capital relief for banks as compared to the baseline approach adopted in the international framework.

We implement a difference-in-difference setting where the exogeneity comes from these new capital requirements set by Basel III and by the European Capital Requirements Regulation (CRR). In this framework we compare the change in loan amounts granted to the same non-financial firm by banks which were differently impacted by new capital rules, before and after the shocks. We thus exploit the existence of cross-sectional differences in banks' capital requirements due to the new tighter (looser) solvency rules by Basel III (CRR). Moreover, the coexistence of both directional shocks allows us to investigate the possible mitigating role of the loosening shock on the tightening one, as

[1] Broadly speaking, this change reduced bank capital requirements for SME exposures by applying an "SME Support Factor" equal to 0.7619, which implied a capital relief as compared to international standards. See the European Banking Authority (2016) report for an overview of this policy, and see also Section 2 of this paper.

well as to analyze whether effects on bank risk-taking are similar or different across both types of capital shocks.

We use firm fixed effects to control for credit demand effects (following Khwaja and Mian, 2008; Jiménez et al, 2012; and Jiménez et al, 2014). For analyzing credit supply compositional risk changes (bank risk-taking), we also use bank fixed effects or industry*province*bank fixed effects to control for the time-invariant unobservable components of both banks and bank-type of firms, respectively. These are relevant controls because, for instance, banks with lower capital levels seem to have a portfolio of riskier firms. Our results are robust to this fact.

Our results show that an increase in banks' capital in response to a tightening in capital requirements implies a decrease in the supply of bank credit to firms. The economic effect is sizeable. The change in the loan amount granted decreases by 8.7% for every percentage point (pp) of increase in the capital ratio (proxied as a leverage ratio in the form of equity over total assets) due to new capital requirements.

Furthermore, we show that there are transitory risk-taking effects on banks' behavior. Those banks that have to increase their capital ratios more due to the new regulation cut the supply of credit more, but with less intensity for firms with higher ex-ante risk.[2] For an interquartile increase of the variable that proxies the risk of the firm, a one pp increase in the capital ratio reduces credit by 7.6% for riskier firms, consistent with loan evergreening purposes.

We also show that when the changes in bank capital requirements imply a capital relief, or capital loosening, then the supply of credit increases. Moreover, the increase of credit supply for riskier firms is lower than for safer firms after the loosening of capital requirements, i.e., similar to capital tightening shocks, the credit supply effects for safer

[2] Ex-ante riskier firms are nevertheless more affected by bank capital changes (i.e., a higher effect of firm risk on change in credit after the change in capital requirements), but we also find that banks more (compared to less) impacted by changes in capital regulation also change less their credit supply to riskier firms than to safer firms.

(compared to riskier) firms are stronger. A capital relief of one pp increases the loan amount three times less for riskier firms (for an interquartile change of this variable) than for the average firm.

Additionally, we document that, for a given bank, the negative effect on credit supply of higher capital requirements is alleviated due to the loosening of bank capital requirements with the introduction of the SME supporting factor.

Finally, at the firm-level, we find evidence that firms cannot offset the loan-level effects of credit supply shocks, and hence those firms that worked more ex-ante with the banks more impacted by the new capital rules face a stronger supply change. For example, after a tightening of capital requirements, a stronger fall in their total bank credit availability, and, consistently a reduction in their probability of firm survival (including an increase in their loan default probability).

However, our results also show that riskier companies with an ex-ante greater relationship with the banks most impacted by Basel III experience a smaller reduction on their overall credit availability and, hence, a reduction of firm closure (despite that these riskier firms show slightly higher default rates than the rest), consistent with the loan level results and with loan evergreening/ zombie lending practices (see Caballero, Hoshi, and Kashyap, 2008). Thus, our results suggest that those banks most impacted by the higher Basel III capital requirements prioritize credit among ex-ante riskier firms to avoid their closure, despite that these firms have higher delinquencies, to avoid the recognition of much greater future loan losses.

Contribution to the literature. Our main contribution to the literature is to show the effects and their interaction of both capital tightening and softening on bank risk-taking (changes in credit supply composition) and their real effects.

In terms of the empirical literature analyzing the increase of capital requirements on banks' behavior, Uluc and Wiedalek (2018) use loan-level data on all new mortgages

issued in UK during 2005-2007, control for loan demand effects using geographical time dummies and exploit the regulatory regime applied by the Financial Services Authority (FSA), which resulted in exogenous shocks to banks' capital requirements. They find that a rise in capital requirements reduce loan size of new mortgages and that this effect is lower for borrowers with a bad credit history. In addition to exploiting both tightening and softening of capital requirements, important differences with respect to our paper are good versus crisis times (2005-07 in U.K. versus post 2010-11 in Spain), empirical identification (e.g. firm fixed effects vs. geographical dummies for controlling for credit demand), individual capital requirements versus Basel III implementation.

Auer, Matyunina and Ongena (2022) use credit register data from the Swiss National Bank (SNB) to capture loan demand using business-type fixed effects and exploit the activation of the Switzerland's countercyclical capital buffer (CCB) in 2012. The differences with our work are similar to those discussed in the previous paper.

More recently, Blattner et al. (2023) analyze how banks reacted to an unexpected capital increase in the context of stress tests by the European Banking Authority. Using the Portuguese credit register they provide evidence of cutting lending and reallocating credit to risky firms (with prior underreported loan loss provisioning). Similarly, Schivardi et al. (2021) using the Italian credit register shows that under-capitalized banks cut credit to healthy firms but not to risky (zombie) firms. However, none of these papers analyze a tightening and softening bank capital shock on credit supply composition (bank risk-taking), the main contribution of our paper to the literature.

The paper is organized as follows. Section 2 describes the data, policy shocks, identification challenges to achieve identification, and our empirical strategy. In Section 3 we describe the results. Section 4 concludes.

2. Data and empirical approach

In this section we describe our data set, the research question, how to analyze it with the sources of data available, and the empirical strategy followed.

2.1 Data sources

The information about the amount granted by current banks is obtained from the Credit Register (CIR) of the Banco de España (which is the owner of this database as the regulator and supervisor of the Spanish banking system). This dataset contains information about all loans above 6,000 euros granted in Spain by all operating banks since 1984 on a monthly frequency, which ultimately makes it a real census of banking loans.

Information firms' characteristics, used as controls and to construct our ex-ante risk measure of firm risk, comes from the Commercial Register. Therefore, the economic and financial information of firms comes from balance sheets and income statements that Spanish corporations must submit yearly, by law, to the Spanish Mercantile Registers. We can merge the CIR dataset with the Commercial Register dataset because both databases contain a unique identifier for each firm, allowing new characteristics of companies to be incorporated into those that already have the CIR (province and industry, for instance). Finally, we also match the CIR with a dataset that contains the balance-sheet and income statement of the Spanish banks at a monthly frequency owned by the Banco de España in its role of banking supervisor.

In the paper, we restrict the sample to non-financial SMEs (which represent more than 90% of all Spanish companies),[3] and to commercial banks, savings banks and credit cooperatives (which represent around 95% of the total system)[4]. We have checked the robustness of the results when credit cooperatives are dropped from the sample and results do not differ neither economically nor statistically.

[3] The definition used to characterize SMEs is the one defined in the EU recommendation 2003/361.
[4] We consider mergers by replicating the structure of late 2015 for the entire sample period.

To measure financial risk of firms we use an industry-based scoring function made of key financial and non-financial variables which are used typically during the granting process of a commercial loan to a SME. This credit rating or scoring function follows the spirit of the classic Z-Score model (Altman, 1968) and uses fifteen financial ratios and firm balance sheet characteristics to assign a score to each company (firm characteristics include financial indebtedness, solvency, liquidity, profitability, expertise, firm structure and credit history).[5]

The sample used in the analysis expands quarterly from 2010Q2-2015Q4. We fix the sample in 2011Q4 as the last period before the capital shocks started and then studied the change of the amount granted at the firm-bank level until the end of 2015, and some quarters before to check whether there is a pre-trend in the data.

2.2 Empirical strategy

The recent global financial crisis has led regulators to the introduction of new capital requirements in the form of macroprudential or microprudential regulations to raise the resilience of the financial system. There is still room to analyze short-run effects on credit supply of these regulations and their measurement implies a great number of challenges. The aim of the paper is to analyze changes in the composition of bank's portfolios in response to demanding tightening of bank capital regulation. We want to test whether higher capital requirements induce banks to shift lending towards riskier borrowers. Besides, we also examine the response of banks to exogenous decreases in capital requirements and the interaction of both measures.

[5] The scoring function segments each of the variables used in up to 9 classes. Each class will have a value between 1 and 9, with 1 being assigned to the lowest risk and 9 to the highest risk. The final score is just the weighted sum of each of the ratings assigned to the firm characteristics analyzed. So, at the end of the process, each company is associated with a continuous measure ranging from 1 to 9, where the higher its value, the higher its likelihood of default. We have checked the validity of this variable as an ex-ante measure of the credit risk of a firm analyzing whether it is a good predictor of the probability of default for one year ahead of non-defaulted firms.

The first challenge we face is the need of disentangling changes in credit demand from concurrent changes in credit supply. After the seminal paper by Khwaja and Mian (2008), the standard in the empirical literature to identify credit supply shocks is the introduction of firm fixed effects. These authors worked at the firm-bank level and, to control for demand, they need to restrict the sample to firms with multiple banking relationships. This is the procedure we will follow in our local empirical strategy where credit growth at the firm-bank level is analyzed. In a cross-sectional analysis firm fixed effects perfectly controls for potentially cofounding demand effects, allowing us to test whether the same firm in a particular month experiences a credit supply shock from banks that were more affected by the new capital requirements. We also check that results are not sample-driven using all the firms and controlling for demand with province and industry dummies.

To address any remaining endogeneity concerns about other simultaneous changes in banks' credit supply, we further include bank fixed effects and bank-level characteristics, which controls for time invariant unobservable and time varying observable supply effects, respectively. This set of fixed effects also addresses concerns about the existence of banks more affected by the crisis. These banks are considered ex-ante more likely to deleverage and to required additional capital. Even so, to fully address this issue, as a robustness check, bail-out banks and those that received funds from the State are excluded and results remain the same (see section 3.1.2).

Finally, policy shocks may not be orthogonal to borrower characteristics. There may be endogenous selection between firms and banks in the sense that less capitalized banks are more likely to be associated with riskier companies. If this is the case, firm fixed effects would alleviate this problem, but unobserved bank-firm variables could still bias our results. We propose the inclusion of industry*province*bank effects to deal with this issue.

The identification in the paper comes from the implementation of Basel III and the introduction of the supporting factor for banks' exposures to SMEs. In Spain there was a

reduction in capital requirements for exposures to SMEs, through the application of a "SME Supporting Factor" equal to 0.7619, anticipating to September (through Law 14/2013) the entry into force of European legislation set for January 2014 (Article 501(1) of CRR).

The focus is on the volume of credit granted to firms by current banks. We perform a difference-in-difference analysis where we compare the lending behavior of the same bank with the same firm before and after the Basel III shock and the SME supporting factor shock, exploiting the heterogeneity of the policy impact among banks (banks were differently affected by the policy depending on their level of capital at the end of 2011, and their capital release after the relaxation of the risk weights to SMEs at the end of 2013).

To ensure that identification is complete, in addition to the set of fixed effects mentioned above, we also capture the strength of the firm-bank relationship by including the length of the relationship. The basic cross-sectional specification followed to analyze the change of the log of credit committed in t with respect 2011Q4 takes the expression:

$$\Delta logCommitment_{ijt} = \beta_1 Scoring_i + \beta_2 Shortage\ of\ Capital_j + \beta_3 Shortage\ of\ Capital_j * Scoring_i + \beta_4 \Delta Capital\ for\ SME\ SF_j + \beta_5 \Delta Capital\ for\ SME\ SF_j * Scoring_i + Other\ controls_{ij} + \eta_{ps} + v_{ijt}, \quad (1)$$

where $\Delta logCommitment_{ijt}$ is the change of the logarithm of committed credit (drawn plus undrawn credit amount, to reduce demand effects) by bank *j* to firm *i* from period 2011Q4 to t (2014Q4 is used as the baseline);[6] *Scoring* captures in a single value the financial risk of a firm one year-ahead (the higher the scoring, the higher the firm risk); *Shortage of* $Capital_j$ is a continuous variable that measures the relative position of bank *j* to Basel III capital requirements as of December 2011 (a detailed description is provided below); Δ*Capital for SME* SF_j is the change in the capital ratio (total capital over risk weighted assets) due to the SME supporting factor; η_{ps} are firm's province*industry fixed effects.

[6] By using the aggregated amount of committed credit, we attenuate the demand factor related to credit lines. However, we will also analyze the change in drawn credit as a robustness check.

Other controls$_{ij}$ includes a comprehensive set of other bank characteristics (such as the log of total assets, the ROA, the liquidity ratio, the solvency ratio, the non-performing loan ratio, the weight of construction and real estate loans over business loans or the weight of firm loans over total loans) and bank-firm relationship characteristics (such as the log of one plus the number of months with the bank or the default status of the firm with the bank); and v_{ijt} is the error term.[7] Standard errors are clustered at the firm, province, industry and bank level, and all bank and firm variables are set in 2011Q4 to alleviate endogeneity concerns. The equation is estimated using Ordinary Least Squares.

In Eq. (1) a negative coefficient on *Scoring*$_i$ is expected ($\beta_1<0$), also a negative relationship between the shortage of capital and change in banking supply ($\beta_2<0$), and a positive association between capital release and bank supply ($\beta_4>0$). The shortage of capital is computed two years before the introduction of Basel III in the EU and more than five years before of full compliance of Basel III by banks. We proxy the Basel III fully loaded ratio in terms of the leverage ratio in 2011 using the fact that the leverage ratio is just the product of the Tier 1 ratio and the density ratio (the risk-weighted assets divided by total assets), which denotes the average risk weight per unit of asset:

$$Leverage\ ratio = \frac{Tier\ 1\ capital}{Leverage\ exposure} = \frac{RWA}{Leverage\ exposure} * \frac{Tier\ 1\ capital}{RWA}$$

$$= Density\ ratio * Tier\ 1\ ratio \quad (2)$$

Given that under Basel III banks must meet a minimum Tier 1 capital ratio of 8.5% (plus an additional buffer for global systemic banks (G-SIBs)) and at the same time a minimum of 3% of the leverage ratio, we use the following definition:

$$Shortage\ of\ Capital_j = max(3\%, (8.5\%+1\%I(G\text{-}SIBs)_j)*density\ ratio_j)\text{-}Capital\ ratio_j \quad (3)$$

Since the leverage ratio information under Basel III rules is not available for the period considered, we proxy *Capital ratio* by equity minus goodwill over total assets minus goodwill.[8] Therefore, this gap captures not only the distance of the leverage ratio

[7] The change in credit is winsorized at the 1st and 99th percentile.

[8] This is a good approximation given that the deduction of goodwill is one of the main adjustments to capital under Basel III and the off-balance sheet activity of Spanish banks has been almost non-existent.

of the bank with respect to the minimum required (3%) but also with respect to the capital requirement based on RWAs translated into a leverage ratio measure (by simply multiplying the requirement by the density ratio, as it is described in Eq (2)).

Our main coefficients of interest are β_3 and β_5, which measure the relative impact on credit supply of the capital shortage, by Basel III, and the increase in capital ratios, by the SME supporting factor, depending on the risk of the firm, respectively. If $\beta_3>0$, this will imply that least compliant banks (those with greater capital scarcity and therefore those that will have to make a greater effort in the future to comply with Basel III) will be the ones that change their credit practices towards greater risk. On the contrary, if $\beta_5 \leq 0$ would mean that banks react taking less risk when they increase lending after a capital release ($\beta_3>0$).

Our benchmark model includes firm fixed effects (η_i) to control for demand; and also province*industry*bank fixed effects (η_{psj}), containing bank fixed effects, to control for alternative sources of supply variability and to better isolate the risk-taking effect: [9]

$$\Delta logCommitment_{ijt} = \beta_3 \, Shortage\ of\ Capital_j * Scoring_i + \beta_5 \, \Delta Capital\ for\ SME\ SF_j * Scoring_i + Other\ controls_{ij} + \eta_i + \eta_{psj} + v_{ijt} \quad (4)$$

Eq. (4) exploits the fact that many firms have more than one bank relationship by including firm fixed effects to control for unobserved firm characteristics (Khwaja and Mian, 2008). With this technique, we are comparing the change in loan size for the same firm with different banks. We show that results are not affected by this firm selection.

We also perform an instrumental variable regression. The estimated equation is similar to Eq. (1) and Eq. (4) but *Shortage of Capital*$_j$, is replaced by Δ*Capital ratio*$_{jt}$, the change in the capital ratio from 2011M12 to *t*. Given the endogeneity of this variable we instrument it using *Shortage of Capital*$_j$, at the end of 2011 as instrument. We also instrument the change in the total solvency ratio after the SME change (Δ*Capital Ratio for*

[9] Firm fixed effects absorb all firm variables, while bank fixed effects absorb bank variables. This is the reason why the Shortage of Capital and Scoring variables do not appear in this specification.

SME SF$_j$,) using the simulated relief of capital at the end of 2011 (Δ*Capital for SME SF$_j$*,) based of the credit portfolios of banks. Therefore, the estimated equation is now:

$Second\ Stage$:

$$\Delta logCommitment_{ijt} = \beta_1 \Delta Capital\ ratio_{jt} * Scoring_i +$$

$$+ \beta_2 \Delta Cap.Ratio\ for\ SME\ SF_{jt} * Scoring_i + Other\ controls_{ij} + \eta_i + \eta_{psj} + v_{ijt},$$

$First\ Stages$:

$$\Delta Capital\ ratio_{jt} * Scoring_i = \theta_1 Shortage\ of\ Capital_j * Scoring_i +$$

$$\theta_2 \Delta Cap.SME\ SF_j * Scoring_i + Other\ controls_{ij} + \eta_i + \eta_{psj} + w_{ijt}$$

$$\Delta Cap.Ratio\ for\ SME\ SF_{jt} * Scoring_i = \alpha_1 Shortage\ of\ Capital_j *$$

$$Scoring_i + \alpha_2 \Delta Cap.for\ SME\ SF_j * Scoring_i + Other\ controls_{ij} + \eta_i + \eta_{psj} +$$

$$w_{ijt} \quad (5)$$

Additionally, we also analyze the interaction of both policy shocks including the double interaction of *Shortage of Capital$_j$* with Δ*Capital Ratio for SME SF$_j$* and the triple interaction with *Scoring$_i$*.

Finally, we also analyze the aggregate effect of both policy measures on firm total credit and future firm performance (future default and future firm closure) estimating the analogous to Eq. (1) but at the firm level. The estimated equation takes the form:

$$\Delta Firm\ Outcome_{it} = \beta_1 Scoring_i + \beta_2 Shortage\ of\ Capital\ for\ average\ bank_i +$$

$$\beta_5 \Delta Capital\ for\ SME\ SF\ for\ average\ bank_j + Other\ controls_i + \eta_{ps} + v_{it} \quad (6)$$

In this equation all bank characteristics refer to the average bank of the firm, computed as the weighted average of the bank characteristics at the firm-bank level using as weights the credit volume between the firm and the bank (as of December 2011). To control for unobserved firm characteristics, we include postal code*industry fixed effects. In line with Eq. (4), we also include interactions between the risk of the firm and the average

bank characteristics. Standard errors are clustered at the level of the postal code, industry and main bank (based on the share of the firm with the banks).

3. Results

3.1.1 Firm-bank level analysis

In this section we explore the impact of both the increase in capital requirements after Basel III and their release after the entry into force of the SME supporting factor, on the amount lent to firms by the banks with which the firm had a relationship before the shock. We start with a sample that includes all firms to later restrict the sample to multiple-bank firms, as our benchmark model includes firm fixed effects.

Table 1 provides summary statistics of the variables used. In this analysis, our dependent variable is the change in total committed amount (drawn plus undrawn amounts) of a firm with a given bank between two periods of time: before and after the announcement of Basel III. For the period 2011 to 2014 the average amount committed decreases by 30% on average, with a standard deviation of 8.7%. Our variable on interest, *Shortage of capital* (which shows the relative solvency position of the bank at the end 2011 with respect of the new capital framework that should enter into force in 2018) has an average and median value of -0.09 with a standard deviation of 2.02. These data show that more than half of the banks considered were undercapitalized under the new Basel III standards. Regarding the capital relief after the introduction of the SME supporting factor, it has an impact of 0.22 pp on average, with the median value being 0.17 pp.

In Table 2 we present estimates of the different specifications using the committed amount as the dependent variable. Estimates are based on Eq. (1) for columns I and II, Eq. (5) for columns IV and VI and Eq. (4) for column V. We start analyzing the effect of the shortage of capital and the SME supporting factor on credit in columns I to IV. Our two first specifications only capture firm heterogeneity through province*industry dummies,

firm-bank controls (length of the relationship together with past and current (Dec-2011) defaults with the bank) and the scoring measure (a proxy for the observable likelihood of the future delinquency of the firm) and differs on the size of the sample. While column I uses all the sample, column II restricts to firms with more than one banking relationship. Results are not statistically different for both columns. For instance, in column I the coefficient on *Scoring* is -0.071***,[10] as expected the higher the risk, the lower the amount committed. In terms of economic impact, an interquartile increase of this variable decreases credit by 6.8%.

The estimated coefficient for the variable that captures the bank' shortage of capital at the end of 2011 is equal to -0.021**, which implies that the bank decreases credit to the firm by 1.7% for an interquartile increase of this variable. The estimated coefficient of the capital increase by the SME supporting factor is 0.400***. This implies a 5.1% increase in credit when this variable increases from the first to the third quartile of its distribution. Results are similar when we restrict the sample to firms with multiple bank relationships (column II).

Column III controls for unobserved firm heterogeneity with firm fixed effects, which absorbs firm's risk variability. The results obtained are similar for our variables on interest although they gain in statistical significance (-0.033** and 0.633***; -2.6% and 8.0%, in terms of the economic impact, respectively). In column IV we explain the change in credit with the change in the capital ratio for the two shocks analyzed. Given the endogeneity of these variables we estimate an instrumental variables regression using as instrument the shortage of capital at the end of 2011 and the estimated change in total capital after the SME supporting factor at the end of 2011.

[10] As in the tables, ***, ** and * indicates statistically significant at the 1, 5 and 10 percent level, respectively.

First, it is worth noting that the estimated coefficients on the instruments are 0.394*** and 1.207***, where the first stage F-test has a value of 14.4 and 700, where the rule of thumb for non-weak instruments is that this statistic should be greater than 10. The effect of the change in the capital ratio on the change in credit is negative and statistically significant (-0.087***), while the effect of the increase in total capital after the SME change is positive and significant (0.376***). This means that every pp of increase in the capital ratio (proxied as a leverage ratio in the form of equity over total assets) decreases the loan amount of the average firm by 8.7%. The overall effect is -0.034 (= -0.087*0.394), a very similar figure to that obtained in column II. Something similar, but in the opposite direction, happens after the reduction of risk weights for SMEs. Regarding the SME supporting factor, a 1 pp increase in the capital ratio due to this measure increase the loan amount by 38% (it must be taken into account that the average increase in capital in the sample is 22 basis points).

In columns V and VI, the risk-taking response by the bank to a shock in capital requirements is tested. Therefore, now we focus our interest on the double interaction between the shortage of capital with respect to Basel III and the release of capital following the SME supporting factor with the scoring variable. To reduce possible bias, all specifications include bank*province*industry fixed effects. In particular, this is an important control to account for potential selection bias among banks and firms, as banks with lower capital levels tend to have greater exposure to higher-risk firms. The introduction of bank fixed effects absorbs all bank variables in levels (in particular, banks' capital shortage and the shock of banks' SME supporting factor). As shown in column V, the estimated coefficient for the interactions equals 0.006** and -0.348***, respectively. This result points out that, although more affected banks by Basel III reduced credit, this reduction is lower among riskier firms (-2.2% for more affected banks and riskier firms, it both cases an interquartile increase), which could be aligned with risk-taking strategies. The

opposite happens as a result of the SME supporting factor shock: banks take less risk. In this case, the increase for more affected banks and riskier firms is 3.8% (compared to 8% for the average company).

Column VI follows the instrumental variables strategy, in line with the one used in column IV, to see whether the increase in capital requirements was the cause behind the risk-taking policy maintained by banks. Results are similar. Now, for riskier firms (interquartile increase) a 1 pp increase in the capital ratio reduce credit by 7.6% instead of the 8.7% for the average firm; and increases it by 11.5% for a 1 pp decrease in the capital ratio.

Figure 1 provides a picture of the risk-taking behavior of banks by showing the estimated coefficient of column V for the different dates keeping fixed the reference year. It is important to first note that a previous trend in the data is not observed. Second, that the compositional effect is transitory: banks started to take on more risk since the mid of 2012 to the end of 2014, once almost all banks have met the new capital requirements.

Summing up, the results suggest that the effort made by banks to meet the new capital requirements had two effects: i) banks' credit supply was constrained; and ii), there was a compositional effect on the supply of credit, causing a temporary shift to higher-risk borrowers. However, if the policy shock was positive for the banks, as it was the release of capital requirements after the reduction of risk weights for SMEs, the credit supply increases and the risk decreases. Results showed are in line with loan evergreening strategies followed by banks more affected by the new more demanding capital requirements of Basel III.

3.1.2 Robustness

Table 3 collects some robustness exercises of column V from Table 2. In column I we introduce loan controls (size of the loan, maturity and whether the loan is

collateralized or not). In column II we replace our dependent variable by the log of change in drawn amount (instead of total amount committed as in the previous analysis). In column III we exclude internationally active banks. Basically, the capital ratio used as a proxy of the solvency rate of the bank is a leverage ratio at individual level (equity minus goodwill over total assets). This can be seen as a good proxy as long as the bank operates locally. This could not the case for the two largest internationally active banks in Spain.

In column IV bailed-out banks or banks that, with public funding support, acquired another bank after 2011M12, were excluded. During the period considered in our study Spain needed the financial assistance of the EU to reform its financial system. The European Financial Stability Facility agreed to provide funds for the recapitalization of the Spanish banking sector. Given that those banks were more likely to deleverage and were required to recapitalize, to disentangle this effect from our results we check the consistency of the baseline model when those banks are not taken into account. This is a very restrictive test because the number of observations decrease by 70%.

Finally, in column V we capture the risk of the firm through its capital ratio (own funds over total assets) as of December 2011, instead our scoring variable. This is a variable observed by all banks because it is taken from the Commercial Register. In summary, in all the cases analyzed we get similar results. We have also tested the robustness of the results to the inclusion of additional cross-effects (bank characteristics times scoring) competing with our double interaction and results remained unchanged.[11]

Furthermore, in the Online Appendix we follow a complementary approach to that used so far to test the robustness of the results on the behavior of banks in the face of an

[11] We also test (although results are not included in the paper) if our results work when our sample includes also big firms. We found that the same results are obtained when larger firms are included. Moreover, given the relevance of construction and real estate firms in the period analyzed, we find that the results found are more relevant for this type of companies, without prejudice to the rest. Finally, we also find that the main results are maintained if the sample is restricted to companies classified as SMEs before the 2013 change (Circular 4/2013, Bank of Spain), when the definition was stricter.

increased in capital requirements. We exploit a database that contains Spanish non-financial firms' loan applications to non-current banks (i.e. banks that are not currently lending to the firm). We analyze whether the likelihood of accepting and granting a loan application changes after December 2011 with Basel III, and whether this also has compositional effects on the supply of bank credit towards riskier borrowers (see Jiménez et al, 2014). This specification also allows us to check whether search for yield strategies occurred as an attempt to increase profitability to accumulate capital through retained earnings and maintain constant ROE.

Briefly, what we find is that an increase in banks' capital in response to a tightening of capital requirements following the publication of Basel III implies a reduction in the probability of granting a loan application by banks to SMEs, and that this decrease was less intensive for firms with higher ex-ante risk (see Tables OA1, OA2 and AO3 and Figure OA1 in the Online Appendix). Moreover, we document that this compositional effect is temporary and that banks face more future defaults arising from those new riskier companies, reduce their grated amount and require them to increase the collateral. All results are compatible with previous findings.

3.1.3 The interaction between tighter and looser bank capital requirements

In Table 4 we analyze how the two policy changes considered so far interact with each other. In column I we start by including the interaction term that links the shortage of capital due to Basel III with the release of capital due to the SME supporting factor. This estimation does not include bank fixed effects because all bank characteristics, included the interaction under study, would be absorbed by the bank's unobserved heterogeneity.

The estimated coefficient on this cross-effect is positive and statistically significant (0.069**), which means that the negative effect on credit of a higher capital requirement is alleviated due to the release of capital after the introduction of SME supporting factor.

Thus, if the average drop in credit for those banks most affected by Basel III is 1.7%, when the bank release capital after the SME supporting factor, this reduction stands at 1% (for interquartile changes). Figure 2 shows the temporal evolution of this coefficient and from it we can conclude that the effect of the supporting factor occurred since the end of 2013, when its introduction took place, and ended a year later, when the impact of Basel III has ceased to have effect.

Columns II and III test whether the SME supporting factor has also a dampening effect on banks' risk-taking strategies. Columns II uses a similar approach to column I, only including firm fixed effects, while column III adds bank*province*industry fixed effects. The estimated coefficient on the triple interaction between the Basel III variable, the SME supporting factor, and the firm risk is insignificant in both specifications. This would indicate that capital release does not affect banks' risk taking, although it would reduce the direct impact of the capital increase after Basel III, as mentioned before. Analogously, Figure 3 shows the estimated time-varying effect of this triple interaction. No significance is observed in the periods analyzed. One could conclude that the size of the capital impact of the SME supporting factor is not large enough to imply an effect on risk-taking.

3.2 Firm level analysis

In this section we analyze the real effects of the policy shocks on firm performance focusing on the change in total bank credit and default. First of all, we want to know whether the effects of the supply shocks found at the local level are maintained at the aggregate level or are offset by firms with the search for new, less affected banks. Secondly, we want to analyze whether changes in banks' credit policies affected the future performance of firms (in terms of probability of future default and firm closure). This would help us answer the question of whether the zombie lending suggested by the results observed at the local level are confirmed, or not.

Table 5 shows the results of the estimation of Eq (6). In the first two columns the change in total credit is analyzed while in the next two columns the effect on the probability of default between 2011 and 2014 is studied, and in columns V and VI the likelihood of firm closure (since 2014 to 2018) is showed. What we observe in terms of the evolution of total credit between 2011 and 2014, is that riskier firms receive less credit, 7.2% less if the risk of the firm increases from the first to the third quartile of its distribution.

In terms of the policy shocks, if the firm worked with banks that had to increase capital due to Basel III, it receives less credit. While if the firm worked with banks that increased capital due to the release after the entry into force of the SME supporting factor, they saw their credit increase. That is, in the analyzed period, firms did not manage to mitigate the negative effects observed at the firm-bank level. Regarding the economic significance, we see that the total credit of the firm that worked with those banks more affected by Basel III (an interquartile increase) decreases by 1.5%, while it increases by 4.0% when worked with banks that increased capital due to the SME supporting factor (always from the first to the third quartile of its distribution).

At an aggregate level, it is observed that riskier firms that work with the banks most affected by regulatory pressure decreased credit less and also that the credit increased less if they work with banks that exogenously released capital (see column II of Table 5). Therefore, the average decrease (increase) of 1.5% (4.0%) is of -0.4% (2.3%) for riskier firms (an interquartile increase of the scoring variable).

Regarding the evolution of the likelihood of default, we observe that riskier firms default more. In particular, in column III of Table 5 we analyze the effect of firm risk profile on future default. The scoring coefficient is positive and highly significant, 0.172***. Since the average default value is 0.20, if the score increases from the first to the third quartile of its distribution, the probability of default increases by 82%. If the

firm worked with banks that were more affected by capital requirements, the probability of default is greater, and lesser if, on the contrary, the firm worked with banks that have seen their capital released. In particular, from column III of Table 5 for firms that worked with banks more affected by Basel III (an interquartile increase), the likelihood of default increases by 6.9%; an even more (8.3%) for riskier firms (as showed in column IV). Otherwise, its decreases by 2.6% when the firm worked with banks more affected by the SME supporting factor (interquartile change).

When we analyze the probability that a company fails, the firm risk is the most relevant variable that explains it. Thus, the probability of business closure increases by 34% for riskier firms (interquartile increase). Similarly, for companies that worked with banks most affected by the higher capital requirements of Basel III, the likelihood of firm closure increases by 2.3% (for an interquartile variation). And what is more relevant is that this probability is significantly lower for riskier firms (0.6% for an interquartile change).

Therefore, in view of the results and in line with Schivardi et al. (2021), there is empirical evidence that the banks most affected by the higher capital requirements of Basel III followed an evergreen lending policy to avoid business closure (in a context of higher defaults) to reduce as much as possible their definitive closure, with the implications of higher loan loss provisions that this fact would require.

All in all, tighter capital requirements reduce credit, which has implications for the future default of firms (and even more when the firms affected by the fall in financing are the riskier ones). This could have important consequences from the point of view of financial stability since it would require more provisions by banks, which would reduce their ability to raise capital.

In turn, the fact that the firms that default the most when faced with a credit supply restriction are the riskier, confirms that the credit policies carried out by banks to reduce

credit less to these borrowers have the objective to prevent having to raise more capital to meet regulatory requirements, which fits with loan evergreening or zombie lending strategies.

4. Conclusions

There is an extensive literature focusing on the impact of capital requirements on bank lending but loan-level analysis focused on banks' appetite for risk are scarce, especially on the impact of both tightening and easing shocks to capital requirements. The analysis to this question is the main contribution of this paper to the literature.

We analyze the Spanish banking sector over the period 2010-2015 and credit granted to non-financial SMEs. Our empirical approach follows a difference-in-difference strategy: the variation in the amount of credit obtained by a firm which was already working with a specific bank before the policy change. The identification comes from the impact of Basel III on credit supply and the introduction of the SME supporting factor that soften capital requirements; importantly, these capital changes impacted banks differentially.

We find that tighter capital requirements during a crisis period reduce the supply of bank credit to firms, while looser capital requirements mitigate the credit supply effects of increasing capital. Importantly, at the loan level (credit supply), banks more affected by capital requirements temporarily change less the supply of credit to riskier than to safer firms, and these asymmetric effects occur for both the tightening and the loosening of bank capital requirements. Finally, these effects are also important at the firm-level for total credit availability and for firm survival. Interestingly, our results suggest that those banks most impacted by the tighter Basel III capital requirements prioritize credit among ex-ante riskier firms to avoid their closure, despite that these firms have higher delinquencies, to avoid the future recognition of much greater loan losses, consistent with loan evergreening.

Importantly, there are relevant economic benefits of increased capital requirements in the long-run which, regrettably, our analysis is not able to capture. Under the new steady state, one could expect an improvement in the access to market funding by banks and a reduction in the cost of this funding given their stronger solvency position. Additionally, increased capital requirements reinforce the banking system thus reducing bank failures and the cost of banking crises, which helps to ensure a more stable credit supply. These long-term effects, which may counterbalance short- and medium-run effects thus resulting in positive effects for the real economy, are beyond the scope of this paper.

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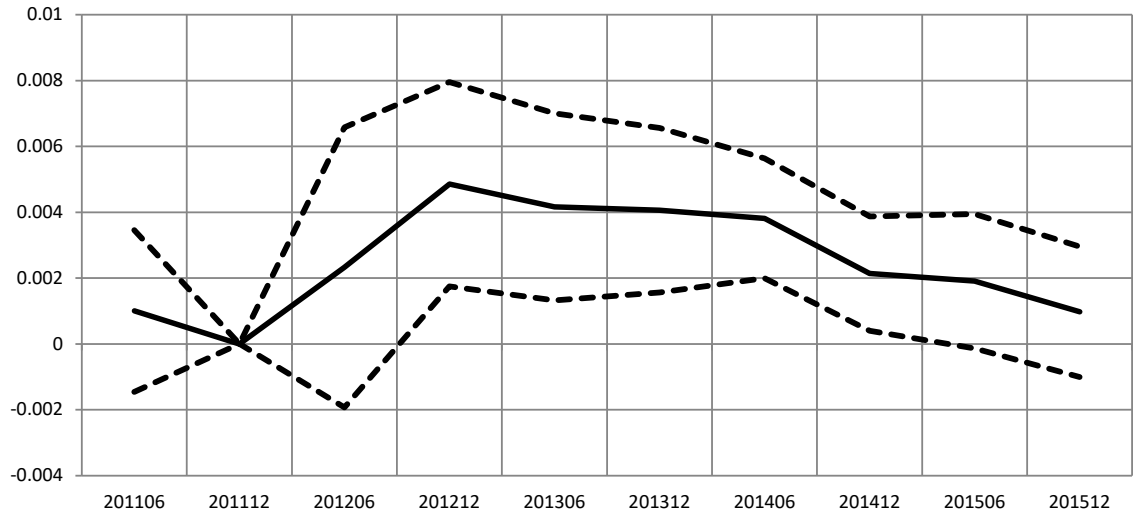
FIGURE 1

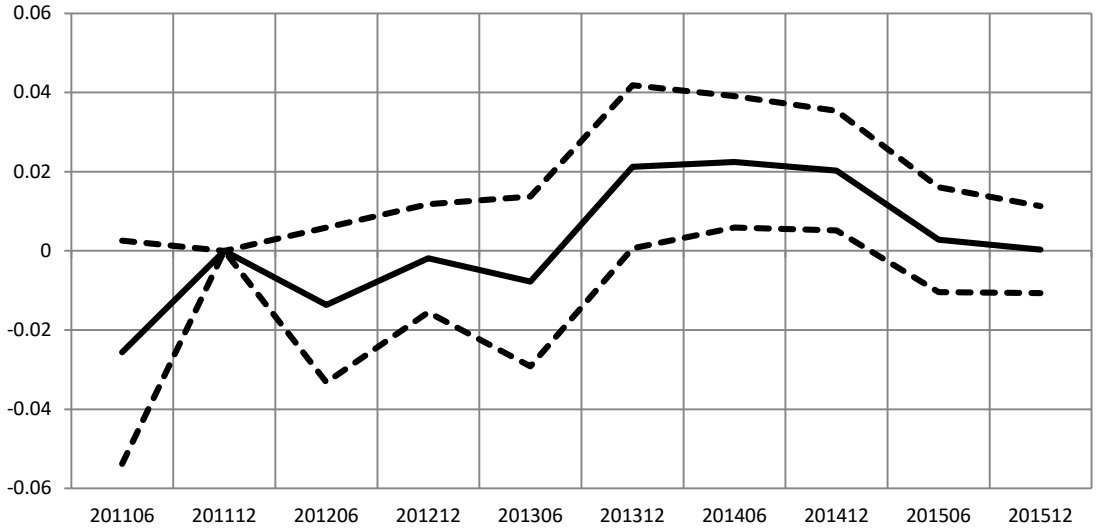
ESTIMATES OF ANNUALIZED TIME-VARYING COEFFICIENTS ON THE INDEPENDENT VARIABLE *SHORTAGE OF CAPITAL$_j$*SCORING$_i$*



Note: the solid line represents the coefficient on *SHORTAGE OF CAPITAL$_j$*SCORING$_i$* in column V of Table 2 for different dates. The dashed lines represent the 90% confidence bands drawn around the coefficient estimates. Higher values of scoring imply higher credit risk.

FIGURE 2

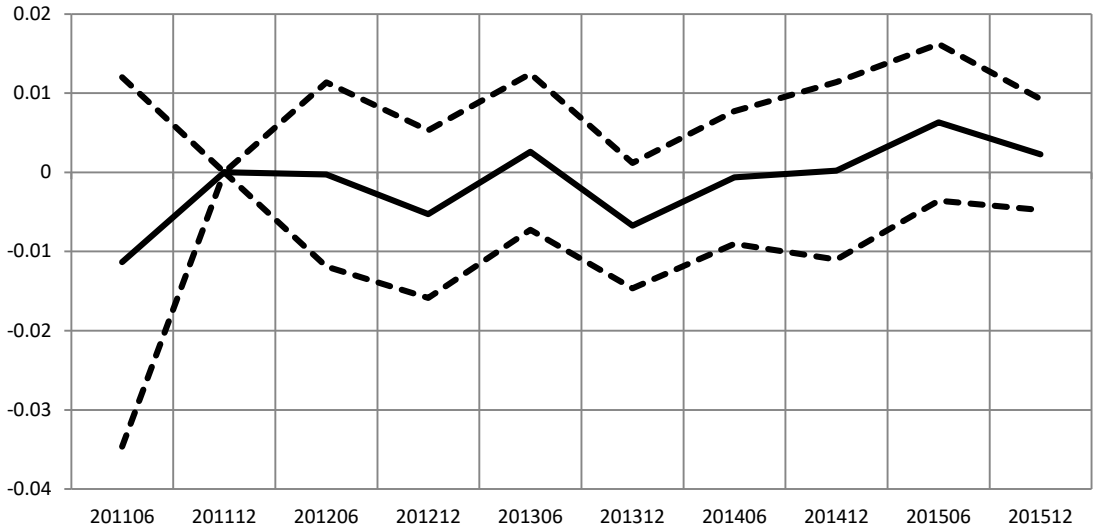
ESTIMATES OF ANNUALIZED TIME-VARYING COEFFICIENTS ON THE INDEPENDENT VARIABLE *SHORTAGE OF CAPITAL$_j$*ΔCAPITAL FOR SME SF$_j$*



Note: the solid line represents the coefficient on *SHORTAGE OF CAPITAL$_j$*ΔCAPITAL FOR SME SF$_j$* in column I of Table 4 for different dates. The dashed lines represent the 90% confidence bands drawn around the coefficient estimates.

FIGURE 3

ESTIMATES OF ANNUALIZED TIME-VARYING COEFFICIENTS ON THE INDEPENDENT VARIABLE *SHORTAGE OF CAPITAL$_j$* ΔCAPITAL FOR SME SF$_j$ * SCORING$_i$*



Note: the solid line represents the coefficient on *SHORTAGE OF CAPITAL$_j$*SCORING$_i$*ΔCAPITAL FOR SME SF$_j$* in column III of Table 4 for different dates. The dashed lines represent the 90% confidence bands drawn around the coefficient estimates. Higher values of scoring imply higher credit risk.

TABLE 1

DESCRIPTIVE STATISTICS OF THE CHANGE IN LOAN AMOUNT

	Unit	Mean	S.D.	Q25	Median	Q75
Firm-Bank Level						
Dependent variables						
ΔLog(COMMITMENT$_{ij}$) (2014Q4-2011Q4)	-	-0.298	0.871	-0.693	-0.238	0.066
ΔLog(DRAWN$_{ij}$) (2014Q4-2011Q4)	-	-0.286	0.969	-0.754	-0.264	0.114
Firm characteristics						
SCORING$_i$	-	3.847	0.911	3.252	3.678	4.206
FIRM CAPITAL RATIO$_i$		0.274	0.240	0.091	0.247	0.429
Bank characteristics						
SHORTAGE OF CAPITAL$_j$	%	-0.090	2.022	-0.659	-0.086	0.143
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$ (2011Q4)	%	0.216	0.129	0.157	0.174	0.283
ΔCAPITAL RATIO$_j$ (2014Q4-2011Q4)	%	0.415	1.545	-0.699	0.758	1.042
ΔCAPITAL RATIO FOR SME SUPPORTING FACTOR$_j$ (2013Q4)	%	0.315	0.167	0.191	0.336	0.379
Ln(TOTAL ASSETS)$_j$	-	19.240	1.272	18.908	18.955	20.358
SOLVENCY RATIO$_j$	%	12.025	2.104	10.448	11.591	12.890
LIQUIDITY RATIO$_j$	%	12.818	3.864	10.861	13.004	16.986
ROA$_j$	%	-0.147	0.862	-0.183	0.177	0.328
DOUBTFUL RATIO$_j$	%	12.486	3.488	10.135	11.812	13.614
PROVISSIONS/INTEREST MARGIN$_j$	%	5.209	5.219	0.681	6.713	8.566
Firm-bank characteristics						
Ln(1+NUMBER OF MONTHS WITH THE BANK)$_{ij}$	-	4.424	1.068	3.892	4.654	5.231
I(PAST DEFAULTS WITH THE BANK)$_{ij}$	0/1	0.105	0.307	0.000	0.000	0.000
I(ACTUAL AND NOT PAST DEFAULTS WITH THE BANK)$_{ij}$	0/1	0.011	0.104	0.000	0.000	0.000
Loan characteristics						
I(MATURITY <1 YEAR)$_{ij}$	0/1	0.397	0.414	0.000	0.245	0.867
I(UNCOLLATERALIZED LOANS)$_{ij}$	0/1	0.728	0.411	0.333	1.000	1.000
Log(LOAN AMOUNT)$_{ij}$	-	4.285	2.256	3.434	4.787	5.765
Firm Level						
Dependent variables						
ΔLog(COMMITMENT$_i$) (2014Q4-2011Q4)	-	-0.462	0.583	-0.793	-0.393	-0.118
DEFAULT$_i$	0/1	0.201	0.401	0.000	0.000	0.000
CLOSURE$_i$	0/1	0.136	0.343	0.000	0.000	0.000
Firm characteristics						
SCORING$_i$	-	3.826	0.925	3.228	3.662	4.183
Average bank characteristics						
SHORTAGE OF CAPITAL$_i$	%	0.035	1.387	-0.540	-0.088	0.227
ΔCAPITAL FOR SME SUPPORTING FACTOR$_i$ (2011Q4)	%	0.210	0.091	0.156	0.194	0.246

Note: The number of observation for the firm-bank level analysis is 183,735, corresponding to 67,820 firms and 43 banks, including commercial banks, savings banks and credit cooperatives. For the firm level analysis, the number of observations is 73,743. The definition of the variables can be found in Appendix 1. Higher values of scoring imply higher credit risk.

TABLE 2

REGRESSION RESULTS OF THE CHANGE IN LOAN AMOUNT.

FIRM-BANK LEVEL

Model	I	II	III	IV	V	VI
Dependent variable	ΔLog(COMMITMENT$_{ij}$)	ΔLog(COMMITMENT$_{ij}$)	ΔLog(COMMITMENT$_{ij}$)	2SLS	ΔLog(COMMITMENT$_{ij}$)	2SLS
SCORING$_i$	-0.071 ***	-0.068 ***				
	(0.009)	(0.010)				
SHORTAGE OF CAPITAL$_j$	-0.021 **	-0.027 **	-0.033 ***	-0.034		
	(0.010)	(0.011)	(0.011)			
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$	0.400 **	0.581 **	0.633 ***	0.454		
	(0.173)	(0.220)	(0.203)			
SHORTAGE OF CAPITAL$_j$*SCORING$_i$					0.006 **	0.008
					(0.003)	
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$*SCORING$_i$					-0.348 ***	-0.333
					(0.072)	
First Stage: ΔCAPITAL RATIO$_j$						
SHORTAGE OF CAPITAL$_j$				0.394 ***		
				(0.104)		
Second Stage: ΔLog(Commitment$_{ij}$)						
ΔCAPITAL RATIO$_j$				-0.087 ***		
				(0.027)		
First Stage: ΔCAPITAL RATIO FOR SME S.F.$_j$						
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$				1.207 ***		
				(0.046)		
Second Stage: ΔLog(Commitment$_{ij}$)						
ΔCAPITAL RATIO FOR SME S.F.$_j$				0.376 **		
				(0.154)		
First Stage: ΔCAPITAL RATIO$_j$*SCORING$_i$						
SHORTAGE OF CAPITAL$_j$*SCORING$_i$						0.629 ***
						(0.092)
Second Stage: ΔLog(Commitment$_{ij}$)						
ΔCAPITAL RATIO$_j$*SCORING$_i$						0.012 *
						(0.007)
First Stage: ΔCAPITAL RATIO FOR SME S.F.$_j$*SCORING$_i$						
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$*SCORING$_i$						1.218 ***
						(0.050)
Second Stage: ΔLog(Commitment$_{ij}$)						
ΔCAPITAL RATIO FOR SME S.F.$_j$*SCORING$_i$						-0.274 ***
						(0.048)
Firm-Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Province*Industry Fixed Effects	Yes	Yes	-	-	-	-
Firm Fixed Effects	No	No	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	-	-	-
Bank*Province*Industry Fixed Effects	No	No	No	No	Yes	Yes
Cluster			Firm, Province, Industry and Bank			
R2	0.09	0.12	0.44	0.44	0.47	0.49
No. observations	308,973	183,735	183,735	183,735	183,735	183,735
No. firms	191,119	67,820	67,820	67,820	67,820	67,820

Note: OLS estimates for the change of the log of credit committed in 2014Q4 with respect 2011Q4. Bank controls include the log of the total assets of the bank, the doubtful ratio of the bank, the solvency regulatory ratio, a liquidity ratio, the ROA, and the ratio of provisions over interest margin. Firm-bank controls include a dummy variable that takes one if the firm has past defaults with the bank and zero otherwise; a dummy variable that takes one if the firm has actual defaults with the bank and zero otherwise; and the log of one plus the number of months since the first relationship between the firm and the bank. Higher values of scoring imply higher credit risk. Coefficients are listed in the first row, robust standard errors that are corrected for multiclustering at the firm, province, industry and bank level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that is not included and "-" that is comprised by the included set of fixed effects. *** Significant at 1%, ** significant at 5%, * significant at 10%.

TABLE 3

REGRESSION RESULTS OF THE CHANGE IN LOAN AMOUNT.

FIRM-BANK LEVEL. ROBUSTNESS

Model	I	II	III	IV	V
Dependent variable	ΔLog(COMMITMENT$_{ij}$)	ΔLog(DRAWN$_{ij}$)	ΔLog(COMMITMENT$_{ij}$)	ΔLog(COMMITMENT$_{ij}$)	ΔLog(COMMITMENT$_{ij}$)
SHORTAGE OF CAPITAL$_j$*SCORING$_i$	0.007 **	0.007 **	0.008 **	0.014 **	
	(0.003)	(0.003)	(0.003)	(0.007)	
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$*SCORING$_i$	-0.349 ***	-0.251 ***	-0.379 ***	-0.400 ***	
	(0.072)	(0.050)	(0.069)	(0.067)	
SHORTAGE OF CAPITAL$_j$*FIRM CAPITAL RATIO$_i$					-0.007 **
					(0.003)
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$*FIRM CAPITAL RATIO$_i$					0.794 ***
					(0.145)
Firm-Bank Controls	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Bank*Province*Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes
Loan Controls	Yes	No	No	No	No
Cluster		Firm, Province, Industry and Bank			
R2	0.48	0.47	0.51	0.54	0.47
No. observations	183,735	162,531	114,075	55,292	183,735
No. firms	67,820	60,062	46,084	24,060	67,820

Note: OLS estimates for the change of the log of credit committed in 2014Q4 with respect 2011Q4. Firm-bank controls include a dummy variable that takes one if the firm has past defaults with the bank and zero otherwise; a dummy variable that takes one if the firm has actual defaults with the bank and zero otherwise; and the log of one plus the number of months since the first relationship between the firm and the bank. Higher values of scoring imply higher credit risk. Coefficients are listed in the first row, robust standard errors that are corrected for multiclustering at the firm, province, industry and bank level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that is not included and "-" that is comprised by the included set of fixed effects. *** Significant at 1%, ** significant at 5%, * significant at 10%.

TABLE 4

REGRESSION RESULTS OF THE CHANGE IN LOAN AMOUNT.

FIRM-BANK LEVEL. THE INTERACTION OF BANK CAPITAL SHOCKS

Model	I	II	III
Dependent variable	ΔLog(COMMITMENT$_{ij}$)	ΔLog(COMMITMENT$_{ij}$)	ΔLog(COMMITMENT$_{ij}$)
SHORTAGE OF CAPITAL$_j$	-0.037 **	-0.039 **	
	(0.015)	(0.015)	
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$	0.815 ***	0.892 ***	
	(0.237)	(0.236)	
SHORTAGE OF CAPITAL$_j$*ΔCAPITAL FOR SME SF$_j$	0.069 **	0.068 **	
	(0.029)	(0.030)	
SHORTAGE OF CAPITAL$_j$*ΔCAPITAL FOR SME SF$_j$*SCORING$_i$		0.003	0.001
		(0.021)	(0.021)
Firm-Bank Controls	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Bank Controls	Yes	-	-
Bank*Province*Industry Fixed Effects	No	No	Yes
Cluster	Firm, Province, Industry and Bank		
R2	0.44	0.44	0.47
No. observations	183,735	183,735	183,735
No. firms	67,820	67,820	67,820

Note: OLS estimates for the change of the log of credit committed in 2014Q4 with respect 2011Q4. Bank controls include the log of the total assets of the bank, the doubtful ratio of the bank, the solvency regulatory, a liquidity ratio, the ROA, and the ratio of provisions over interest margin. Firm-bank controls include a dummy variable that takes one if the firm has past defaults with the bank and zero otherwise; a dummy variable that takes one if the firm has actual defaults with the bank and zero otherwise; and the log of one plus the number of months since the first relationship between the firm and the bank. Higher values of scoring imply higher credit risk. Coefficients are listed in the first row, robust standard errors that are corrected for multiclustering at the firm, province, industry and bank level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that is not included and "-" that is comprised by the included set of fixed effects. *** Significant at 1%, ** significant at 5%, * significant at 10%.

TABLE 5

REGRESSION RESULTS OF THE CHANGE IN LOAN AMOUNT.

FIRM LEVEL

Model	I	II	III	IV	V	VI
Dependent variable	ΔLog(COMMITMENT$_i$)	ΔLog(COMMITMENT$_i$)	DEFAULT$_i$	DEFAULT$_i$	CLOSURE$_i$	CLOSURE$_i$
SCORING	-0.075***	0.399***	0.172***	0.233***	0.048***	0.047***
	(0.008)	(0.144)	(0.005)	(0.034)	(0.005)	(0.005)
AVERAGE SHORTAGE OF CAPITAL	-0.019*	-0.065**	0.018***	0.022***	0.004*	0.004*
	(0.010)	(0.030)	(0.003)	(0.003)	(0.002)	(0.002)
ΔCAPITAL FOR SME SUPPORTING FACTOR	0.445***	0.633	-0.058*	-0.059*	-0.004	-0.003
	(0.158)	(0.549)	(0.030)	(0.032)	(0.025)	(0.026)
SHORTAGE OF CAPITAL*SCORING		0.014**		0.004***		-0.003**
		(0.006)		(0.001)		(0.002)
ΔCAPITAL FOR SME SUPPORTING FACTOR*SCORING		-0.200**		-0.032		-0.009
		(0.094)		(0.023)		(0.015)
Postal Code*Industry Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Average Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Cluster	Postal Code, Industry and Main Bank					
R2	0.259	0.259	0.443	0.444	0.268	0.268
No. observations	73,743	73,743	73,743	73,743	73,743	73,743

Note: OLS estimates for the change of the log of credit committed in 2014Q4 with respect 2011Q4 (columns I and II), the probability of future default of the firm (columns III and IV) and the probability of firm closure (columns V and VI). Average bank controls computed as the weighted average of the bank characteristics using as weights the amount of credit between the firm and the bank. It includes the log of the total assets of the bank, the doubtful ratio of the bank, the solvency regulatory, a liquidity ratio, the ROA, and the ratio of provisions over interest margin. Higher values of scoring imply higher credit risk. Coefficients are listed in the first row, robust standard errors that are corrected for multiclustering at the postal code, industry and main bank (based on the share of the firm with the banks) level are reported in the row below. "Yes" indicates that the set of characteristics or fixed effects is included. *** Significant at 1%, ** significant at 5%, * significant at 10%.

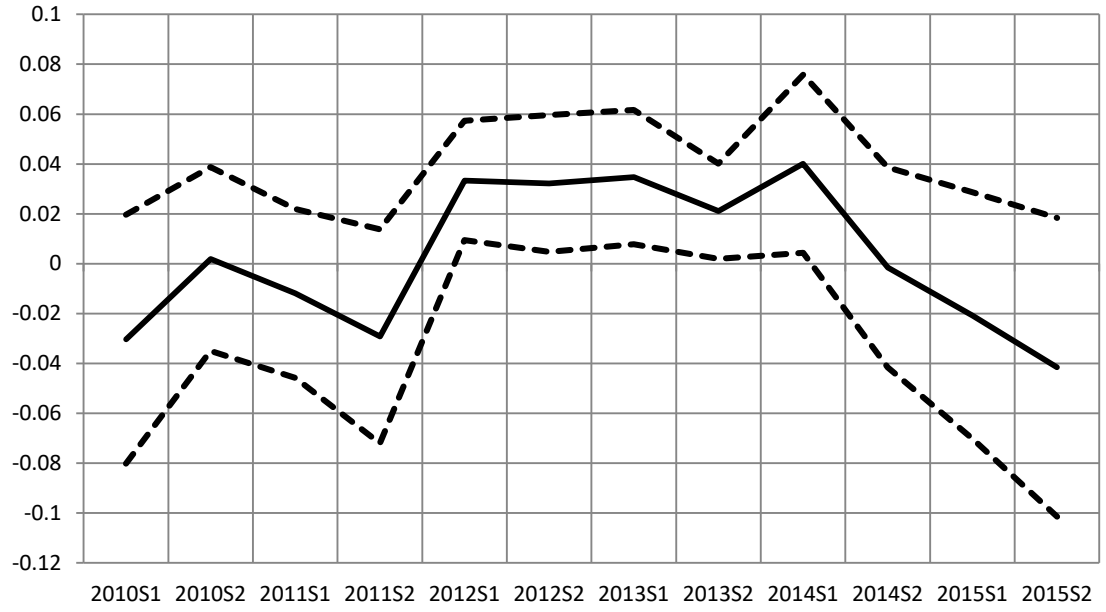
APPENDIX 1

Variable	Definition
Dependent Variables	
ΔLog(COMMITMENT$_{ijt}$)	The change of the log of the committed loan amount of firm i with bank j between 2011 and 2014
DEFAULT$_i$	A dummy variable that takes the value of one if the firm defaults any time between 2011 and 2014, and zero otherwise
CLOSURE$_i$	A dummy variable that takes the value of one if the firm closes any time between 2014 and 2018, and zero otherwise
Other Variables	
Firm Characteristcis	
SCORING$_i$	A continous variable that approaches the solvency risk of firm i at December 2011. The higher its value, the higher the probability of default
CAPITAL RATIO$_i$	The ratio of own funds over total assets of firm i as of Decemberr 2011
Bank characteristics	
ΔCAPITAL RATIO$_j$	The annual change of the capital ratio of bank j between 2011 and 2014
SHORTAGE OF CAPITAL$_{jt}$	A measure which shows the relative solvency position of bank j at the end 2011 with respect to the new capital framework that should enter into force in 2018
ΔCAPITAL FOR SME SUPPORTING FACTOR$_j$	Change in bank j's capital due to the SME supporting factor between 2011 and 2014
Ln(TOTAL ASSETS)$_j$	The log of the bank j's total assets as of December 2011
SOLVENCY RATIO$_j$	The ratio of bank j's capital over risk weighted assets as of December 2011
LIQUIDITY RATIO$_j$	Bank j's liquid assets over total assets as of December 2011
ROA$_j$	The ratio of the bank j's net profits to total assets as of December 2011
DOUBTFUL RATIO$_j$	Non-performing loans (doubtful and 90 days overdue) over total loans of bank j as of December 2011
PROVISSIONS/INTEREST MARGIN$_j$	The ratio of loan loss provissions over bank j's interest margin as of December 2011
Firm-Bank Characteristics	Bank j's liquid assets over total assets as of December 2011
Ln(NUMBER OF MONTHS WITH THE BANK)$_{ij}$	The log of the number of months plus one of firm i with bank j as of December 2011
I(PAST DEFAULTS WITH THE BANK)$_{ij}$	A dummy variable that takes the value of one if firm i had loans inarrears with bank j before December 2011, and zero otherwise
I(ACTUAL AND NOT PAST DEFAULTS WITH THE BANK)$_{ij}$	A dummy variable that takes the value of one if firm i had loans inarrears with bank j at December 2011 and not before, and zero otherwise
Loan Characteristics	Bank j's liquid assets over total assets as of December 2011
I(MATURITY <1 YEAR)$_{ij}$	A dummy variable that takes the value of one if the (average) loan of firm i with bank j has a maturity less than one year, and zero otherwise
I(UNCOLLATERALIZED LOANS)$_{ij}$	A dummy variable that takes the value of one if the (average) loan of firm i with bank j is uncollateralized, and zero otherwise
Log(LOAN AMOUNT)$_{ij}$	The log of the committed loan amount of firm i with bank j as of December 2011

ONLINE APPENDIX

FIGURE OA1

ESTIMATES OF TIME-VARYING COEFFICIENTS ON THE INDEPENDENT VARIABLE $\Delta CAPITAL\ RATIO_{jt-1}*I_t*SCORING_{it-1}$



Note: the solid line represents the coefficient on $\Delta CAPITAL\ RATIO_{jt-1}*SCORING_{it-1}$ in column IV of Table OA2 for different dates. The dashed lines represent the 90% confidence bands drawn around the coefficient estimates.

TABLE OA1

DESCRIPTIVE STATISTICS OF THE EXTENSIVE MARGIN ANALYSIS THAT A LOAN APPLICATION IS GRANTED

	Unit	Mean	S.D.	Q25	Median	Q75
Dependent variables						
I(LOAN APLICATION GRANTED$_{ijt}$)	0/1	0.316	0.465	0.000	0.000	1.000
I(FUTURE DEFAULT)$_{ijt}$	0/1	0.078	0.268	0.000	0.000	0.000
Log(CREDIT AMOUNT)$_{ijt}$	-	4.233	1.083	3.401	4.143	5.011
I(COLLATERAL)$_{ijt}$	0/1	0.043	0.203	0.000	0.000	0.000
I(SHORT TERM MATURITY)$_{ijt}$	0/1	0.733	0.442	0.000	1.000	1.000
Firm characteristics						
SCORING$_{it-1}$	-	3.723	0.745	3.205	3.633	4.126
Bank characteristics						
CAPITAL RATIO$_{jt-1}$	%	6.252	1.944	4.886	6.001	7.420
ΔCAPITAL RATIO$_{jt-1}$	%	0.228	0.749	-0.116	0.196	0.566

Note: The number of observation is 149,136, corresponding to 49,753 firms, 94 dates (year:month) and 59 banks, including commercial banks, savings banks and credit cooperatives. *I(Loan Application Granted)* is a dummy variable which equals one if the loan application made in month *t* to bank *j* by firm *i* is successful and the loan is granted in *t* to *t+3*, and equals zero otherwise. *I(Future Default)* is a dummy variable that takes the value of one if the loan granted in month *t* by bank *b* to firm *i* defaults in a two-year horizon, and zero otherwise. *Log(Credit Amount)* is the logarithm of the committed loan amount granted in months *t* to *t+3* by bank *b* to firm *i* following a succesful application filed in month *t* to bank *b* by firm *i*. *I(Collateral)* is a dummy variable which equals one if the loan granted in month *t* by bank *b* to firm *i* has guarantees, and equals zero otherwise. *Capital Ratio* is the ratio of equity minus goodwill over total assets.

TABLE OA2

REGRESSION RESULTS OF THE EXTENSIVE MARGIN ANALYSIS THAT A LOAN APPLICATION IS GRANTED

Dependent variable: I(LOAN APLICATION GRANTED$_{ijt}$)	I	II	III	IV
SCORING$_{it-1}$	-0.012 *	-0.046 ***	-0.051 ***	
	(.006)	(.009)	(.008)	
ΔCAPITAL RATIO$_{jt-1}$	0.007 **	0.008 ***		
	(.003)	(.003)		
ΔCAPITAL RATIO$_{jt-1}$*I(TIME≥2012M1)$_t$	-0.015 ***	-0.017 ***		
	(.006)	(.006)		
ΔCAPITAL RATIO$_{jt-1}$*(TIME≥2012M1)$_t$*SCORING$_{it-1}$	0.012 **	0.016 ***	0.018 ***	0.019 ***
	(.005)	(.006)	(.005)	(.005)
Year:month Fixed Effects	Yes	Yes	-	-
Bank Fixed Effects	Yes	Yes	-	-
Bank*Year:month Fixed Effects	No	No	Yes	Yes
Industry FE*Province FE*Year:month Fixed Effects	Yes	Yes	Yes	-
Firm Fixed Effects	No	Yes	Yes	-
Firm Fixed Effects*Year:month Fixed Effects	No	No	No	Yes
Cluster		Firm , Bank and Year:month		
R^2	0.27	0.47	0.49	0.52
No. of Firms	49,753	49,753	49,753	49,753
No. of Observations	149,136	149,136	149,136	149,136

Note: This table reports estimates from a linear probability model using ordinary least square for the period 2007M12 to 20015M09. The dependent variable is I(LOAN APLICATION GRANTED$_{ijt}$) which equals one if the loan application made to bank b by firm f at time t is approved by the bank and the loan is granted in month t to t+3, and equals zero otherwise. All regressions include linear and double interaction terms related to the triple interaction showed. Coefficients are listed in the first row, robust standard errors that are corrected for clustering at the indicated level are reported in the row below, and the corresponding significance levels are in the adjacent column. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that is not included and "-" that is comprised by the included set of fixed effects. *** Significant at 1%, ** significant at 5%, * significant at 10%.

TABLE OA3

REGRESSION RESULTS OF THE ANALYISIS OF THE LOAN AMOUNT, MATURITY AND REAL GUARANTEES OF GRANTED LOANS

Dependent variable:	I(FUTURE DEFAULT)$_{ijt}$	Log(CREDIT AMOUNT)$_{ijt}$	I(COLLATERAL)$_{ijt}$	I(SHORT TERM MATURITY)$_{ijt}$
	I	II	III	IV
ΔCAPITAL RATIO$_{jt-1}$*(TIME≥2012M1)$_t$*SCORING$_{it-1}$	0.025 **	-0.078 *	0.017 **	0.030
Bank*Year:month Fixed Effects	Yes	Yes	Yes	Yes
Industry FE*Province FE*Bank FE*Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Loan controls	Yes	Yes	Yes	Yes
Cluster		Firm , Bank and Year:month		
R^2	0.84	0.88	0.79	0.82
No. of Firms	6,771	6,771	6,771	6,771
No. of Observations	17,720	17,720	17,720	17,720

Note. This table reports estimates from a linear model using ordinary least square for column II, and a linear probability model using ordinary least square for columns I, III and IV, for the period 2007M12 to 20015M09. The dependent variables are: I(FUTURE DEFAULT$_{ijt}$), a dummy variable that takes the value of one if the loan granted in month t by bank b to firm f defaults in a two-year horizon, and zero otherwise; Ln(CREDIT AMOUNT$_{ijt}$), the logarithm of the committed loan amount granted in months t to t+3 by bank b to firm f following a successful application filed in month t to bank b by firm f; I(COLLATERAL$_{ijt}$) which equals one if the loan granted in month t by bank b to firm f has guarantees, and equals zero otherwise; and I(SHORT TERM MATURITY), which is a dummy variable that takes the value of one if the loan granted has a maturity lower than one year. All regressions include linear and double interaction terms related to the triple interaction showed. All Coefficients are listed in the first row, robust standard errors that are corrected for clustering at the indicated level are reported in the row below, and the corresponding significance levels are in the adjacent column. "Yes" indicates that the set of characteristics or fixed effects is included, "No" that is not included and "-" that is comprised by the included set of fixed effects. *** Significant at 1%, ** significant at 5%, * significant at 10%.

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